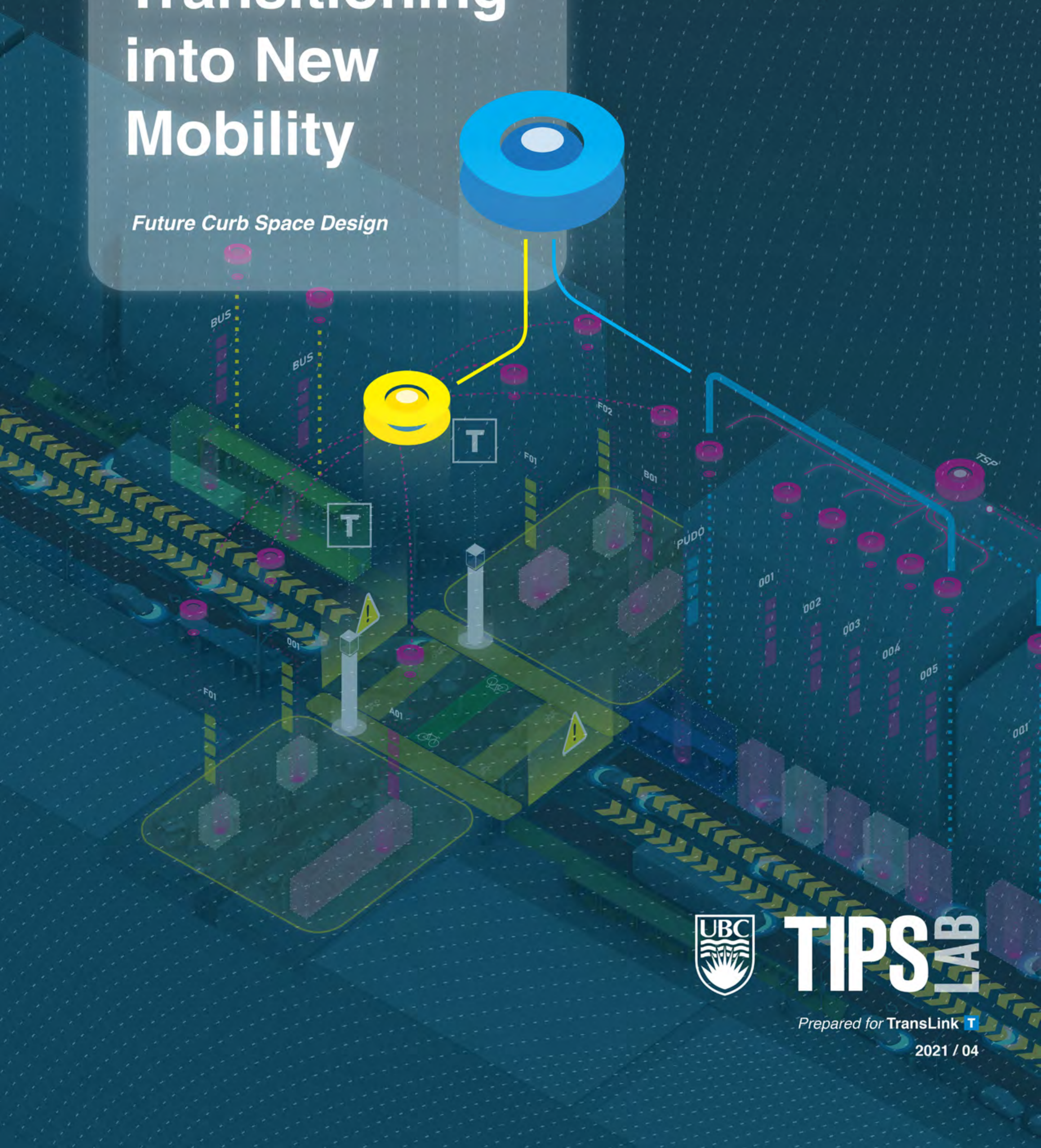
# Transitioning into New Mobility

*Future Curb Space Design*




Prepared for TransLink

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# Transitioning Into New Mobility

*Future Curb Space Design*


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*Cover: Virtual coding of public space and mobility hub design. Image taken from section 4.3.4. Image by TIPSLAB.*

TransLink
Tomorrow

# TransLink

*Taken from TransLink Tomorrow website:*

## *New Mobility Lab*

The New Mobility Lab is our new engagement portal for post-secondary institutions, researchers, and university students.

We provide stable, multi-year funding towards a coordinated program of applied research aimed at answering new mobility related questions of relevance to us and our local government partners.

## *TransLink Tomorrow*

Solutions for a better transportation future. TransLink Tomorrow is our commitment to continuously explore, test, and implement innovative ways to improve mobility in Metro Vancouver.

It is also our commitment to a more open and nimble approach to collaborating with industry, entrepreneurs, and academia. Working together, we can more quickly surface worthwhile new ideas and technologies that:

- Enable seamless and efficient door-to-door mobility for people and goods.
- Promote safe, healthy, clean, and compact communities.
- Ensure affordable and equitable access for all
- From battery electric buses to accessible fare-gates to on-demand micro-transit, TransLink is always looking for new and better and more cost-effective ways to keep the region moving forward.

*www.translink.ca/plans-and-projects/programs-and-studies/translink-tomorrow*

# UBC

The Transportation Infrastructure and Public Space (TIPSlab) is an interdisciplinary research group which examines the potential and implications of future transportation infrastructure. TIPSlab aims to integrate social and ecological concerns into emerging design methodologies.

A collaborative team engaged with current design theories in architecture, landscape architecture, planning and engineering, the lab speculates on future opportunities for infrastructure design and provides grounded scenarios for pulling the future closer.

The lab is based in the School of Architecture and Landscape Architecture and has worked in collaboration with the Sauder School of Business, School of Community and Regional Planning as well as the varied engineering departments at UBC.

*www.tipslabubc.com*

https://blogs.ubc.ca/tipslab/transitioning-into-new-mobility/

# Abstract

As new mobility technologies continue to disrupt how people move around and provide more transportation options and greater certainty on schedules and availability, municipalities and transportation authorities must also engage this technology and learn to manage it for both their own and their citizen's benefit. This research identifies opportunities to leverage new technologies in order to achieve the sustainability targets of municipalities and transit authorities regarding urban mobility. It explores how to redesign public spaces to be responsive to real-time use and demand.

This research imagines a comprehensive approach to the design of the curb space physical and digital infrastructure. The approach fully integrates the advantages of the digital into the organization and use of the curb space itself. To do this, a 'digital twin' is proposed – a virtual twin of the physical infrastructure which exists and connects to the virtual. The 'Virtual Curb Space' is seen as the building block to scale to a city-wide network of Mobility Hubs, which is explored and broken down into urban typologies and components.

The approach discussed in this research foregrounds the transitional period – where technology is evolving and adoption of technology is trialed. The curb is the testing ground for this. The transitional methodology proposed is based on 'Tactical Urbanism' where temporary, easily changed infrastructural elements are used – this brings the 'update rate' of the physical infrastructure closer to the virtual realm – where updates happen quickly and with more agility. By trialing and coordinating the virtual and the real infrastructure, municipalities can start to change curb space use and pricing on a temporal basis responding to real-time demand.

The research hopes to provide ideas and design solutions that may help municipalities and transit authorities formulate strategies to take first steps into a design and planning process that takes into account the nature of disruptive innovations with their unpredictable outcomes. An iterative initial steps summary is hypothesized through case studies in seven locations in the Metro Vancouver area served by TransLink. The case studies provide a glimpse on how mobility hubs and virtual curb spaces can be designed and managed.

*To cite this work:*

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# Context of the Research

As technology becomes more and more embedded in all parts of our lives, our city infrastructure is still relatively unimpacted. While there is much talk of 'smart cities,' there are relatively few changes to the street itself or our public space. Much of the smart city technology proposed – such as smart traffic signals or streetlights which detect pollution and the sounds of guns – are aimed at improving operational issues for the cities themselves and provide limited agency to the public. New mobility providers are producing apps and services that are giving people new transportation options and allowing greater certainty in how long it will take to get somewhere as well as providing easier payment options (for parking meters for example) but these are run by private companies and have limited interaction with the cities. The contracts are set up with the municipalities and the transportation providers provide the technology and the services. At this point most municipalities do not have the technological tools or know-how to engage with virtual infrastructure. Larger corporations would love to come in and manage the city's infrastructure for them, however this creates a monopolistic position and gives the large corporations access to extensive private citizen's information. Again – who benefits from this type of arrangement?

This brings up many questions of jurisdiction, of data management and of where the role of government is – issues which this report highlights but does not address. What this report does address is how to step into the fray – how to start the engagement with the digital and how to think about the relationship between the digital and the physical. As more and more transportation options have significant virtual presence, the city must also be present in the virtual – to direct operations and participate in allocating resources and collecting revenue. Moving the responsiveness of infrastructure to real time allows the city to close roads or change speed limits as events dictate or allocate curb space differently on a temporal basis. If curb space can be allocated every few minutes in real-time to a different new mobility provider, how will the city track and record these events if it doesn't also have a presence? How will it record and enforce what it needs to?

The trialling of infrastructural changes allows citizens to engage with the change and to give feedback. It allows tuning of the change. This can happen both in the physical and the virtual. This allows cities to start to build their capacity – to try and see what works and doesn't and finally to set up robust systems that the citizens support and have chosen. The methodology proposed in this report seeks to do just that, in hopes that the outcome will be that which works for citizens, the municipalities and the transportation providers themselves.

**Academic Context** - This report is an edited version of the text done for the thesis report below. The research for the thesis and report was conducted in tandem.  This report is has additional graphic content and reference images. However, it does not include the academic context. Please refer to the thesis document:

*Fogelson, Yuval. Transitioning into New Mobility : Future Curb Space Design. University of British Columbia, 2021. doi:10.14288/1.0396952. https://open.library.ubc.ca/clRcle/collections/ubctheses/24/items/1.0396952*

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# 1

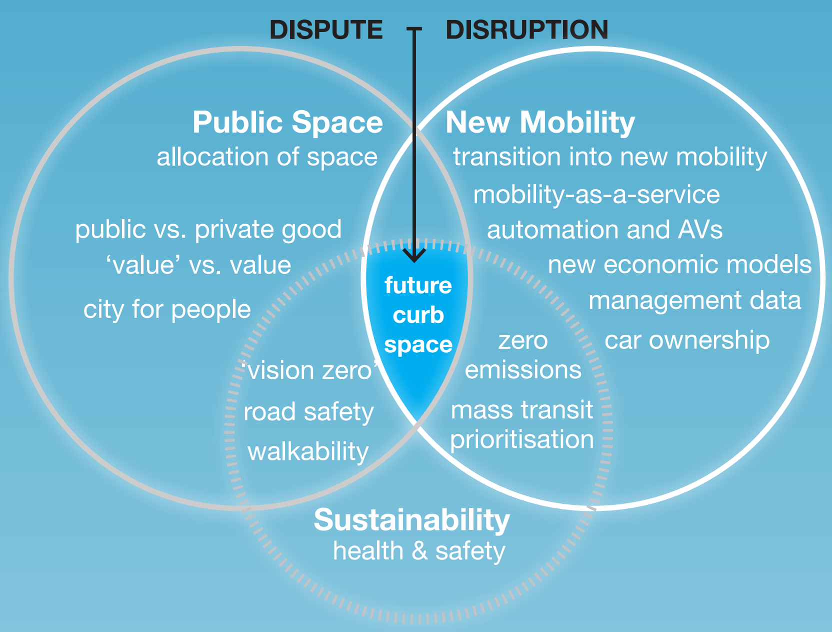
***Chapter 1*** *contextualizes the problem by highlighting the questions raised in the initial NMRG (New Mobility Research Grant) grant proposal which paved the path for this document to materialize. It looks at the curb space spatial dispute between the different uses and users, as well as challenging the current value system and the automobile status quo. Finally, it looks at the disruption caused by a convergence of technologies, giving birth to the data economy and the potentially disruptive transformations as urban mobility becomes increasingly connected, shared, autonomous and electric.*

# 1 INTRODUCTION

# 1.1
# Research Proposal

This research sets to explore the over-arching themes of the future design of public space in conjunction with the future of urban mobility. Under the spotlight is a specific public real estate, namely the curb space, which will act as the protagonist of the story. The focus on the curb space is largely related to the need to research the implications and possibilities of future curb space design and management, a need expressed in the research grant explained in this section.

The research positions curb space in the intersection between three spheres: 1. Public Space; 2. New Mobility; and 3. Sustainability. In terms of the public space, curb space is positioned amid a debate over how to design and allocate public space uses and to which value systems. The spatial dispute over curb space occupation and the contention over its use, is further amplified by new mobility uses, such as car-share, bike-share or deliveries of e-commerce. In terms of transitioning into new mobility, curb space is positioned under the pressure of a possible disruption creating new demands. The new mobility sphere raises the issue of the disruption caused by a convergence of technologies and new forms of economic activity. In both spheres, sustainability and safety play a defining role.



## *Proposal for New Mobility Research Grant (NMRG) TransLink* *(Dec 2019)*

The following description was posed as a 2019 priority research topic for TransLink's New Mobility Research Grant (NMRG), which initiated this research:

> *"Curb management and infrastructure for new modes: With the rise of new forms of mobility (electric, automated and shared), along with growing e-commerce, management of curb space is critical. As such, there is need for research on policy measures to allocate, regulate and value curb space and on design of future curbspace and other infrastructure based on anticipated changing needs." (One of the 2019 priority research topics on TransLink New Mobility Research Grant – July 17,2019)*

*NMRG proposal title (December 2019):* ***"Transitioning into new mobility, redesigning public space in the context of curbspace dispute"***

Below an excerpt from the proposal including the executive summary and initial Statement of Problem:

> *As we transition into new mobility, the use and design of the public realm will need to adjust in response to anticipating disruptive changes associated with new mobility operators and service providers, as well as new curbside management and enforcement technologies. Cities are already experiencing a spatial dispute over the curb space, caused by the plentitude of its uses and users, often with conflicting needs and benefits. The proposed research sets to first map out this dispute by analyzing the existing and anticipated future curbspace uses and users, as well as their interconnected relationships. Design solutions will be tested in eight [1] different locations in municipalities across the Metro Vancouver area, served by TransLink. These studies will serve as a base for urban design and implementation strategies and tactics for new mobility, which will be assessed by their adaptability to rapid and unpredictable transformation of cities and development in technologies.*
>
> *Ideally, transitional design solutions for future curbspace allocation and use, should correspond to anticipated changing needs generated by the disruption associated with new mobility, which is set to further impact the existing spatial dispute over the curbspace.*
>
> *In the absence of a holistic approach for the allocation of space between the different parties disputing the public realm, different new mobility operators and new entrants may push their own agenda. Additionally, on-ground design solutions and enforcement require clear policies regarding management and monetisation of the curbspace use in the context of a Mobility-as-a-Service related platform.*
>
> *While there is some discussion around autonomous urbanism, there is less focus on design solutions for the transition period prior to automation, responding to the highly dynamic new mobility landscape. As new mobility diffuses into the city space, inadequate permanent designs may be costly to reconfigure and may impair the sustainability objectives of cities.*


*"Transitioning into new mobility, redesigning public space in the context of curbspace dispute" NMRG proposal, TIPSLAB (December 2019)*

The different curb space uses have been studied and mapped as proposed. They have been incorporated as distinct design components within the rationale of a 'Mobility Hub' design (chapter 4). Chapter 4 lays out a speculative design proposal that uses the transitional design methodology, allowing for transitional design solutions to be piloted. This 'proof of concept' is used to investigate hypothetical design configurations in specific case study locations (chapter 5).

The initial proposal emphasized new mobility and innovative technology, however, at the time the significance of the digital infrastructure and the design possibilities it brings with it was not yet understood. Finally, this digital infrastructure and the 'virtual urban realm' gained prominence and was incorporated in every design and phasing aspect investigated throughout this research.

1 The location selection process has narrowed down from **eight** locations (as mentioned in the original proposal) to **seven** locations as theoretical case studies responding to different typologies (chapter 5).

## Research Objectives

As cities transition into new mobility, the use and design of the public realm will need to adjust in response to anticipating disruptive changes associated with the digitization of cities and new mobility services with new business models. Disruptive innovation associated with digitization and automation causes unpredictable and uncertain outcomes regarding the deployment of new technologies. In such a scenario it is difficult to create a lasting long-term framework vision that can be followed. It is also increasingly difficult to adapt to changes in the short term or in real-time, as planning processes traditionally take time to implement.

As new technologies continue to change how we move around, the road space must also be readjusted to facilitate this new mobility, in this context, one of the critical areas under discussion is the future of the curb space. This research sets to investigate the future design of curb space, both physical and virtual, as part of a city-wide network based on connectivity through urban street infrastructure, new mobility and transportation provider services, as well as digital connectivity and 5G and IoT (Internet of Things) infrastructure.

This research sets to test a design methodology that allows for a process of transitioning into automation and digital transformation in the urban realm. This could be applied to different complex urban networks; however, this research focuses on the urban mobility network. More specifically it focuses on the 'Transition into New Mobility' which is associated with mobility networks in the urban realm.

Objectives regarding the urban mobility network are divided into three categories: Sustainability, Transition, and Innovation.

**Sustainability**

- Design an urban mobility network that prioritizes sustainable modes of transportation and is anchored around transit.
- Leverage new technologies and advances in automation in order to help achieve the cities' sustainability targets.

**Transition**

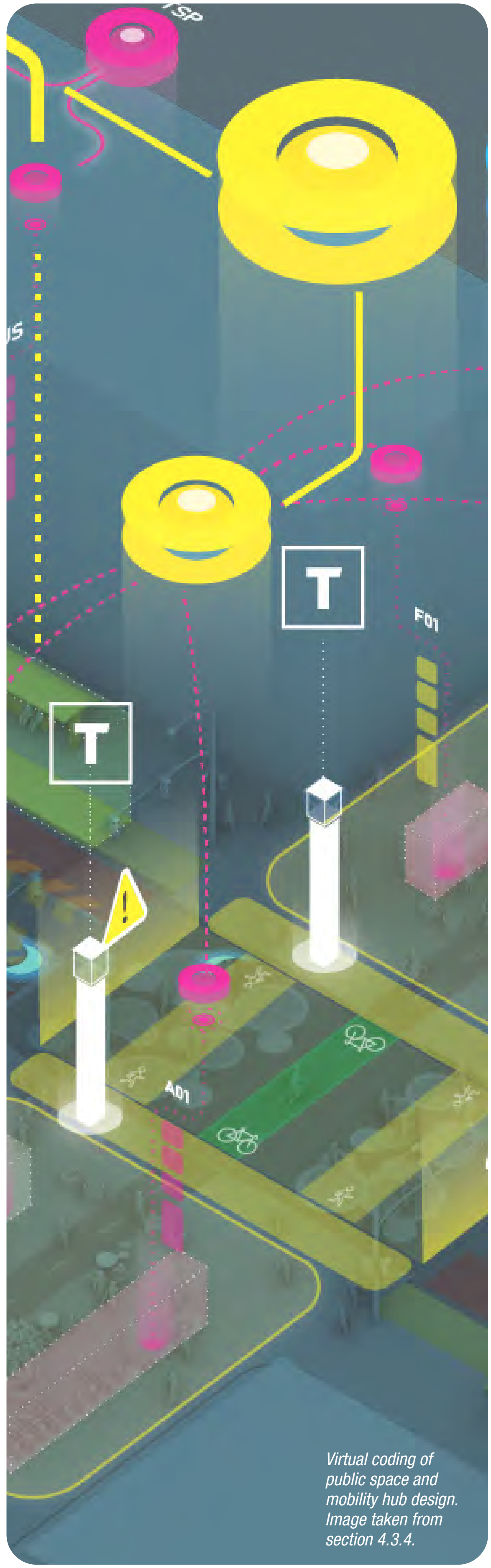
- Design an urban mobility network that is adaptable to rapid changes and uncertain outcomes associated with digital innovation and disruption.
- Design an urban mobility network that can be reconfigured frequently and respond to real-time demand of movement of people and goods across the city.

**Innovation**

- Increase collaboration in innovation between the public and private sectors with regards to infrastructure, shared mobility, and civic entrepreneurship.

In a more focused sense, this research narrows in on a specific public space type, namely the 'curb space'. The 'curb' separates the sidewalk and the road space, the curb 'space' is the lane of the road adjacent to the curb. It is most commonly associated with on-street parking. This space is in increasingly high demand by different uses and users such as bike-share, parklets, loading zones, and space to drop off passengers.

How does one design and manage the curb space in a way that benefits its uses and users, while at the same time helping achieve a more sustainable modal split, prioritizing transit and more sustainable mobility modes? The objective of the research is to incorporate the curb space as a 'building block' to achieve the outcomes of the network discussed above.




*Virtual coding of public space and mobility hub design. Image taken from section 4.3.4.*

## Research Proposal

The research suggests that the introduction and the updating of technological innovation related to new mobility is to be done in tandem with the reconfiguration and updating of physical space. This allows for the creation of a dependent process marrying change in the physical and virtual realms in the same design process, through parallel timelines. The proposed design process follows an incremental phasing methodology that allows experimentation and piloting of new technology, as well as the testing of different physical configurations using tactical urbanism methodologies. This design methodology responds to uncertainties in outcomes of the implementation of disruptive innovations.

To define the direction of innovation and urban transformation, municipal and transit authorities need a guiding framework or design vision. The future vision explored in this research, proposes a pro-transit, people's first, new mobility integrated, MaaS-enabled, digitally connected design. It does this at the macro level through a city-wide network of mobility hubs that are interconnected and function as a system of networks. In this vision phase, we can imagine that the urban mobility network can be integrated within a wider eco-system of private and public services beyond the basic provision of mobility needs. At the local level, the research explores the concept of the mobility hub, looking at its design components and phasing strategy, with an emphasis on both physical and digital infrastructural changes.

**Chapter 1** discusses questions revolving around curb space, challenging the automobile status quo, as well as digital disruption.

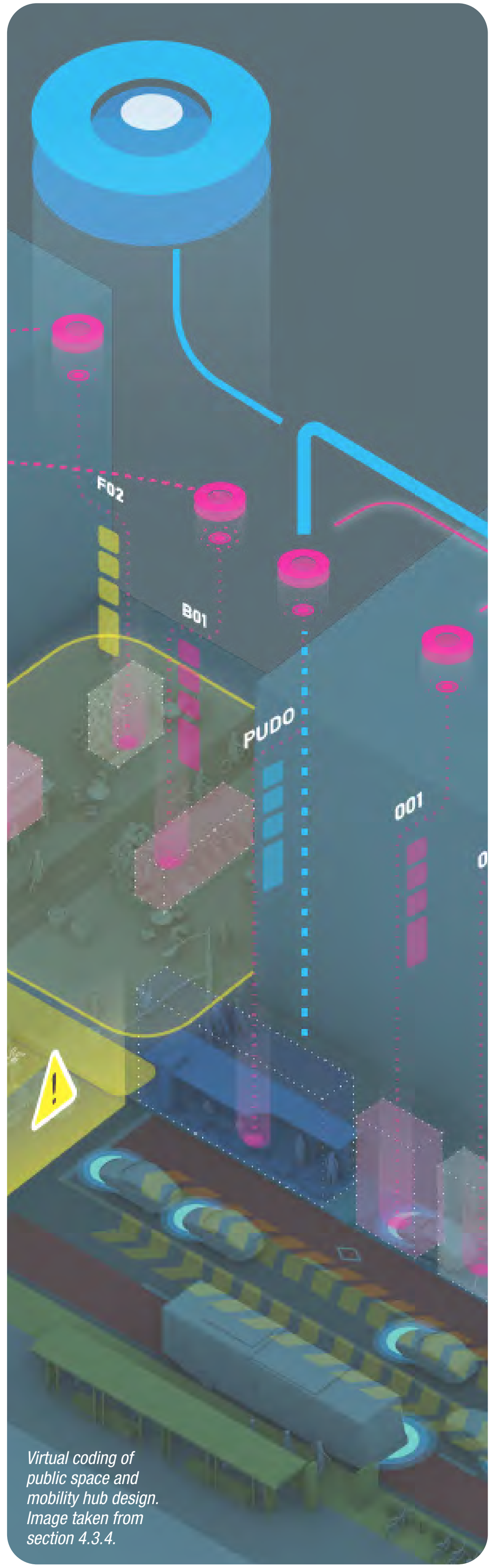
**Chapter 2** delves into an exploration of the 'digitization' of public space and its possible digital transformation. This includes looking into concepts such as the virtual and the physical urban realms; the effects of the data economy and surveillance capitalism; the automation of an urban mobility system through the analogy of 'Airportization'; and finally, through exploration of the idea of the 'Virtual Curb Space', central to this research.

**Chapter 3** looks at transition strategies and design methodologies to understand how to help incorporate the virtual realm in the design process. It looks at an incremental phasing approach over time, that matches the virtual and the physical that are designed in tandem. Tactical urbanism can be used to accelerate the reconfiguration of physical space and match it with updates of digital infrastructure and service.

**Chapter 4** lays out the speculative design proposal of a city-wide digitally connected 'Mobility Hub Network', with its different urban typologies. On the local scale, 'Mobility Hub Design' is explored through an incremental phasing strategy, based on Chapter 3, in both the physical and virtual realms, based on Chapter 2. The different components of the Mobility Hub are investigated and broken down into phases.

**Chapter 5** explores locations in the Metro Vancouver area that were selected as case studies, together with local municipalities and the transit authority. Each case study explores an urban typology, reflecting on Chapter 4. The speculative design proposal in Chapter 4 with its Mobility Hub components is used to explore the unique locations through a transitioning phasing strategy, reflecting on Chapter 3.

**Chapter 6** concludes the research by revisiting research objectives and looking at the outcomes. Major findings are categorized and translated into recommendations, directed at municipalities, transit authorities, designers, innovators in urban mobility and civic innovation. Areas of further study are also looked at and challenges cities might face moving forward are discussed.



*Virtual coding of public space and mobility hub design. Image taken from section 4.3.4.*

# 1.2 Why the Curb?

“Curb space” is a sub-set of the road space edging the sidewalk. It refers to any configuration of space-related to the curb on an urban street. ‘The curb’ separates between the sidewalk and the road space, with ‘curbside’ activities happening on the sidewalk but supporting activity that uses the curb lane. The curb typically has a height difference, except for ‘curbless’ configurations, such as in shared streets. Part of the sidewalk can be extended to the road space through ‘curb extensions’ or ‘bulb-outs’. The ‘curb lane’ can be used for movement or permanence.

Curb Space is a unique urban infrastructure that is widely abundant within the urban realm as it is a standard design feature in any urban street. The research argues that precisely because of its ubiquitous existing nature, it can serve as a building block in the creation of a connected city-wide network of mobility. A network whose working model is based on a new economic logic and is designed to prioritize more sustainable modes of transit. This new logic is based on the ability to invent an ‘urban virtual realm’ through the process of the digital transformation of public space, which operates under

*Tactical curb space use during Covid-19 pandemic. Lonsdale Ave, North Vancouver, Sept 2020 Image: Y. Fogelson*

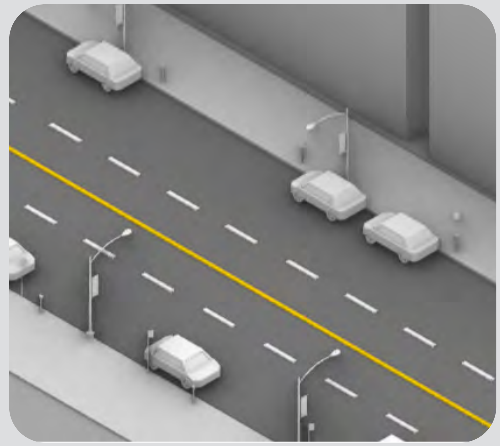
Curb space is a dynamic, regulated, and monetizable public space. The higher the demand for curb space is, the more it becomes regulated and enforced. This is expressed through paid parking, resident permits, or signage regulating other uses. In essence, we have a network of abundant physical infrastructure, which is most contended at places where there is the highest demand for its use. At the same time, in locations where there is very low demand, curb space usage is offered basically at no charge (in the form of free parking).

Highly contended curb space has higher 'real-estate' value, for lack of a better term, while at the same time, it is a public space whose use is moderated through city bylaws and other government uses.

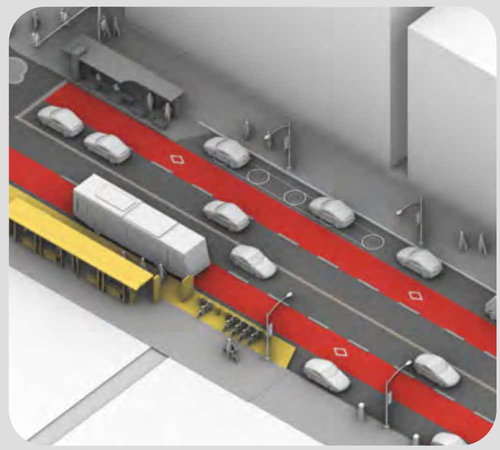
At strategic locations where contended high-demand, high-value curb spaces meet well-served transit, there is an opportunity for strategic design interventions. Here, it is possible to leverage this high value to reconstruct a set of new values which is based upon the 'inverted' pyramid of transport priorities.[2] This can be done by identifying places that have a confluence of transportation types and intensifying them, for these purposes. This intensification can be done through the re-allocation of curb space strategically and tactically, which leads to an easier transition between modes, thus encouraging the uptake of sustainable and healthy transportation modes. These modes are further integrated through digital means in the virtual setting of connected and shared mobility services software and hardware. Selected transformed curb space real estate can then be managed and operated under greater certainty of offering available, accessible, and timely service of its mobility uses. For this, it will need to adhere to a new set of rules, which needs to be pre-defined and coded, as well as responsive to real-time operations, enforcement, and optimization.

The move towards a widespread process of digitization can lead to innovation that may disrupt current patterns of mobility usage and consumption of mobility services. This disruption can be leveraged to create a network of interconnected, managed, and operated spaces that can be used to prioritize and regulate transit, shared, and connected new mobility uses. This can be done by connecting a collection of strategically located curb space real estate throughout the city to form the physical representation of a city-wide mobility network. This network exists de-facto in the virtual space, namely in the 'Digital Twin' of the city-wide network. In this sense, the decisions and transactions occur on-line in real-time as the authorities respond and regulate demands and flows of use of the virtual real estate. In turn, this informs users and connected devices in the physical urban realm and makes intelligent use of the physical curb-space real estate dynamically and responsively.

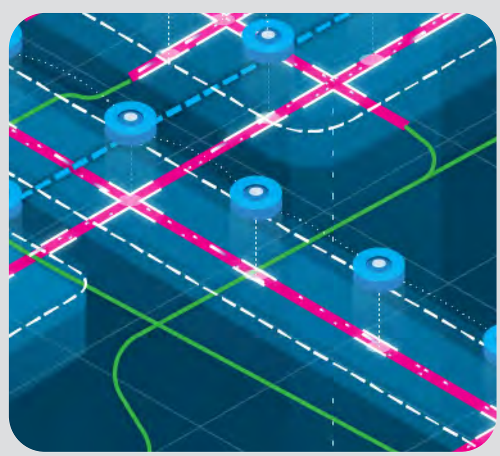
For this system to become a successful functioning network, it needs to be adopted on a large scale. Typically, when new technologies or business models are adopted at an increasingly large scale, they are considered a disruptive innovation. Disruption can happen when a wide segment of the population gets access to products or services, they previously did not have access to, whether because they are novel or because economically accessible. We can ask ourselves how can innovation be used to reach as wide a population as possible while securing equity and an equal level of service to late adopters, disadvantaged populations, or other non-compliances? At the same time, how can it help secure road safety and incentivize the use of more sustainable and healthier modes of mobility? How can it serve as a viable alternative to private car ownership? How can this transformation be leveraged to enhance community-building through physical and virtual placemaking? Finally, how can this system protect data privacy and prevent unethical use of data?



*Currently the curb space is typically used for temporary vehicular storage (aka parking). It is an undervalued public real-estate which is offered to the general public for temporary use for 'free' or under-priced.*



*Prioritization of transit, micromobility, and new mobility uses requires transforming the public space, as investigated in the speculative design proposal laid out in chapter 4.*



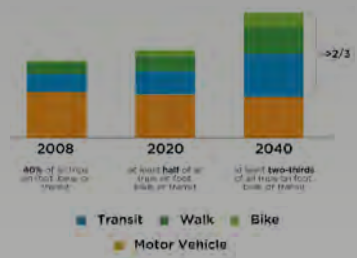
*Strategically located connected curb space can form a new mobility network with city-wide coordination and growth logic.*

2 National Association of City Transportation Officials. Blueprint for Autonomous Urbanism: Second Edition. 5 Sept. 2019. nacto.org, https://nacto.org/publication/bau2, p.117.

# 1.3
# Curb Space Uses

'Curb space' refers to any configuration of space related to the curb on an urban street. 'The curb' separates between the sidewalk and the road space, with 'curbside' activities happening on the sidewalk but supporting activity that uses the curb lane. The curb typically has a height difference, except for 'curb-less' configurations, such as in shared streets. Part of the sidewalk can be extended to the road space through 'curb extensions'. The 'curb lane' is used for movement or permanence.

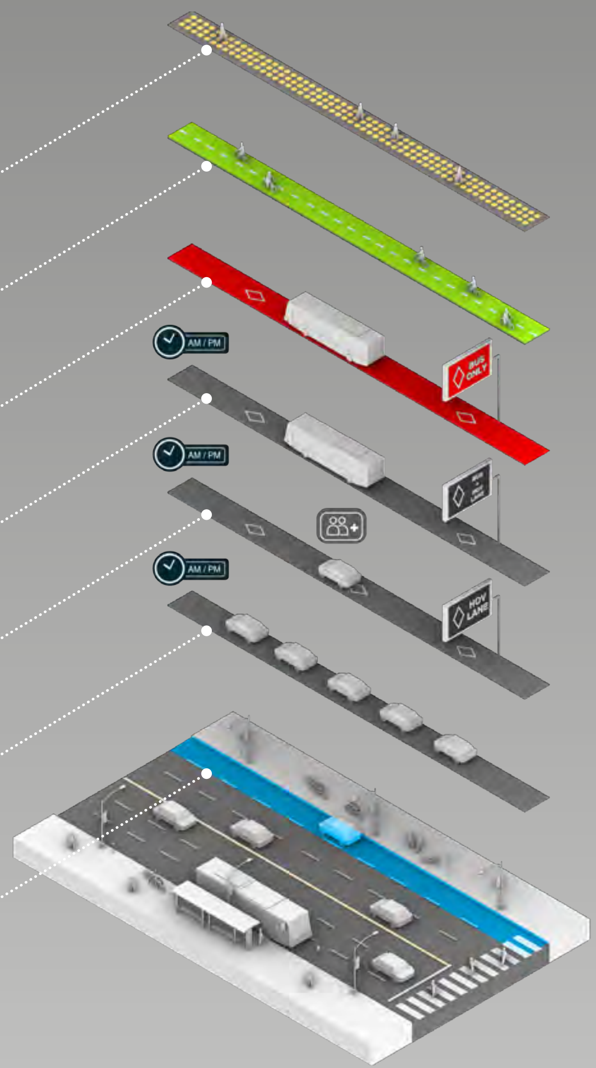
**Total number of trips in the City of Vancouver**




*https://vancouver.ca/files/cov/transportation-2040-plan.pdf*

## *Movement*

The 'curb lane' can be used for general unrestricted use of vehicular movement as part of the right-of-way of the street. In some cases, it can be used for temporary stationary use of off-peak parking; or temporary movement as a High Occupancy Vehicle (HOV) lane during peak hours. However, it may also be used for more sustainable modes of transportation such as transit (24 hours or peak hour bus-only lane), cycle lanes and ways, or curb-extensions for temporary pedestrian use. Dedicating the curb lane to these modes can function as an instrument to achieve targets of increasing the share of sustainable mobility, a goal which many cities are pursuing such as the City of Vancouver's targets to reach at least two-thirds of all trips on foot, bike or transit by 2040.



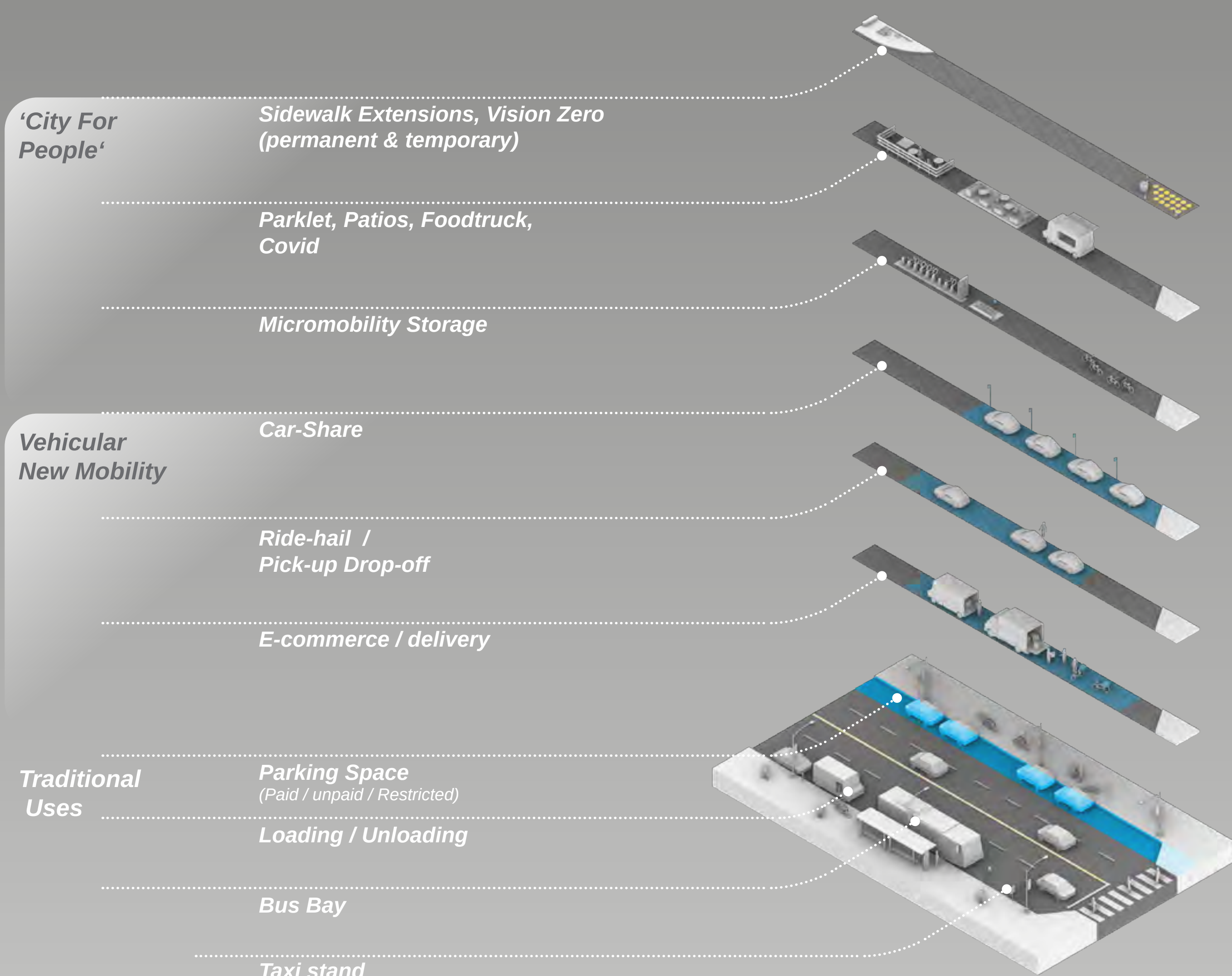
## Stationary

The curb lane is typically used for stationary activities such as parking, bus stopping zone, taxi zone, loading zone.

The use of the curb space is coming under pressure by ever-growing new uses related to new mobility. These include car-share parking demand (whether designated or not), ride-hail (requiring space to pick up or drop off passengers), bike-share or e-scooters (requiring space for docking stations or parking space), as well as increasing use of unloading relating to delivery with the increased use of e-commerce.

Other curb space occupations relate to uses that make cities more people-oriented ('Cities for People'). These include tactical or temporary sidewalk extensions related to activation of public spaces for gathering, for increased safety of shortening crossings at intersections (Vision Zero), or for responding to the increased need for physical distancing (Covid curbs). Other initiatives include food trucks, parklets, pop-up plazas, greening, storm-water rain gardens.

Amongst the disputing users of the curb space are: cars driving and parking, buses, delivery vehicles, garbage collection, taxis, car-share vehicles, ride-hail, cyclists, senior's buggy, wheelchairs, and ultimately in all cases, the pedestrian.



# 1.4
# Valuing the Curb

### *Challenging the Automobile Status-Quo*

The prioritization of automobile parking, use and ownership, is coming under pressure from two different sides: ‘Cities for People’ and ‘New Mobility’. These challenge the automobile status-quo not only through a spatial dispute over the occupation of public space, but also through a change in mobility habits and lifestyle related changes.

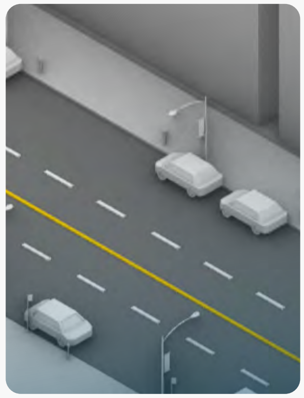
There is a need to find a balance between transforming automobile related space (usually as parking space) into public space functioning as civic space, or space dedicated exclusively for non-private vehicle related usage. As these are interconnected and competing with each other, inevitably any addition in mobility space or civic space comes at the price of reducing storage space, which challenges the automobile status quo in a very tangible way. This can be experienced when, for example, parking spaces are removed and affected residents or commerce owners often express their negative sentiment to change.

While prioritization of healthier and more sustainable modes creates value in the form of positive externalities that are not captured, these are indirect and results may be less tangible or immediate. These do not translate into direct revenue in the same way that on-street parking generates direct revenue which many municipalities depend on. New mobility has the potential to generate revenue in alternative ways that need to be trialed, as such, it can be linked to the service providers (which may pass on fees to end-users), however, they are not bound to elected officials in the same way residents are. Here we can imagine an alternative model where revenue is used for creating new or investing in existing curb real estate, giving it added value in return, in a cyclical way (This is further explored in section 4.1).


*Redesign of street to prioritize transit and cycling. Wesbrook Mall, UBC, Vancouver, Oct 2020. Image: Y. Fogelson*

***Challenging the Automobile Status Quo** – Road space (re) alloaction*


**'Cities for People':** Prioritization of active transport, transit and public space activation



**Automobile Status Quo:** The majority of public space is dedicated to vehicular use


**New Mobility:** Sharing economy challenges car ownership model

*Road space (re) allocation challenging the automobile status quo. Left: Cycle Infrastructure, Transit Priority, Plazas & Civic Space. Right: Car-share, Ride-hail*

## *'Value' vs. Value $ vs. Value < >*

While sustainable uses of the curb space such as: 'vision zero' road safety redesign, bicycle infrastructure, public plazas, or greening, are of great 'value' for future-proofing cities, they usually generate costs for the city. On the other hand, uses like parking and some new mobility usage can generate revenue for the city. In this context there arises a need to understand the design logic of the different uses, question the sustainable 'value' versus the monetary 'value' to be able to increasingly introduce more sustainable practices for curbside use and design with less friction.

Different value sets have to be assessed to define a new value system to serve as a framework from which to re-allocate curb space for different uses. These values are sometimes at odds with each other and do not correlate, as the societal value may conflict with the monetary value when revenue-generating uses are prioritized over more equitable civic uses. Sustainability generating value such as cycle and bus lanes may conflict with the electoral value of residents and the needs of parking.

The digitization of the curb space may initially be used to optimize and charge for use of specifically designated locations, this process may be expanded and used for automation of a booking system for usage based on predetermined rules. As the digitization process and coding of land use and space regulation becomes increasingly automated, a new form of value is introduced into the equation, namely that of coding the value system into a set of rules. Here we can say that a 'coding value', a quantifiable value is needed for what is essentially unquantifiable, as it is based on a set of decisions prioritizing use A over B at a specific location at a specific time of day. This is where policy innovation is needed as the current policy can be reevaluated and translated into quantifiable guidelines upon which to base the reallocation algorithms. This is especially true in the context of dynamic pricing and usage that is based on real-time demand and supply, which is made possible through the correlation between digitized physical and virtual infrastructure, mobility services with connected devices, enforcement mechanisms, and new business models around the shared and data economy.

Arguably, the digitization of public space brings with it the opportunity to revisit the current value systems and the challenge to codify a set of value systems that can set a policy-driven framework upon which a publicly granted mobility network is built, which can maintain close scrutiny on how one set of values is to be prioritized over the other.

# 1.5 Digital Disruption

Rather than a specific stand-alone technology like the Autonomous Vehicle, or a category such as New Mobility, this research sees the process of digitization and automation as the disruptive innovation at play, therefore noted as ‘Digital Disruption’.

The automation revolution is often seen as the forthcoming major technological disruption of the mid-21st century, however, what are the enablers of this revolution and what makes it disruptive? What are the disruptive innovations that may affect mobility and the urban realm?

The word ‘disruption’ is associated with new technologies, it is used frequently to classify anything novel and inventive. However, its origins are in business theory and refer more to an innovation that causes major unavoidable changes. According to Clayton Christensen, a ‘disruptive innovation’ is *“an innovation that creates a new market and network. By targeting the bottom end of an established market, it eventually disrupts it and its value network, displacing established market-leading firms, products, and alliances.”*[1] It makes products and services affordable and accessible, it creates growth, creates jobs, but needs capital. Disruptive innovation has more to do with enabling economical accessibility to technology rather than the new technology in itself. Taking the 20th century as an example, here, the automobile did not directly cause the disruption in living and commuting patterns, but rather they were perpetuated by the increasing accessibility to buying or using an automobile. This was made possible by mass production manufacturing facilities, such as those of Henry Ford, as well as an all-encompassing road infrastructure and highway system.

1 Disruptive Innovation'. Wikipedia, 17 Mar. 2021. Wikipedia, https://en.wikipedia.org/w/index.php?title=Disruptive_innovation&oldid=1012651092.

Disruption happens when technologies converge, according to Jeremy Rifkin[2]. The convergence of different technologies can cause a major economic paradigm shift at a certain moment in history as three defining technologies emerge and converge. *"**New communication technologies** to more efficiently manage the economic activity; **New sources of energy** to more efficiently power the economic activity; and **New modes of mobility**, transportation logistics, to more efficiently move the economic activity."*[3] In what Rifkin describes as the Third Industrial Revolution of the 21st century (see diagram above), connectivity allows for the creation of three "Internets": **New Energy 'Internet'** - The connected power grid, a renewable-energy 'Internet'. **New Communication 'Internet'** - The communications Internet expanded into the physical realm, enabling widespread connectivity of devices and physical assets through IoT and 5G technologies. **New Mobility 'Internet'** - The transportation mobility network allowing for connected infrastructure, vehicles and transportation technologies, eventually becoming partially to fully automated.

These three 'Internets' ride on top of a platform called the Internet of Things (IoT). We can ask ourselves what implications this IoT might have on the physical space and the design of the city, through smart city technologies and greater connectivity. We can also ask ourselves how people, goods, and services will move through the public space, both physically and virtually, while taking into consideration an economy that increasingly shares its assets and services.

The digital revolution gives birth to the data economy which is gaining an increasingly dominant role in the global and local economy. The data economy is being enabled by a process of digitization that, in turn, enables its perpetuated growth, perceived as 'disruptive'. The data economy can derive 'value' from the convergence or correlation between any data point from any of the three 'Internets'. Using artificial intelligence and machine learning, an increase in computing power, communications speed, and bandwidth, it is possible to do this in real-time across the globe.

The data economy, built upon 'data' as its commodity, impulses "data-driven" innovation which then naturally seeks to expand data gathering or extraction. This is done through digitization of inventory (for example curb space inventory), surveillance, data mining, data farming, and other forms of data extraction. The more precise the data, the more accurate the ability to predict futures through prediction algorithms. In the urban realm, this can be beneficial for a more efficient (eventually automated) connection of people and goods throughout the city. 'Smart City' technologies seek to optimize different aspects of our daily life, which influences the choice of what should be optimized, whether it's the movement of cars or the wellbeing of people: "A traffic system of autonomous cars could be optimized for maximum throughput, or maximum sharing within social networks, or for maximum novelty and surprise."[4]

Harari warns of 'Dataism' where there is the belief in data as a source of authority, there is a shift in authority to the 'cloud', namely the algorithms controlled by private corporations.[5] This becomes evident in the economic model of surveillance capitalism which exploits the asymmetry in knowledge of the Artificial Intelligence that is used to predict human behaviour and trade this knowledge for profit (this is explored in section 2.2).

With this in mind, the following chapter will investigate the 'digitization' of public space and its implications

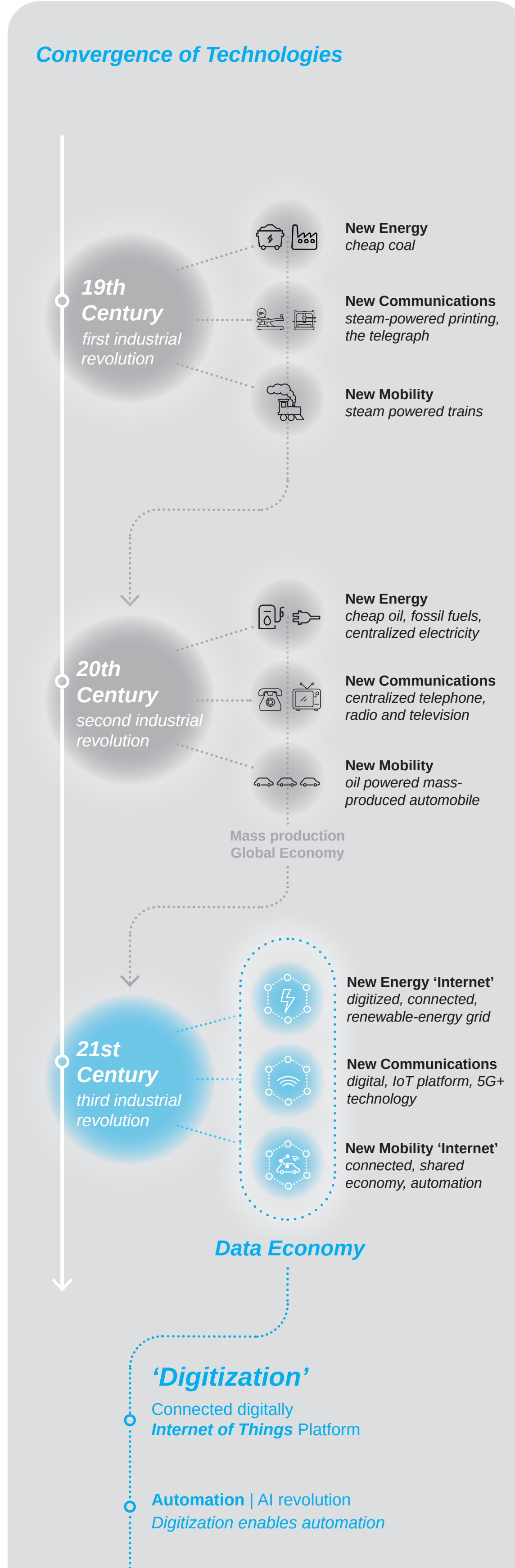



*Diagram based on Rifkin, J. explanation of The Third Industrial Revolution*

2 Rifkin, J. The Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World. St. Martin's Publishing Group, 2011.
3 Jeremy Rifkin Interview: 'Third Industrial Revolution' - Business Insider. https://www.businessinsider.com/jeremy-rifkin-interview-2017-6.
4 Talton, Remington Tonar and Ellis. 'Smart Cities Are Built By Smart People, Not Smart Things'. Forbes, https://www.forbes.com/sites/ellistalton/2019/07/09/smart-cities-are-built-by-smart-people-not-smart-things/.
5 Harari, Y. N. Homo Deus: A Brief History of Tomorrow. McClelland & Stewart, 2016.

# 2

***Chapter 2*** *defines a framework for inventing a new type of 'space' in the connected urban realm; namely the 'Virtual Urban Realm'. This virtual space is explored from a geographical, urban planning and urban design perspective, relating zoning, the built environment, and the division of public and private space manifesting in the 'Urban Digital Twin'. Issues around data and public space are looked at, in the context of the data economy and surveillance capitalism. The idea of 'Airportization' explores how mobility space can be re-conceived through a process of the creation of a closed system with 'Ground Traffic Control', booking and scheduling slots and an urban interface in the form of a 'Mobility Hub Network'. This leads to the investigation of the 'Virtual Curb Space' and the introduction of the idea of 'Virtual Curb Space Real Estate'.*

# 2

# DIGITAL TRANSFORMATION OF PUBLIC SPACE

# 2.1

## The Virtual Urban Realm

The idea of the ‘Virtual Urban Realm’ can be further detailed through the concept of the ‘Urban Digital Twin’, leading to a real-time operational-regulatory system of ‘Virtual Zoning’. For a form of virtual zoning apparatus to exist, regulations need to be geographically coded and triangulated, legally binding their correspondent physical locations.


Vitual and Physical realms

## The Urban Digital Twin

The 'Urban Digital Twin' is an idea developed in this research to encompass a city-wide connected network allowing for transactions of services of people and goods within the physical urban realm.

The urban physical realm relates to the physical world composed of mostly man-made physical infrastructure and constructions. A subset group in the non-physical realm, is the 'virtual realm'. Nineteenth century encounters of the virtual realm can be seen with the invention of the Morse machine to produce telegraphs which could travel through distances unimaginable previously.[6] The modern-day particularity of the virtual realm is that it is a non-physical entity with access to an increasing number of people, devices and sensors. In this virtual realm lies an 'on-line' world which is connected through the 'Internet' or multiple networks. These networks are housed in servers in the physical world, at locations which are often out of sight of the general populations,[7] accentuating the unconscious (human) perception that the virtual realm has no physical standing in the geographical real world.

A 'Digital Twin' is a virtual or digital representation of a physical object, entity or system, representing both the element and the dynamics of how an IoT device operates and lives through its lifecycle[8]. The digital twin bridges the gap between the virtual and the physical element, allowing for continuous update and improvement to both under the same time frame and not as two separate processes. In the context of the urban realm this can refer to a representation of activity and usage of the urban realm utilizing connected devices, IoT sensors or other generated, harvested or mined data.

6 Yandell, Kay. Telegraphies: Indigeneity, Identity, and Nation in America's Nineteenth-Century Virtual Realm. Oxford University Press, 2018.
7 Wainwright, Oliver. '"The Countryside Is Where the Radical Changes Are": Rem Koolhaas Goes Rural'. The Guardian, 11 Feb. 2020. www.theguardian.com, https://www.theguardian.com/artanddesign/2020/feb/11/rem-koolhaas-rural-countryside-the-future-guggenheim.
8 IBM Internet of Things. Introduction to Digital Twin: Simple, but Detailed. 2017. YouTube, https://www.youtube.com/watch?v=RaOejcczPas.

# Virtual Zoning

Zoning is a legal layer for regulating physical land use, as such its physical enforcement is through a process of manual permitting and approvals, supported by an online database of existing specifications for every plot of land within a municipal jurisdiction. GIS systems synthesize information pertaining unique geographical locations. This information may be updated to reflect changed on-ground reality. In contrast, the idea of 'Virtual Zoning' as put forward in this research contemplates the idea of the virtual information acting as the de-facto up-to-date legal designation of land use, by the fact that it is a form of 'live' zoning, formed by geofenced perimeters in virtual space, corresponding to physical space. The most interesting aspect that 'Virtual Zoning' can offer, is that it is (real-) time based in addition to the geographical based zoning which urban planners use to define regulations for land use. Virtual Zoning can become an essential element in the enforcement of charges and fees which may be applicable for a specific geographical location. This location may be marked up through geofencing, however, it requires to be kept continuously up-to-date, as well as be under oversight, while abiding to some form of 'E-Jurisdiction' linking local (municipal) power with its virtual access and representation. Furthermore, in order to function systematically, this zone should have the (legal) power to override other resolutions and multiple geofenced zones for the same location, especially for commercial purposes, guaranteeing user privacy and rights over data usage.

An array of virtual zoning regulations can be imagined in the long run to mitigate and regulate the use of private data by private entities, especially if taking into account the correlation of private data and the use of geographical related nudges by companies to potential customers using their online services in the public space. Here the connection to the data economy and its business is important, this is further discussed in 2.2.

Virtual zoning can also be related to physical safety, it can help enforce travel speeds which can be coded on a street-by-street basis and then restrict or override vehicle speed remotely, through geofencing and software in the operation system of future cars. A working example for this can be seen in Gothenburg, Sweden[9] where such technology is being tested for buses as well as vehicles and is expected to eventually become obligatory nation-wide for all new vehicles with operating systems. This opens the possibility of a 'ground traffic control' system as part of the 'airportization' of mobility space, discussed in 2.3.

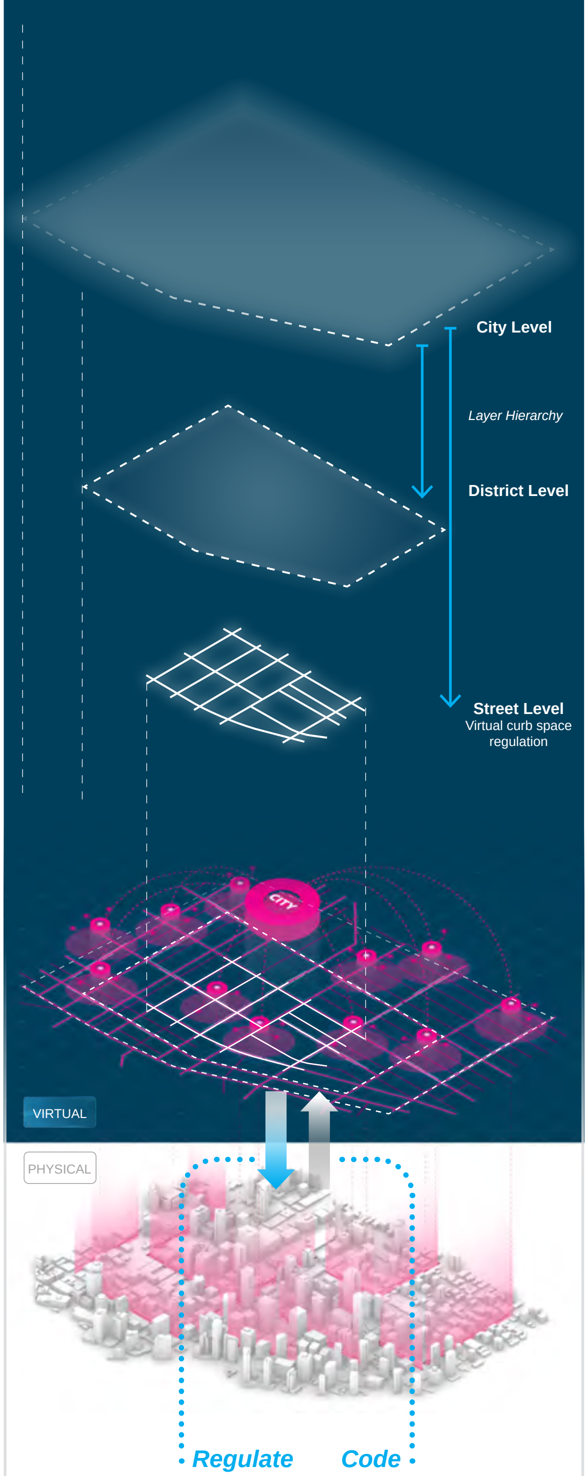
Another way of utilizing virtual zoning, is through the implementation of a virtual congestion charge which can be changed according to time of day for example. This zoning could be a family of different interrelated zones such as LEZ (Low Emissions Zone), ULEZ (Ultra Low Emissions Zone) (which have been utilized in London[10]), or ZEZ (Zero Emissions Zone) which can alter with time or necessity, as well as can be reconfigured to different geographical areas regarding real-time pollution levels.

Finally, one of these virtual zoning layers which coincides across the urban realm is the zoning of usable curb space, henceforth the 'Virtual Curb' or 'Virtual Curb Space' which will be the main point of discussion (2.4) moving forward to a speculative design proposal (Chapter 4).

The zoning regulations for each unit of space needs to be coded from 'the bottom up' regarding the actual location in real-time, while

### *Zoning Layer Hierarchy*

*Zoning layer hierarchy from city level regulation (such as emissions charge) overriding local level regulations (such as parking regulation). Coding of physical realm / Regulation of virtual realm over physical realm.*




9 The Swedish Transport Administration. Comprehensive Action Plan: Joint Mobilization on Digitalization for Secure and Smart Urban Environments. 2017, https://www.roadsafetysweden.com/contentassets/ca32148ed2974ba2876d48770a1de5de/ny-katalog/plan-of-action-geofencing_english.pdf.

10 Transport for London. 'ULEZ: Where and When'. Transport for London, https://www.tfl.gov.uk/modes/driving/ultra-low-emission-zone/ulez-where-and-when. Accessed 3 Feb. 2020.

higher hierarchy zoning layers can override certain aspects of usage or charging fees in a top-down approach. The basic definitions and specifications of each spatial unit (the digital twin) need to be geo-coded first through digitization of current regulations and use and second through the inclusion into a city-wide network. Different functional space for movement or permanence can be coded accordingly. A top-down hierarchy of layers of virtual zones will be established with higher level override status both legally and operationally, in terms of e-charging and enforcement. Here we can imagine traffic regulations being enforced, as well as time-based usage charge. This zoning will have the capacity to be updated in real-time to accommodate the cities current needs as well as optimized to adhere to long term vision goals and targets. The zoning will be done through the Geo-coding of space.

**Regulate** - Movement in direction from the virtual towards the physical realm can include regulation pertaining use of geo-coded spaces. These can be geofenced restrictions on real-time usage, or permanent data reflecting zoning restrictions.

**Code** - The movement from the physical to the virtual includes the real-time data of usage of any connected (mobility) service. It also includes the coding of regulations, zoning and physical digitized inventory of devices, infrastructure, vehicles and urban spaces, divided further as shown below:

## Geo-Coding of Public Space

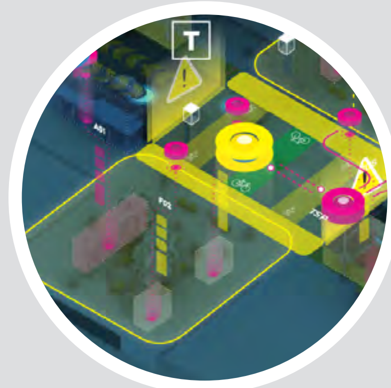
**Civic Space** - The civic space is the public space which is not dedicated to traffic movement, although it may include provision of micromobility uses. The coding of the civic space can include sidewalk and curbside provisions, as well as plazas and public squares usage. Here special geo-e-permits can be used to facilitate use of street vendors and low-end commerce, as well as community activities and gatherings.

**Transaction Space** - Coding of the transaction space accommodates the chargeable usage of space in its various forms, each sub-set with their own charging and usage provisions for: pick-up drop off of passengers through mobility services; for e-delivery of goods; the storage and EV-charging of e-fleets. The provision for more dynamic interchangeable usage of space can be further defined.

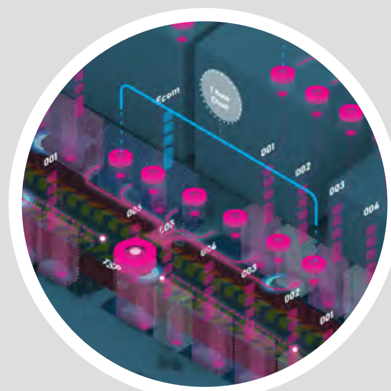
**Mobility Space** - The mobility space is a crucial part of the airportization process (section 2.3) of creating a closed movement system. Mobility Space will geo-code corresponding geofencing of road-space dedicated to movement (traffic lanes), it will include the traffic regulations such as speed limit, as well as specific road rules and time restrictions, such as peak-hour bus lane for example.

### *Geo-Coding of Public Space*

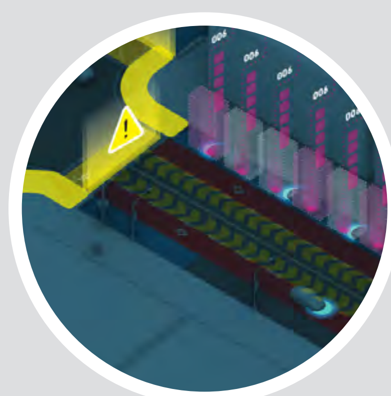
*Three uses of space in the virtual realm.*
*Image extracts taken from section 4.3.4*



**Civic Space**



**Transaction Space**

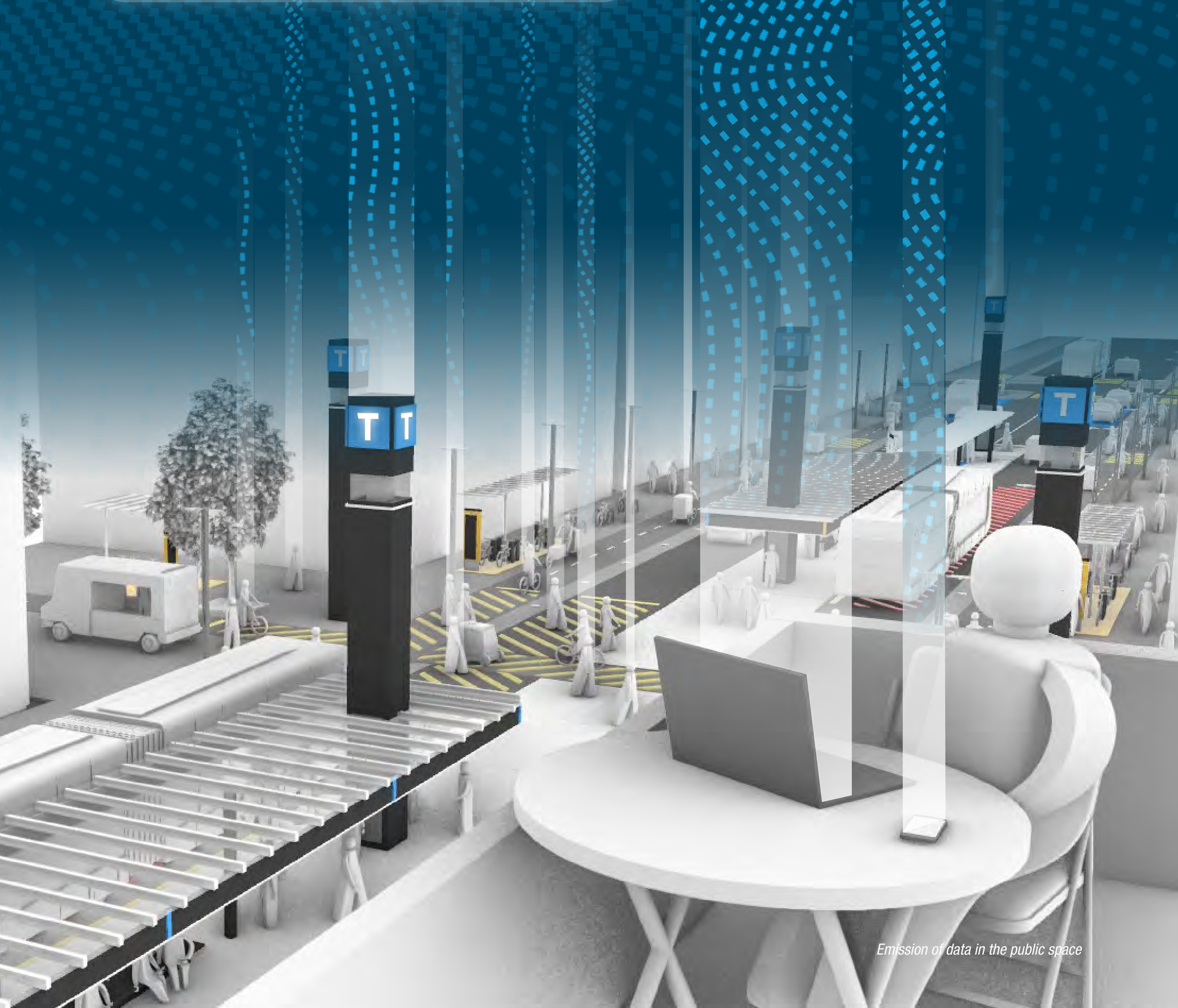


**Mobility Space**

# 2.2

# Data Economy and Public Space

The Data Economy plays an important role in the digitization of public space. A potential ethical concern is raised, as user data over geographical space is harnessed (Digital Exhaust) through a form of surveillance capitalism. The research suggests that virtual space is in essence privately owned and raises a concern for a virtual privatization of the public space. Examples of private and public space remote interference through the virtual realm are looked at from *Amazon Go to Pokémon Go.*



*Emission of data in the public space*

## 2.2.1 Virtual Realm Privatization

When geo-referenced data of users using connected services is of economic value to the Data Economy, then the ownership or access to this data may become a key determinant in business models of corporations and tech companies. Some questions arise regarding the virtual geo-referenced space, creating a ‘virtual urban realm’, or virtual ‘space’. Will there be a distinction between data generated in virtual space corresponding to physical public space over physical private space? Does it matter if data is collected in public versus private? This section opens a discussion in this regard, although further study is needed to better understand the consequences of the Data Economy on public space.

Connected assets (such as mobile phones, wearables, connected vehicles and other mobility related vessels) are often linked to their users' information. One can extract the data that relates time, location and action performed by the user. As users may also be potential consumers of goods and services, they can be legally targeted by third party businesses or organizations, while by-passing the users' awareness. This can be done through the extreme personalized targeting made possible by predictive behaviour AI of large tech corporations.

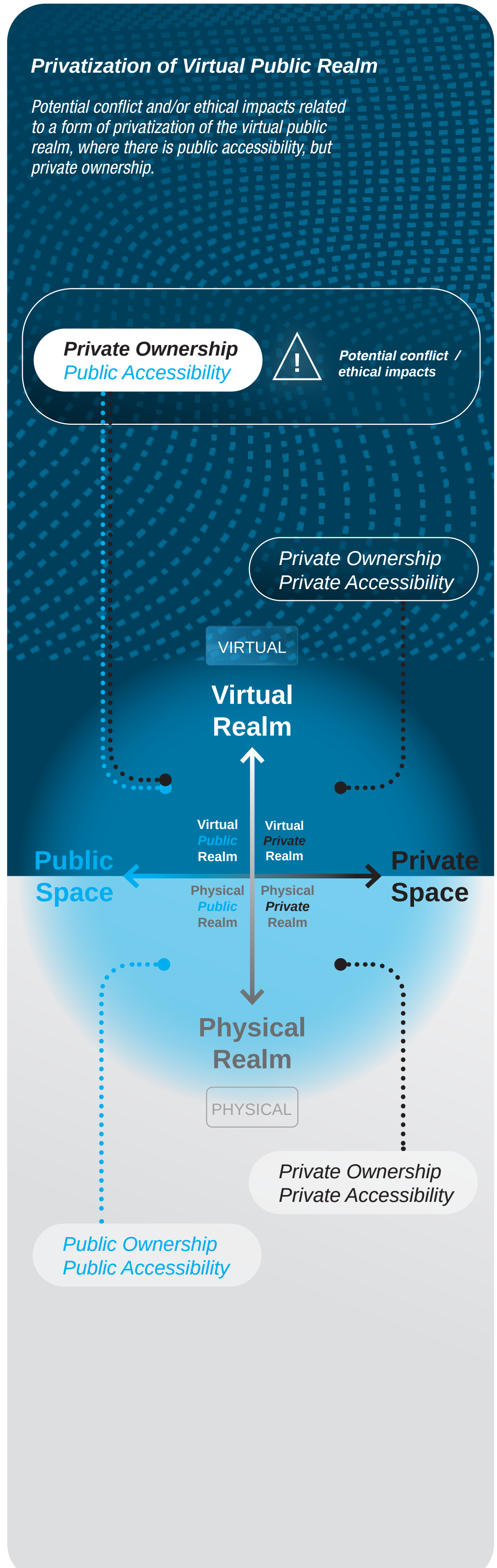
While physical public space is accessible to all citizens, private place is open to those permitted by law or custom.[11] These spaces can use, beyond legal enforcement, physical design to reflect who is welcome or not in these places.

In the physical realm, the demarcation between public and private space is exercised either through physical design (architecture) or convention of use. However, in the virtual realm, is the division between ‘private’ and ‘public’ has to be further studied. To further we can imagine four quadrants as shown in figure above, with two axis: X- public or private space, Y: physical or virtual realm.

**Private Space** - Both ownership of physical real estate and ownership of virtual data are private. Private access to both physical real estate or virtual data is generally protected by law for both owner and visitor / user.

**Public Space** - While ownership of infrastructure is public or governmental in the physical public realm, it is a different case in the ‘virtual public realm’. Here the ownership of data is private as well, as data can be attributed to an individual, organization, company, or public agency.

In the context of data ownership, we may refer to a form of ‘privatization’ of the virtual realm. This raises a flag around the gap between the traditional revenue models for monetizing public space in the physical versus the virtual realm. In addition, this raises potential ethical concerns regarding private ownership of users' data generated by the use of public transportation and complimentary mobility services. As the economic value derived from connected activity increases, there is more potential for a conflict of interest between data privacy and business interests. This is of specific relevance not only to private corporations, but also for the public sector wishing to embark on the digitization of urban mobility without clearly setting the rules in advance.




11 Birch, Eugenie. Public and Private Space in Urban Areas: House, Neighborhood, and City. 2010, pp. 118–28, doi:10.1007/978-0-387-32933-8_8.

## *Virtual Private Space vs. Public Space*

Another concern of data in the virtual realm, is that geo-referenced real-time data can be utilized to generate profit through influencing or incentivizing ('nudging') activities in the physical space. It is possible to influence a consumer choice of an individual (in some cases without their awareness[12]), this can happen in both public as well as private spaces. We can look at two precedents that depict how the data economy is an integral part of the virtual realm, both in the private and public space in the examples below:

**Private Space - 'Amazon Go'** is an automated convenience chain store, It is a 'brick-and-mortar' retail space which resembles an on-line website in the way every activity is captured and analyzed while a user account is needed to make use of the services being offered. It is equipped with multiple weight sensors and cameras to monitor store consumption and activity. Analytics is generated of every product touched and purchased in real life (through weight sensors and cameras), as well as data on every customer purchasing a product. The user's Amazon account is key here in enabling the automated check-out process (which is required for in-situ consumption). It is also key in overcoming potential legal or privacy concerns, as these can be incorporated and updated in the user agreement or the terms and conditions, required in order to obtain an account, in the first place.

This model of 'web-site-ization' may also be applied to other services in the public realm, such as mobility services or MaaS related technology. With the need to generate 'big data' and be an integral part of the Data Economy, serious privacy and ethical concerns are raised. There is risk of illegitimate / controversial or unethical use of users' data, as part of Surveillance Capitalism's[13] dominance over the current Data Economy landscape.

**Public Space - 'Pokémon Go'** is an app that uses GPS to integrate real-time physical location with augmented reality in a form of entertainment as a game which incentivizes walking in public space. According to Zuboff, the game directs players, through incentives and rewards of the game, towards destinations of business customers (Starbucks and McDonald's are mentioned)[14]. Zuboff equates the nudging of the users physically into the commercial establishments to its online equivalent of the 'click-through-rate', she argues that in this new advanced form of surveillance capitalism, one can predict where a user will go to, analogous to predicting what a user will click online. The ethical implications of redirecting users to physical locations, by-passing their awareness, may well be integrated as a form of 'nudging' It may be potentially (mis-)used in MaaS technology, however, this area requires further study to evaluate the possible negative impacts.


*Amazon Go automated convenience store, produces analytics of both products and customers for operation.*
*Image: Amazon -https://www.supermarketnews.com/store-design-construction/amazon-go-goes-smaller*

12 Zuboff, S. The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power. Profile, 2019.
13 Idem
14 Shoshana Zuboff on Surveillance Capitalism I VPRO Documentary. YouTube, https://www.youtube.com/watch?v=hIXhnWUmMvw.

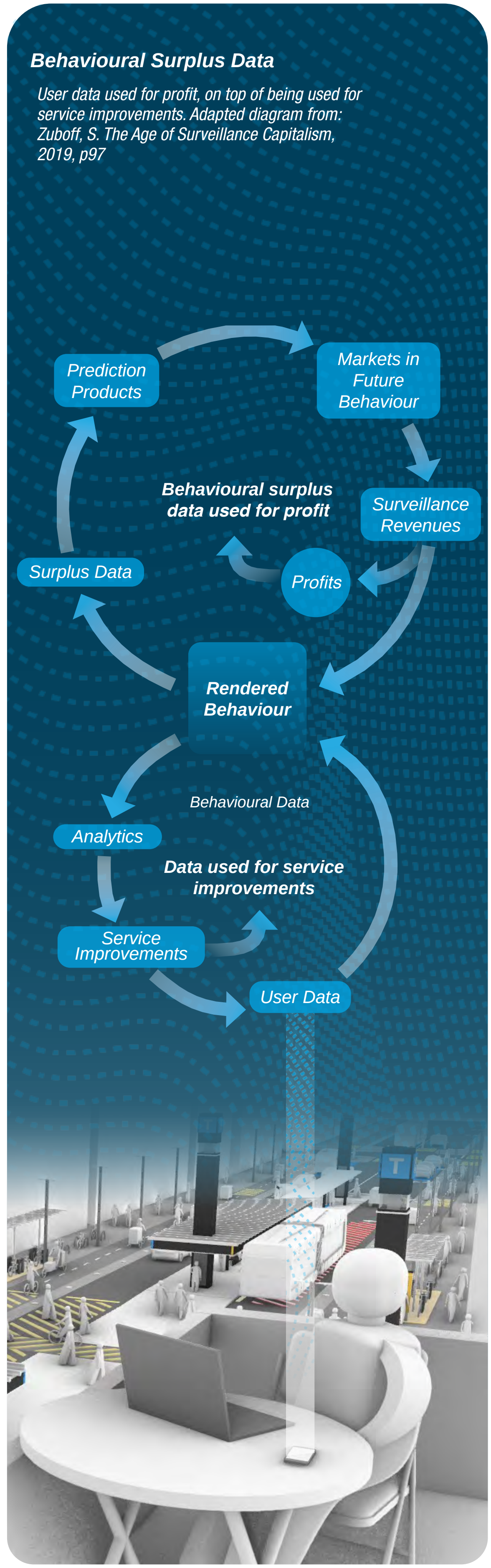
## Digital Exhaust in the Public Space

One of the main power struggles of the 21st Century is the control over data. According to Harari it is currently in the hands of giant tech corporations[15]. These giant tech corporations are called by Zuboff the 'Surveillance Capitalists' which create a new form of economy known as 'Surveillance Capitalism'[16]. In Surveillance Capitalism, data on users is extracted as raw material. Then it can be analysed across a vast array of data sets which are used (with the help of AI) to create predictions on users' future behaviour. These are traded in the 'predictive behaviour markets' to businesses which want to target users with their services or products.[17]

Connected devices, whether mobile devices, vehicles or urban infrastructure 'emit' real-time, geolocated information in the form of data. The 'digital exhaust'[18] is a term used to describe the data emitted which is not essential for the functioning or improvement of a specific service or product. Zuboff describes this digital exhaust as behaviour surplus of which only a small proportion is being used for service improvements, while the vast majority of this data is used to make prediction products which are traded in markets in future behaviour, generating revenue for the surveillance capitalists (the large tech corporations), resulting in profits.[19] This is shown in figure 11. The digital exhaust consists of all the collateral data and data sets which may not have any implications on the user's privacy, however, it is harvested from the user data and done so without their consent or awareness, bypassing user's consciousness.

In another example, transportation payment cars were originally intended for payment management of fares and the measuring of general use of the system. For fare payment deduction one only needs to know the point of entrance and exit at stations as well as the time frame. Other data which can be derived from the trips, including transfer stations, idle times and waiting times are not released as they are not essential for fare calculation, therefore this data is seen as 'digital exhaust'. Batty shows that with this digital exhaust data collected from London's Oyster card system, one can reconstruct real-time use patterns of the London Underground system[20] with AM/PM peaks which he refers to as 'pulses'[21]. The visualization from aggregate data ('Big Data') can help identify real-time delays in the system for example.

The digital exhaust of data emitted in public space is an area which needs further study, both in terms of personal privacy and of collective benefits that can arise for optimization of city-wide services.




**Behavioural Surplus Data**

*User data used for profit, on top of being used for service improvements. Adapted diagram from: Zuboff, S. The Age of Surveillance Capitalism, 2019, p97*

15 Harari, Yuval Noah. Yuval Noah Harari on Big Data, Google and the End of Free Will. 26 Aug. 2016, https://www.ft.com/content/50bb4830-6a4c-11e6-ae5b-a7cc5dd5a28c.

16 Zuboff, S. The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power. Profile, 2019.

17 Idem

18 Zuboff, S. The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power. Profile, 2019, p90.

19 Zuboff, S. The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power. Profile, 2019, p97.

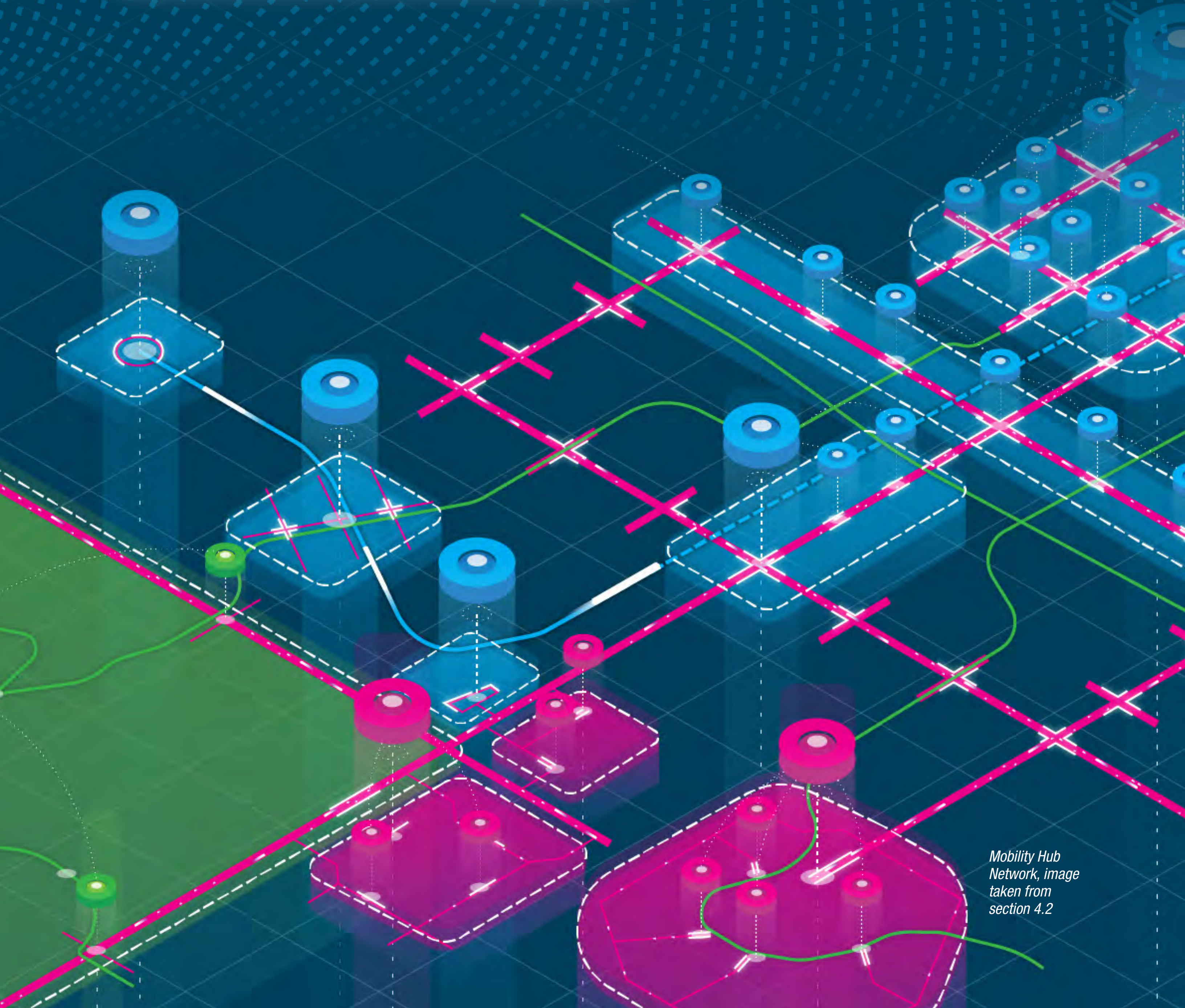
20 Digital Twins, Triplets, and the Rest: Families of Simulation Models for Urban Analytics. 2020. YouTube, https://www.youtube.com/watch?v=Ov4r0wn_hy4.

21 Batty, M. Inventing Future Cities. MIT Press, 2018.

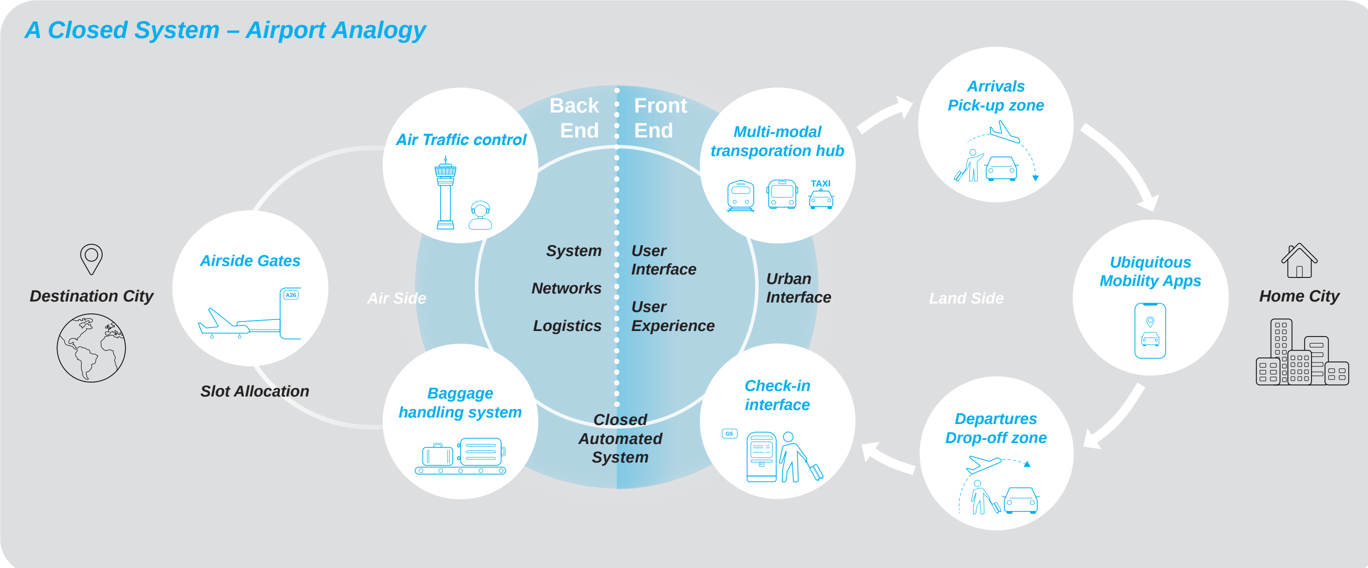
# 2.3

## Airportization of Mobility

'Airportization' is an abstract term, an oversimplified analogy of a 'closed system' creating a framework for the architecture of a connected urban mobility network. It requires a front-end urban interface, while in the back end an operational system to manage and operate the use of public infrastructure destined for shared and connected urban mobility services. Here MaaS plays an important role, setting the ground for an Urban Mobility Hub Network.



*Mobility Hub Network, image taken from section 4.2*




*Airport as an analogy of a closed system – back-end and front-end. User Interface, User Experience and Urban Interface of terminal with city*

'Airportization' is an abstract term, an oversimplified analogy of a 'closed system' creating a framework for the architecture of a connected urban mobility network. It requires a front-end urban interface, while in the back end an operational system to manage and operate the use of public infrastructure destined for shared and connected urban mobility services. Here MaaS plays an important role, setting the ground for an Urban Mobility Hub Network.

Airports, as opposed to the urban fabric of a city, are public accessible locations with specific controlled regulations and form a universal point of entry to the city. 'Airportization' (term invented for this research) can be described as the process of creating a closed system, akin to that of an airport, which operators and users have to adhere to. 'Airportization' is the systematization of the space into part of a connected and controlled network. In the case of the research, 'space' refers to 'public space of the urban realm', while the 'network' refers to the 'urban mobility network'. 'Airportization' refers to a framing of design standards which may support a future mobility system that can be used collectively and universally.

## Closed System

As the data economy is driven largely by prediction data, the ability to make predictions more accurate increases if there is more certainty. A closed system is an ideal environment for higher certainty and therefore more predictability. As philosopher Karl Popper argues that "*only in entirely closed systems – can you ever have complete certainty.*" [22] The notion of a city as a closed system is highly problematic as there will always be external factors influencing that environment, as well as continued growth and the undefinable (geographical) limits of the system.[23] However, city infrastructure, mobility and transportation systems do function in environments which are largely planned. An example for a man-made mobility system which functions in a 'closed system' can be seen as airports and how they are linked globally in a standardized network of airports.

An airport can be described as a closed automated system transporting passengers and goods. One which strives for minimum real-time surprises and maximum predictability of service, both on the land side

22 Batty, M. Inventing Future Cities. MIT Press, 2018.
23 Batty, M. Inventing Future Cities. MIT Press, 2018.

and air side of airports. It is fed by the back-end composed of its system, networks and the logistics, while the front-end is where passengers come in contact with the operations. Hence, where user interface and user experience come into play, as well as the interface with the external word, the urban interface.

## *Slot Allocation*

In airports, landing / parking slots allocation follows a seasonal / year-round scheduling system, with continued 'grandfather rights' to book popular time slots to carriers that comply with a minimum 80% usage, this explains the phenomenon of 'ghost flights' during Covid pandemic.[24]

An iteration of such a booking system may potentially gradually replace some desired and popular time/place locations, such as curb space with high demand for temporary occupation. In the context of the street, the current working model is a first-come-first-serve model, allowing for flexibility and public use, yet this is being challenged by apps like Curbflow[25] and Curbd[26] to book slots for unloading zone curb space usage (see 4.4.5).

## *Terminal Urban Interface*

The urban interface of an airport is the point of contact with the land-side of the airport, as well as the gateway to the airport's home city. Arrival and departure terminal design has become relatively standardized internationally, as wayfinding and terminal layout design assist with orientation for first time arrivals or frequent users alike. It is a place where different modes of transportation are offered and connected, with a higher degree of predictability towards the frequency and availability of mobility services offered.

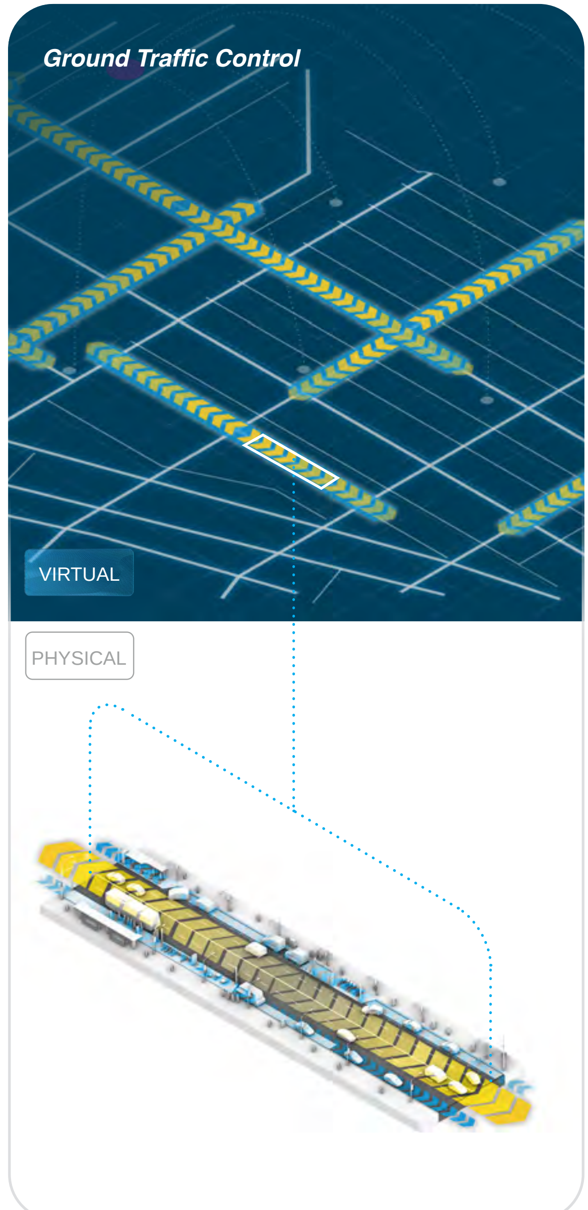
In the urban interface context, adequate ride-hail pick-up allocation in a designated zone in the airports terminal have been incorporated in many airports. In some airports such as in Los Angeles, a special PU-DO terminal has been designated (LAXit)[27]. Geofencing makes it possible to send users to a specific pick-up location, as well help with regulation of TNC usage. It also allows users to become independent from local transportation ticketing or currency systems, as the user utilizes apps which work in multiple cities.

## *Ground Traffic Control*

Traffic control centers can coordinate traffic signals and access connected urban infrastructure. Communication technology of V2I (Vehicle to Infrastructure), V2V (Vehicle to Vehicle) and V2X (Vehicle to Everything) may eventually become ubiquitous, paving a path to (in theory) a more regulated and controlled real-time traffic management and operation system.

Even during the period of pre-adoption of AVs, one can imagine automobile operating systems with the ability to connect to a remote system. This remote system or code can be used to enforce road rules, such as the geofencing system contemplated to be deployed nationwide in Sweden.[28] Such a 'Ground Traffic Control' system could emulate the logic behind airports' air traffic control, with direct control to each connected vessel, with their real-time data on arrivals and departures.

This raises the question of who should be in charge of deploying and operating such a system. Perhaps more importantly, who will be in charge of keeping the up-to-date / valid real-time code. Who will own this algorithm? Or will it be a public good?




*Virtually coded regulation over physical movement of Mobility Space (road space right-of-way) and Transaction Space (activity on curb space)*

24 Sillers, Paul. 'Ghost Flights: Why Our Skies Are Full of Empty Planes'. CNN, 2020. www.cnn.com, https://www.cnn.com/travel/article/airport-slots-ghost-flights/index.html.
25 'CurbFlow'. CurbFlow, https://curbflow.com.
26 Curbd - The Smartest Way to Park. https://www.curbdparking.com/.
27 LAX Official Site | LAXit. https://www.flylax.com/lax-it.
28 The Swedish Transport Administration. Comprehensive Action Plan: Joint Mobilization on Digitalization for Secure and Smart Urban Environments. 2017, https://www.roadsafetysweden.com/contentassets/ca32148ed2974ba2876d48770a1de5de/ny-katalog/plan-of-action-geofencing_english.pdf.

## MaaS Integration

Mobility as a Service (MaaS) enables seamless integration between modes, each with different physical needs imposed on the public space. According to MaaSLab "Mobility-as-a-Service (Maas) is a user-centric, intelligent mobility management and distribution system, in which an integrator brings together offerings of multiple mobility service providers, and provides end-users access to them through a digital interface, allowing them to seamlessly plan and pay for mobility."[29]

'Mobility as a Service' related apps may become available in a global or regional context, similar to mobile phone service providers. This will allow users to seamlessly converge between different mobility services in different cities, providing a seamless and predictable service upon arrival at an airport. MaaS aims to create seamless integration between modes, as well as eliminating the need for separate paying mechanisms for each service. This may become even more prevalent as there is a shift towards a cashless society, as well as new prevalent Data Economy business models such as the subscription model. However, in terms of the physical design of seamless integration, apart from airports one can look at the concept of 'Mobility Hubs', currently mostly used in a context of new mobility services offered at rapid transit stations. However, one can learn from airports organization and operation and apply these ideas in scaled down versions city wide to form a network. Streetscape urban design is of particular importance, as seamless integration between modes of transport can follow 'Airportization' logic. Chapter 4 applies these concepts in greater depth.

## Transit Oriented Mobility Hub Network

It is possible to imagine a city-wide network of Mobility Hubs, functioning like a network of inter-connected airports, each as a closed circle, together functioning as a piece in the entire network. The system could be broken into hierarchies and different urban typologies, this idea is further explored in 4.2.

Analogous to airports, dealing with passenger, freight, private and low-cost air traffic, the Mobility Hub Network could include transit and new mobility options. The speculative proposal in Chapter 4 explores a transit-oriented system which is anchored around transit in distinct common urban typologies.

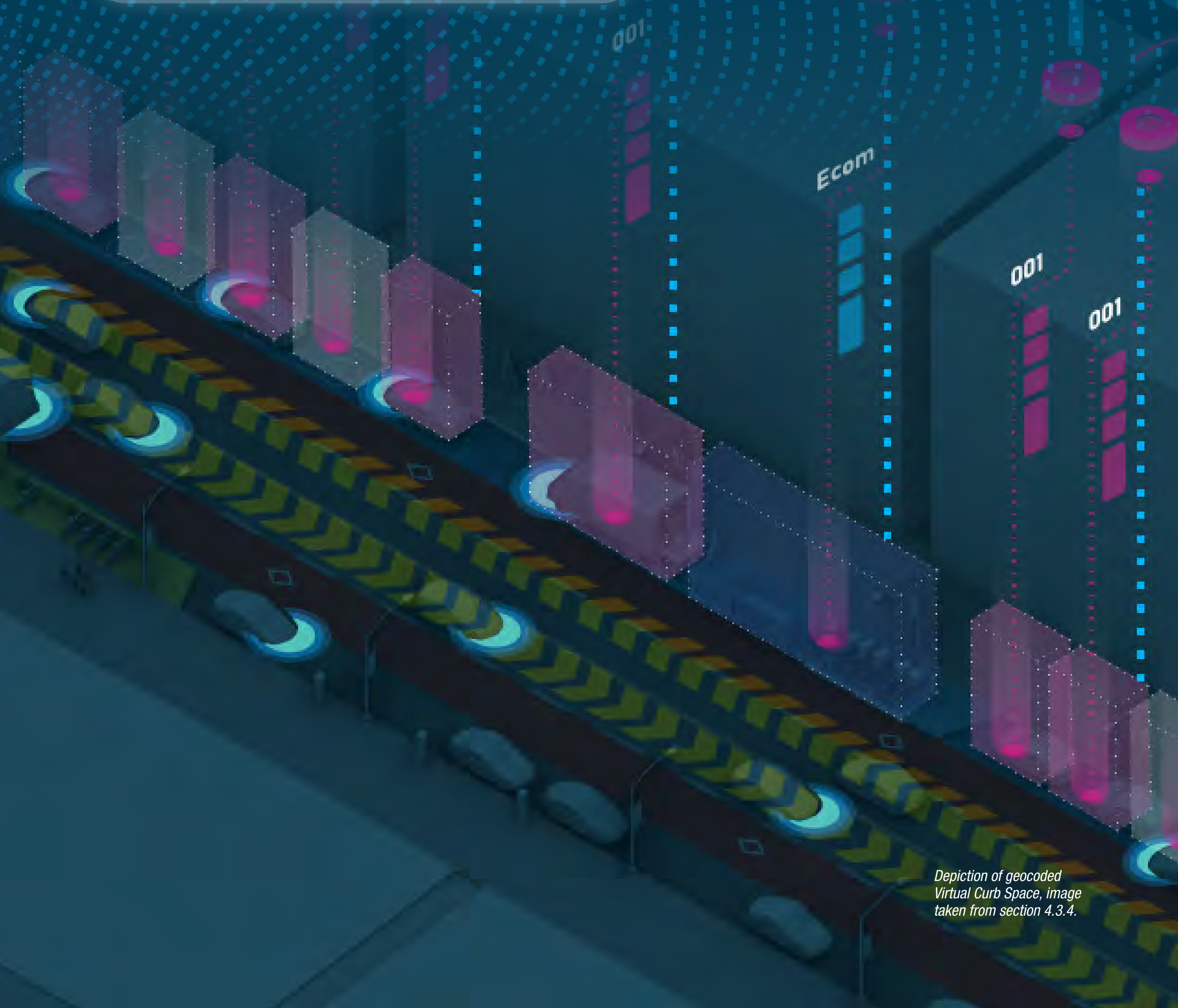
29 Kamargianni, M, et al. The MaaS Dictionary. MaaSLab, Energy Institute, University College London. July 2018, https://www.maaslab.org/.


*In the macro scale – the Mobility Hub Network composed of different urban typologies (see section 4.2). In the local scale, Mobility Hub design translates into terminal logic. Transit & PU-DO terminal taken from visionary phase (Phase 3), see section 4.3.5.*

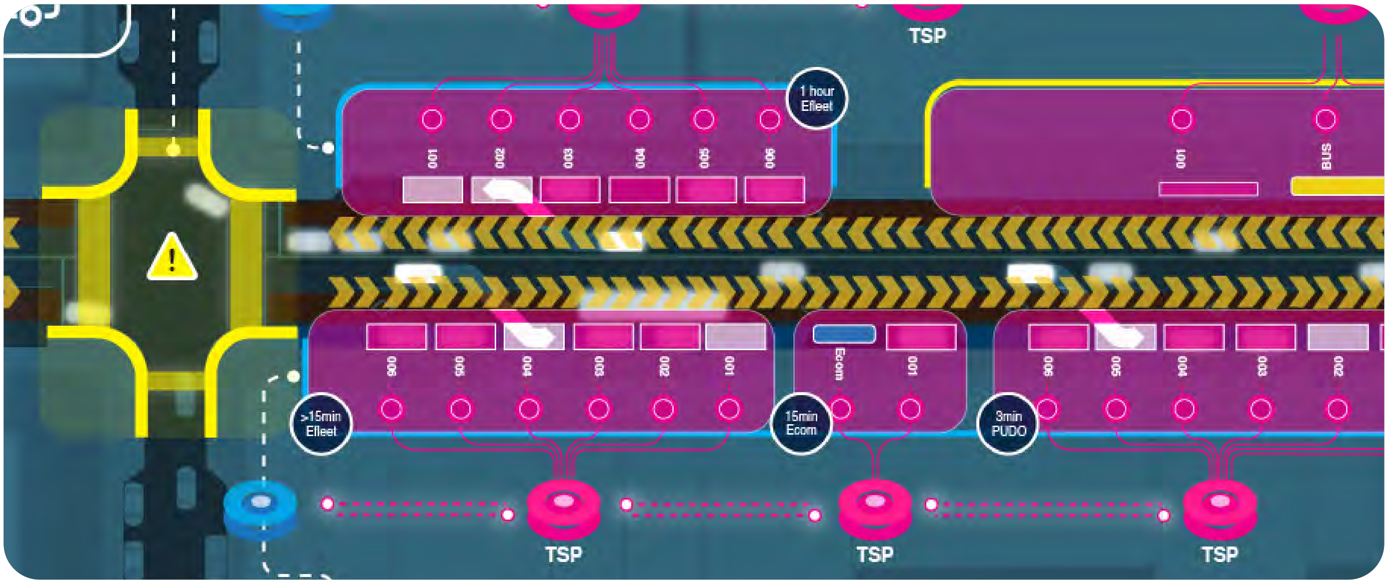
# 2.4

# The Virtual Curb

The Virtual Curb Space is the building block, the unit from which the Urban Mobility Hub Network can be built from the ground up. It connects the physical space and its virtual counterpart through geo-coding of each space within a larger logic. Hereby it is possible to remotely manage and operate this monetizable and bookable space on-demand. The idea of Virtual Curb Space Real Estate can reframe and reimagine the economic logic of the current public space revenue model of curb space.




*Depiction of geocoded Virtual Curb Space, image taken from section 4.3.4.*

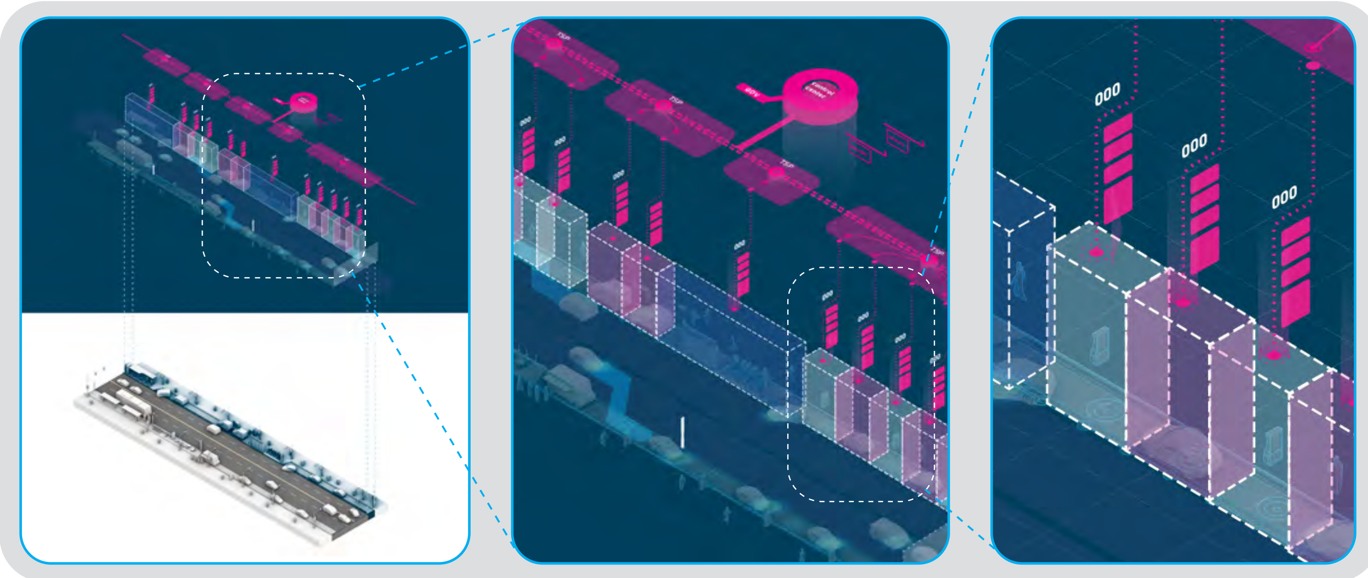



*Depiction of geocoded street space with Mobility Space and Virtual Curb Space. Image taken from case study section 5.2.1.*

The physical curb space is part of an infrastructure present in every urban space wherever paved roads exist. It's near omnipresence and continuous spread throughout the city make it a backbone on which one can string an array of different recurring uses and activities. Systematizing and streamlining the recurring uses of curb space and their individual business models will be needed in order to digitally connect physical spaces to 'Virtual Curb Space'. The curb space is therefore a key component in the process of digitization of the urban realm.

The participation in the data economy (as discussed in section 2.2) may influence the economic model of the virtual curb, as virtual public space leans toward private interest, dictating its demands according to market dynamics. In this sense the virtual curb's primary reason to justify its existence is arguably more an economical one, rather than one stemming from a need for optimization of operations through efficiency or increasing the convenience of its uses. The virtual curb's raison d'etre in the strict sense is to be able to charge a usage fee. While in the rational sense, it is to serve as a trip- origin, stop-over point, or destination, facilitating the movement of passengers, services and goods with postal codes or geographical locations within the urban realm. Virtual curbs could therefore be imagined as transaction spaces between movements and activities, while serving as a virtual and automated charging system for usage of physical public space for a specific purpose for a specific amount of time.

The physical geographic space which the curb space occupies, although a public good, functions as a valuable real estate in the city, whose value can be derived from the degree of which the use of its space is contended, by many different actors. It functions both as real estate as well as a transaction space, one which has various forms of revenue for usage of the space. This is true today, even before any substantial digital transformation has occurred, in this context we can ask ourselves what would happen if this valuable real estate gets connected to a wider city network and 'goes on-line'? A design speculation for this scenario is explored in Chapter 4.



*Zooming in on the Virtual Curb Space. From left to right: Virtual and Physical representation of curb segment. Connection of spaces to Transportation Service Provers, urban network. Individual curb space identification.*

## Geo-Coding the Curb

The 'Virtual Curb Space' is the virtual space corresponding to the physical curb space. It functions as a geo-coded layer visualized 'on top' of its physical counterpart. Here any legally binding information of permitted uses can be coded, as well as operational and optimization related data points. It can be realized by the use of Geofencing technology which needs to either be coded in the users' devices or can be coded as openly accessed data which third parties refer to, in order to legally use the physical space.

For the virtual curb to be systematized, managed and operated, each curb space needs to be coded with its regulations, permitted uses, times of operations, enforcement mechanisms, charging for usage and payment systems. As each designated space is geographically unique, there is a need to geographically code curb regulations and have a universal retrieval system. While there may be different business models and payment possibilities, there can only be one clear non-conflicting regulation for each space at a specific time. In the long-term vision, the algorithms overseeing the activities eventually become the 'final authority', as power shifts from the physical to the virtual realm (3.1). Implicating a strain on resources which are dedicated to digital transformation in municipal councils and transit authorities. Therefore, creating systematical, easy to codify policies is essential to respond to the changing demands of new technologies and business models.

Coding curb space can initially be done by creating an inventory of permitted uses and times, this can be done by using different curb management software (such as Coord[30]). The data can be used to create analytics, enabling the virtual simulation of scenarios which can then be tested in physical space. As this system evolves, it can be incorporated within a city-wide network with real-time demand and response which can only be done through automation.

30 Coord. Home I Coord. https://www.coord.com.

## Operation & Management

The 'Virtual Curb' provides the ability to connect to a city-wide mobility network through the mechanism of 'Airportization' (2.3), making the physical curb space an extension of the mobility space. In the context of curb space uses for permanence (1.3), if all uses are systematized, there is a possibility in the long-term to manage and operate this space digitally and remotely. The key to integral operation and management of this space is related to the control and standardization needed in order to respond on-demand to the stream of real-time data of its current use, as well as scheduled future use (booking).

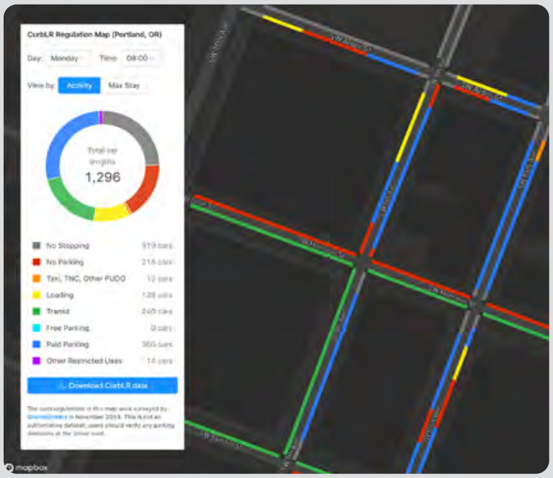
Optimization of the curb stock can be done through analytics of the curb usage over time. Here, reconfiguration of curb uses in 'underperforming' street segments can be simulated virtually and later changed on ground. The mapping of a city-wide or district area can retrieve a geographically fragmented inventory. A process of periodical 'defragmentation' of city-wide curb stock can help calibrate a specific district's needs. It can also help with the gradual reallocation of space to more sustainable modes to meet desired municipal targets, this can be done in an incremental, yet holistic way.

Curb or transport data management software such as Coord,[31] Inrix,[32] Remix[33], Streetlight Data,[34] or SharedStreets,[35] offer tools to code, analyze and simulate curb inventory. These are looking at developing an open data standard for the curb, such as the 'CurbLR',[36] which can then be used by different governmental agencies and third parties for mobility related apps for parking or loading activities. Parking management software combined with physical sensors can be used to indicate and allocate in real time availability of space for use.

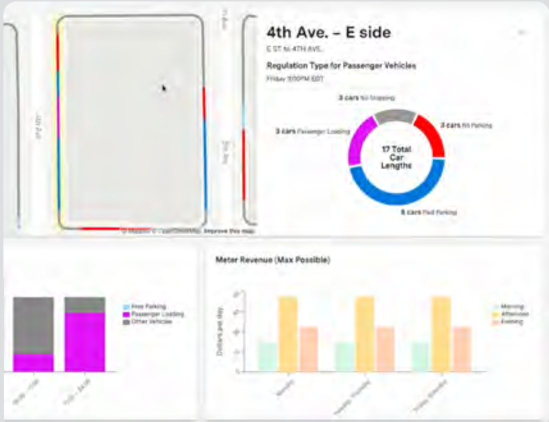
The real-time data can be used for enforcement by actioning an alert through physical means, or virtually through charging a fee, or by providing notification to user or operator on a device. The 'Virtual Curb' provides the possibility (in the long run) to enforce the digital usage of the curb solely through digital means, such as geofencing and blockchain technology. However, in the foreseeable future, back-up enforcement verifications other than enforcement officers, such as sensors or cameras may be required to be physically installed at near proximity. Here one can raise concerns over surveillance technologies, residing on both ends of the spectrum from 'state surveillance' to 'surveillance capitalism', with their respective potential concerning impacts which need to be studied further.

31 Coord. Home I Coord. https://www.coord.com.
32 Home - INRIX. https://inrix.com/.
33 Remix I The Collaborative Platform for Transportation Decision-Makers. https://www.remix.com/
34 Transportation Analytics On Demand I StreetLight Data. https://www.streetlightdata.com/
35 SharedStreets. 'SharedStreets'. SharedStreets, https:/sharedstreets.io/.
36 CurbLR. https://curblr.org/.

### Curb Space Management

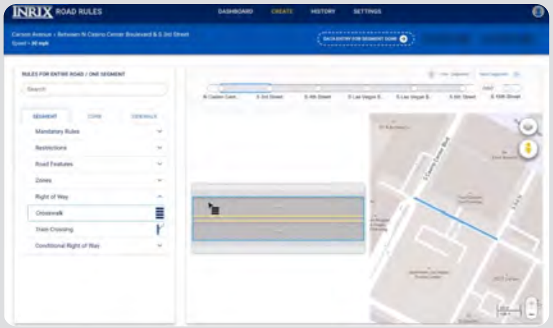



Curb regulation map (CurbLR) data from SharedStreets




Analytics of curb space use (Coord)


Regulation of use and time of day per parking spot (Coord)




Simulation of road rules for segment of street (Inrix)

## Bookable vs. On-demand

The ‘Virtual Curb’ provides the opportunity to create a bookable reservation time slot system for future curb use. This is similar to the landing slots used in airports (2.3) potentially guaranteeing prime time slots for different providers. In such a scenario large companies may end up monopolizing the use of prime locations, while new entrants may be deprioritized, a concern which requires further study.

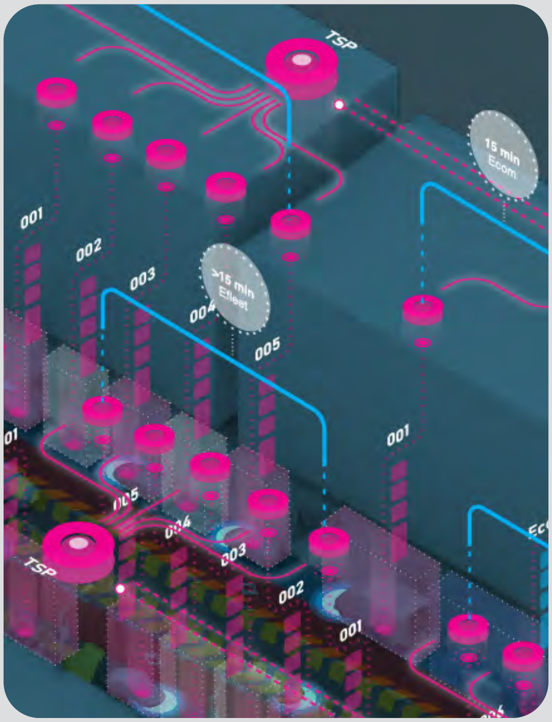
An example of a functioning booking system can be seen in two curb use operation apps such as ‘Curbflow’[37] and ‘Curbd[38] which allow booking of short time slots for drop off or unloading of goods at a specific curb location or parking spot designated to use only through the specific app.

A specific zoning could designate a physical area to be available for pre-booking, while other curb spaces can be designated ‘on-demand’. On-demand curb space allocation can be zoned to keep specific curb space locations ‘un-bookable’ responding to first-come-first-serve logic, as in pre-digitization times. This may be a solution for transitioning phases where the booking technology is being tested or is not yet widely adopted.

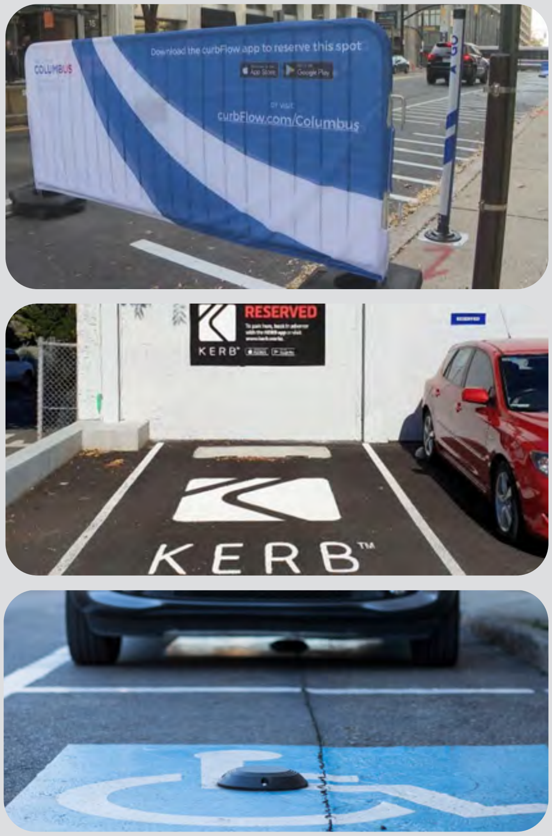
‘Smart Parking’ pilots have been conducted using sensors embedded in the road space of each curb parking space, linked to communication devices in lamp posts of the same street segment, these can be linked to a city-wide notification system, or to an app.

The problem arising with booked spaces, is how to guarantee the availability of the booked space prior to the vehicle arriving at the designated space. While this can be done virtually (by blocking off a reservation), it cannot be done physically. In order to enforce the misuse or erroneous use of space, physical infrastructure may need to be required such as sensors, as well as on-site enforcement personnel. Theoretically, as we shift towards increased automation, this may be resolved in alternative ways, which need to be explored.

37 ‘CurbFlow’. CurbFlow, https://curbflow.com.
38 Curbd - The Smartest Way to Park. https://www.curbdparking.com/.




*Detail of coded Virtual Curb Space regulation with restriction of usage per time and use, and connection to Transport Service Provider network.*




*Curb space reservation: Curbflow drop-off and delivery (top), Kerb parking (middle), parking sensor (bottom).*
Images: Top: WSYX/WTTE - https://abc6onyourside.com/news/local/kicked-to-the-curb-some-downtown-businesses-not-a-fan-of-new-delivery-zones / Middle: Kerb Twitter @kerbparking / Bottom: Libelium - https://www.libelium.com/libeliumworld/success-stories/iot-technology-to-monitor-parking-for-disabled-citizens-in-the-north-of-spain/

## Monetization & Pricing the Curb

The existing current revenue model of charging fixed rates for on-street parking is being challenged, Shoup argues for the benefits of charging market rates for competitive spaces about getting the price 'right', as well as a clearer oversight of revenue-destination directly to local streetscape improvement and business improvement associations for example.[39]

The 'Virtual Curb' provides the possibility to charge for digital usage without additional physical infrastructure, once a virtual charging system or monetization strategy has been put into place. It is possible to virtually charge market rates for usage of space in a responsive way through dynamic pricing. In the long run, the evolution from the traditional physical parking meter into pay-by phone apps may continue evolving into an acceptance of dynamic pricing by the general public, as ideas such as surge pricing (for example Uber) are normalized. The charging of space usage will be shifted to the fleet operators, as the curb usage charge becomes predominantly a business-to-business activity rather than business-to-client. Here individuals are using a service mediated by a third company, which may choose to transfer the additional charge to their clients depending on their business models.

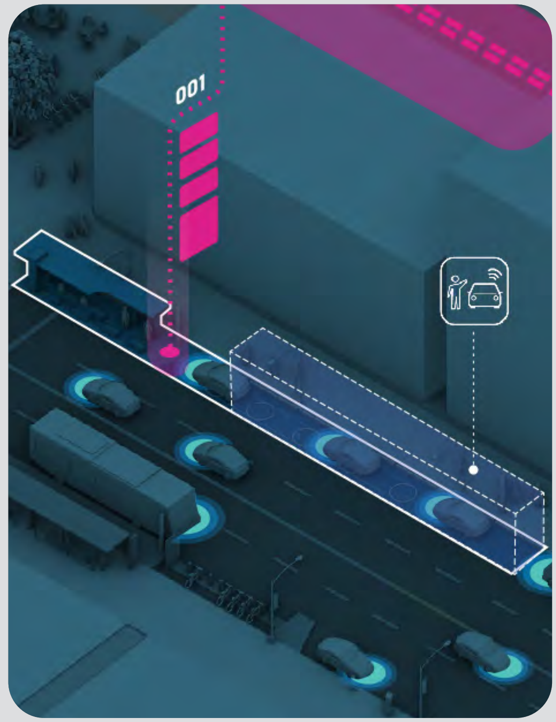
The digitization of the curb can lead to new revenue models which can be more sophisticated and more fine-tuned to real-time usage and demand, as well as allow municipalities to limit or prioritize specific uses that are more sustainable. The different uses and activities that may be charged include amongst others:

- Temporary time-based storage (parking) for private vehicles and shared fleets, following market rates.
- Pick-up drop-off fees for ride hail and short duration permanence of 3 minutes, which is currently already put to use in different cities.
- Loading and unloading fees for commercial and delivery services.
- Booking fees for spot pre-reservations for fleets or commercial activity.
- EV charging fees, whether connected or wireless

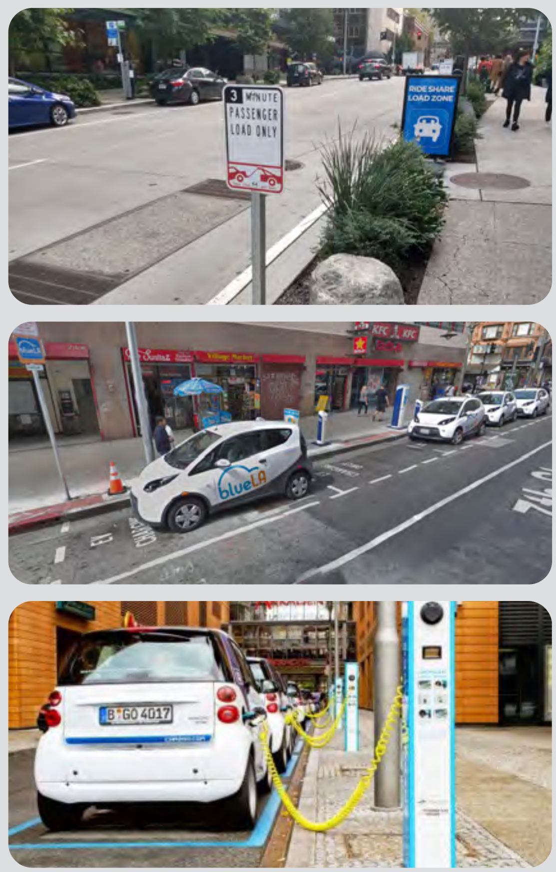
This raises questions on how to monetize the curb? Should this be done in a unified system which overlooks all the uses mentioned above, in addition to new uses in the future? Or should each use have a different charging system and economic logic to it, in order to fit the various needs of the specific activity? As the different uses are represented by different companies using different apps, currently, it is more logical to take the siloed approach of the creation of a different charging logic for each use, one which corresponds to the time and spatial needs of each activity. However, in the long run, one can imagine a unification of these charging logics into an eco-system which understands the different logics and the gaps between the different uses. Symbiotic relationships between the uses are built into the rationale of its dynamic fee structure.

On-street recharging of EVs batteries, whether with a plug or in the future wireless, can also be virtually charged (fee per usage). However, the latter would require large scale physical infrastructural changes, which may become viable in a scenario where EVs have been widely adopted. On the other hand, such an initiative may help expand and normalize use of EVs as ICE vehicles get phased out in the 2030s and 2040s.[40]

39 Shoup, D. The High Cost of Free Parking: Updated Edition. Taylor & Francis, 2017.
40 Phase-out of Fossil Fuel Vehicles'. Wikipedia, 26 Mar. 2021. Wikipedia, https://en.wikipedia.org/w/index.php?title=Phase-out_of_fossil_fuel_vehicles&oldid=1014327103




*Example of PU-DO zone, virtual curb space, image taken from 4.4.4 phase 2.*



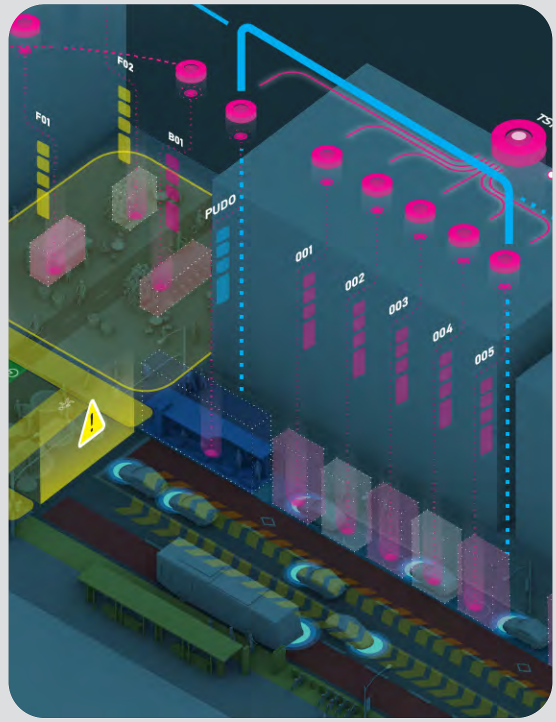

*Curb space occupation for limited 3min pick-up drop-off, Seattle WA (top), EV car-share fleets, Los Angeles CA (middle), EV car-share fleets, Berlin, Germany (bottom).*
Images: Top: Y. Fogelson | Middle: Google Streetview | Bottom: Avda www.avda-foto.de - https://en.wikipedia.org/wiki/Plug-in_electric_vehicles_in_Germany#/media/File:Berlin_-_Potsdamer_Platz_-_E-Mobility-Charging.jpg

## Virtual Curb Space Real Estate

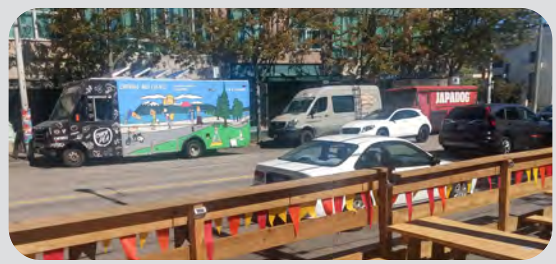
The ‘Virtual Curb’ provides the possibility to form a ‘virtual curb space real estate’ which, in essence, is a ‘floating’ real estate rental system of land use based on time (both in its duration, as well the time of day, date and year). There emerges a new form of real estate that is both physical and virtual at once, it is built upon a physical public infrastructure which is connected to the energy Internet grid as well as to a future mobility network of connected mobile vehicles and devices. The curb space is a physical public space which can be charged for its use by the general public. As a public good, it does not follow the real estate logic of land ownership. However, it can be argued that its virtual counterpart, depending on how it is structured and ‘invented’, may follow the real-estate logic, following the discussion in 2.2 on the private aspect of the virtual public space. This new real estate is virtual as well as mobile, it takes into account the virtual allocation of space to a specific use or user, in the context of new mobility service providers (B2B business model), diverging from the direct offering of a public good to a user, the electorate.

‘Mobile Real Estate’ is a contradictory concept, as real-estate is by definition a fixed unique location, linguistically in several languages ‘real estate’ is literally ‘non-movable’ goods. However, the transaction-able virtual curb space offers an opportunity to experiment with the real estate model to value demand and supply for mobility services using the curb space. The idea of the ‘floating address’ can accommodate a delivery or pick-up point for mobility/delivery services of movement of goods and people, based on a temporary legal address with a limited time validity. In this context it is possible to contemplate the process of bidding, common both in the realm of real-estate land value, as well as in the virtual space of allocation of information in website search results for example. Additionally, bidding for a space with similar characteristics and economic parameters can allocate curb space through-out the city to non-geographically specific spaces (for example any space within a radius of a specific commercial establishment), may result in multiple results which can be contested, detaching the real-estate from the specific land and allocating to a space of equal economic value.

‘Mobile Real Estate’ can be further extrapolated to the physical realm through mobile commercial space, such as food-trucks, street vendors, mobile cafes, mobile banks and other corporate promotional spaces on wheels. Here, utilizing the transaction space in favour of activation of the informal or entrepreneurial economy, can be done through lowering the threshold of entry level for local and communal digital entrepreneurship. It creates a framework to fund public space activations which have no intrinsic revenue (such as patios and pop-up plazas). The funding can happen in the form of exemption from usage charge for the physical space occupied, in addition to the provision of commercial rights to virtual usage by sponsors. For example, a company can fund a plaza for public use and in return acquire credit redeemable towards operational time/place slots strategic to their business model.




*Floating temporary ‘address’ coding*



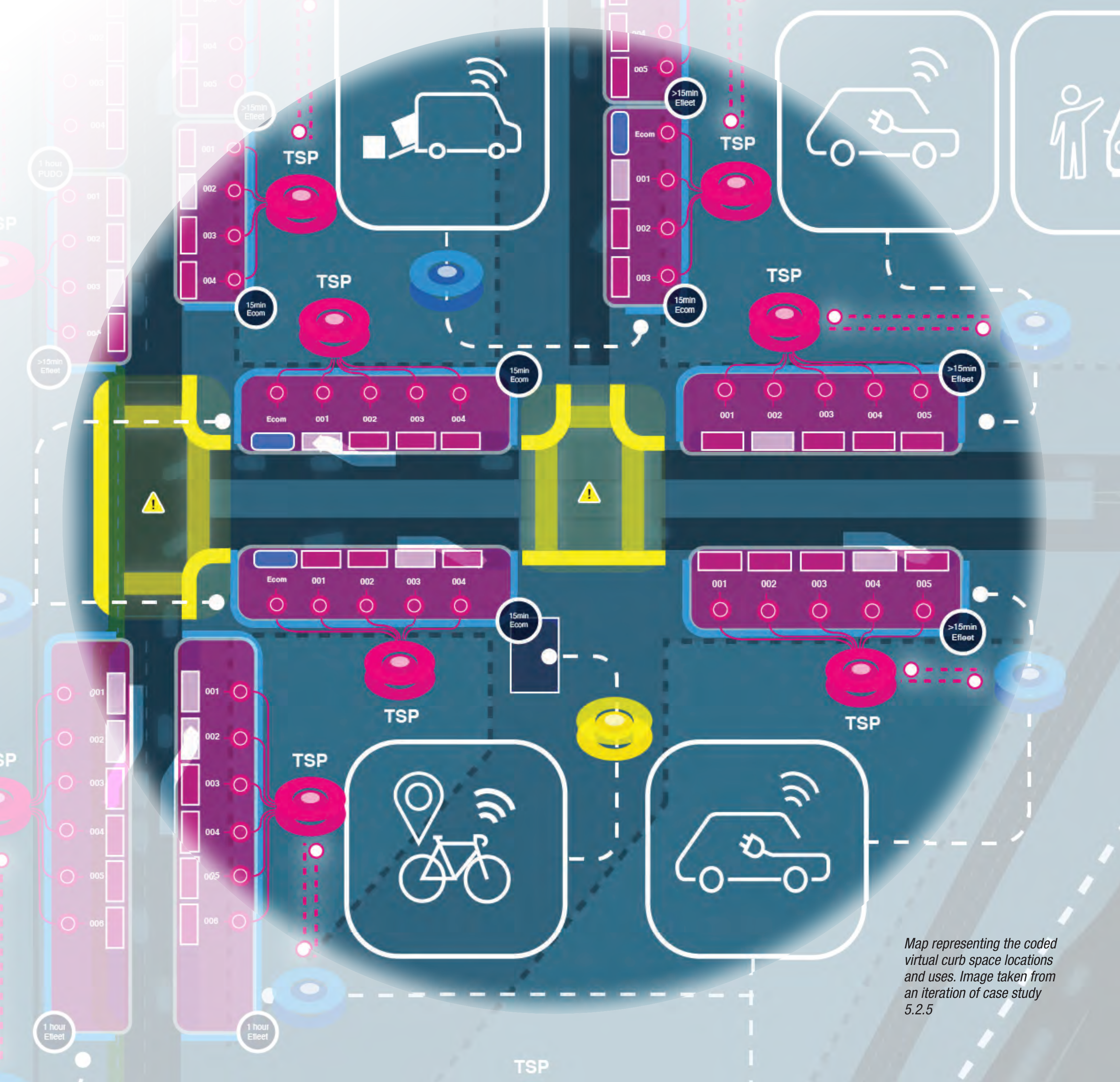


*Mobile Real Estate - Regulation of vehicular commercial activity. Example food trucks (above), mobile bank (middle), AV mobile cafe (below).*

Images: Top: Y. Fogelson | Middle: NatWest mobile bank on wheels - https://www.thisismoney.co.uk/money/news/article-3505158/Is-draughty-van-really-answer-branch-closures-NatWest-says-yes-customers-passionately-disagree.html. | Bottom: Renault EZ-PRO - https://www.automobile-propre.com/renault-ez-pro-un-concept-de-robot-livreur-pour-2030/

## *Building block of the Digital Twin*

This research helps imagine the ‘Digital Twin’ of the city as more concrete by breaking it down into smaller quantifiable economical and operational units. The virtual curb space is a logical, quantifiable unit from where to start. It can be envisioned as a ‘building block’ of the Digital Twin, as the collection of many such virtual spaces can build up a logic that is greater than the sum of its parts, namely creating a city-wide or regional network of floating space allocations for mobility uses of movement of goods, services and passengers, with dynamic pricing. This virtual network, in turn, responds to the physical network and feeds off it by its real-time usage data, making it possible to adapt and reconfigure to the real-time demand, offering a flexible urban management solution with an economic logic.




*Map representing the coded virtual curb space locations and uses. Image taken from an iteration of case study 5.2.5*

# 3

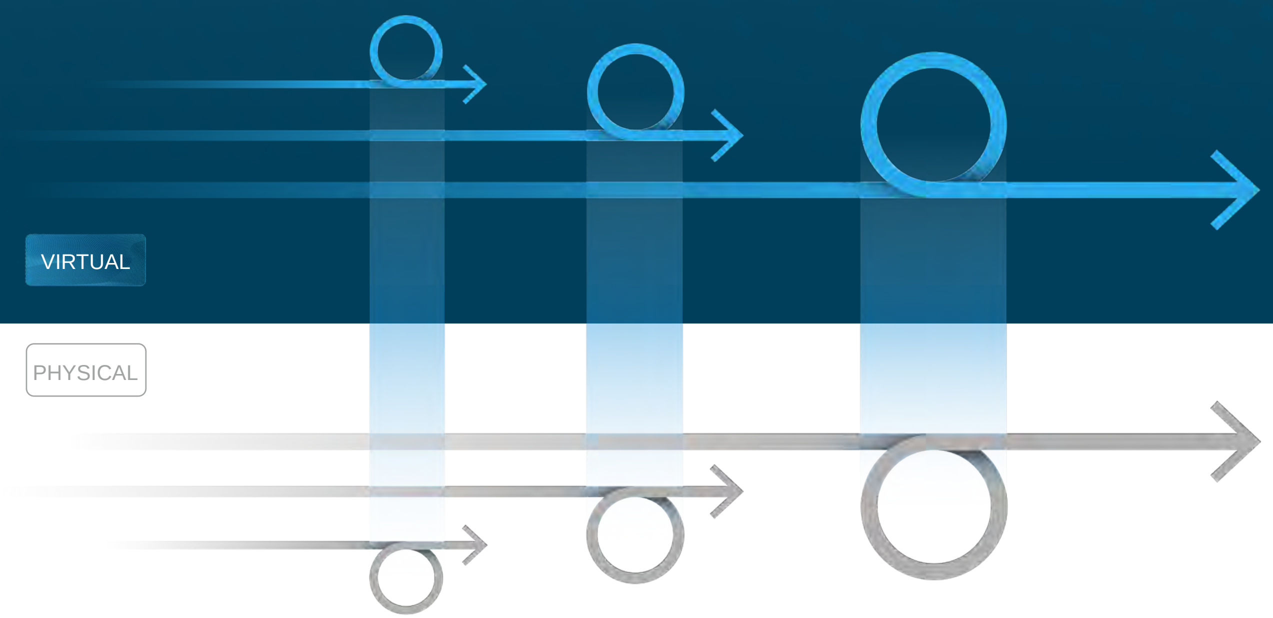
***Chapter 3** deals with the element of time in the transition into a connected, shared, autonomous future. The 'Transitional Design Methodology' lays out a 3-phased strategic and incremental approach that looks at both the physical and virtual realms. Methodologies such as Tactical Urbanism are explored, which help deal with the uncertainty and unpredictable outcomes of disruptive innovations. The discussion explores strategies to match the update rate of the digital and physical realms, which materializes itself through physical public space re-configuration. The transition process into automation will be looked at more closely and the transformation from silos to networks to ecosystems will be explored. The idea of incubation is explored to accompany the incremental expansion and piloting of new physical and digital infrastructure solutions.*

# 3 TRANSITION STRATEGY

# 3.1

## Transitioning Strategy

As we move into the second quarter of the 21st century, we are faced with a fast-changing landscape caused by economic, social, and technological disruptions. Setting a vision has become ever more difficult in an increasingly unpredictable and uncertain scenario. For this, a Transitional Design Methodology is introduced in this section, which looks at three different time-frames in both the virtual and physical realms to favor an incremental approach towards shaping future design.




*Corresponding feedback loops of phasing strategy in both the virtual and physical realms.*

## *Uncertainty & Speculation*

This section was sparked by issues that are on the global agenda, while cities are questioning how to design in times of uncertainty and disruption. How can/should they respond to multiple crises: Covid-19 health crisis, financial crisis, climate crisis? How can cities move forward, taking concrete steps, while in a scenario of unpredictable outcomes related to technological advances and exponential change?

In the 20th century, the planning profession leaned towards a mono-functional visionary approach, with the planning of entirely new cities or an expansive network of highways and physical infrastructure designed and built to be durable. This approach means that extreme inflexibility is a built-in feature of the design. In response, the 21st-century paradigm has shown that there is a need to consider further life-cycles of previous unsuitable or inadequate urban infrastructure. It can be argued that planning has become a less visionary top-down endeavor of the few as it is moving towards an approach of co-creation and finding ways to balance top-down targets and goals with bottom-up needs and demands. It can also be argued that in the 21st-century scenario, what can be classified as a visionary approach in planning may be associated with the struggle to respond to the climate crisis and the reduction of GHG emissions towards a more sustainable distribution of energy, resources, and use of the land.

Cities are often reactionary in the face of innovation and the uncertainties which come with it. They fear the disruptive ramifications which may misconfigure current working models and cause discontent amongst its constituencies. This can explain the distancing and rejection by the planning and design professions from large-scale visionary approaches which were more common in 20th-century city visioning.

Meanwhile, the private sector and giant tech corporations are leading the way in urban innovation technologies and consequently affecting the direction of the industry as a whole.

The ultimate responsibility rests on the shoulders of the public sector, which needs to be very explicit about 'setting the rules of the game'. These should be composed in a way that enables pluralistic innovation in a manner that responds to challenges which cities are trying to solve.

## *Transitional Design Methodology*

The design methodology developed for this research is referred to as the 'Transitional Design Methodology'. It supports the transition from a current logic to a future logic under the process of digitization and automation. In the case of this research, the methodology was used to focus on transitioning into new mobility, in the urban context. However, it is possible that this methodology can be adapted to other fields that require the digitization and automation of urban networks, such as: urban freight, energy grid and charging of vehicles, waste collection and management, or the integration of communications technologies within the urban fabric.

The Transitional Design Methodology lays out the design process of a project along a timeline through a strategic phasing strategy. It looks at each of these phases through two lenses: the virtual realm, and the physical realm.

Looking at a timeline from today (A) to this desired future scenario (Z), many possible future scenarios exist, ranging from the 'probable' business as usual to the limit between the 'possible' and the impossible, namely the 'Utopian'. The design explored in Chapter 4 tries to envision and speculate on a 'possible' future scenario which is also desirable. The goal is to use the desired scenario (Z) as a guide, a long-term vision. With this vision in mind, it is easier to justify proposed changes and experimentation in the near-mid-term (B) that fall in line with this future vision (Z), regardless of whether this future scenario eventually emerges.

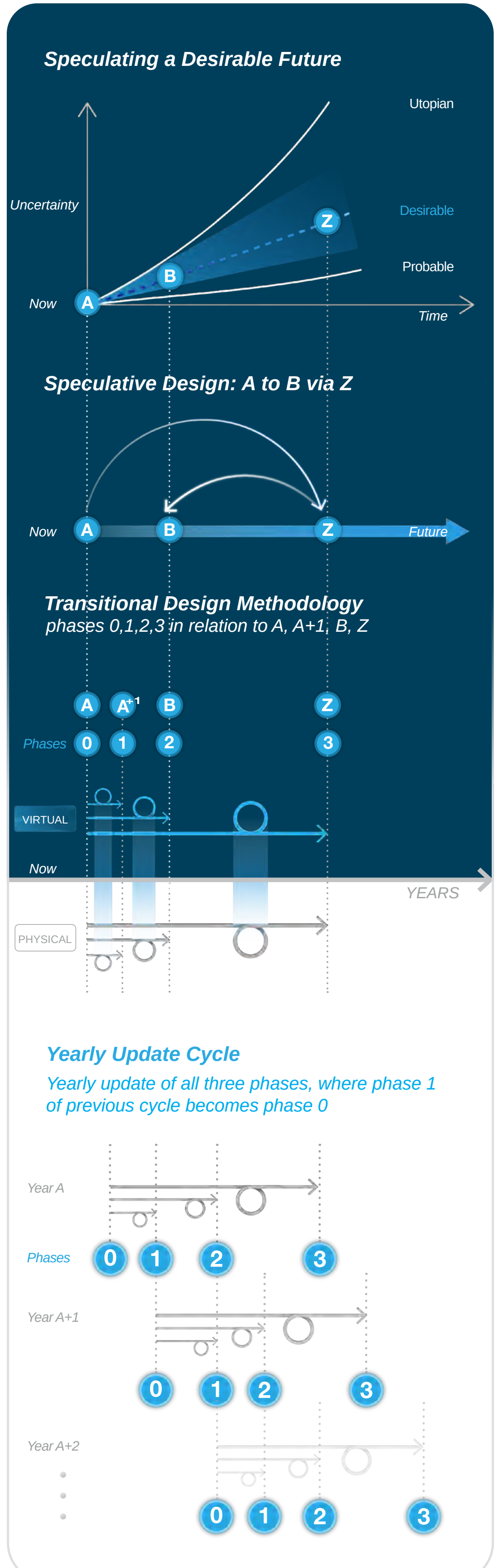
A complementary approach to speculative design, is thinking of a timeline of how to get from 'now' (which they refer to as 'A') to a possible future. Ruecker and Radzikowska highlight the persuasive role of a future design vision based on a remarkable unlikely future, which they refer to as 'Z'. In such a way, a speculative design can entice decision makers (or clients) to think further ahead than moving from A to A (+1) and venture further to B. Therefore, the presentation of a hypothetical long term 'Z', can have a role in shaping the short-term actions. They call this notion of speculative design 'A to B through Z'.[41]

Speculative design facilitates the transition process by providing a path of getting from A (today) to B (near future, political mandate), guiding decision-makers in moving forward. The design phases explored in this research coincide with 'A' being 'phase 0'; A (+1) being 'phase 1', short term; 'B' being 'phase 2', mid-range; and 'Z' being 'phase 3', which is visionary and non-binding. The visionary phase has an important role in the shaping of the direction in which the short-term phases are designed.

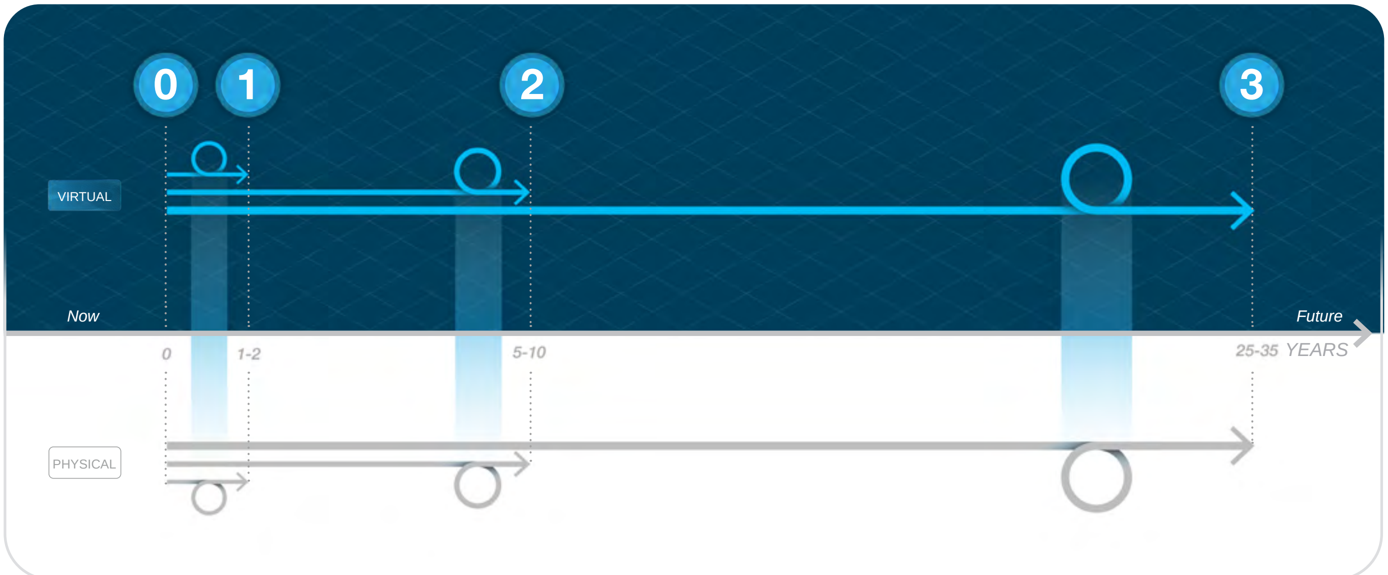
The Transitional Design Methodology is composed of three phases within a logic of a phasing strategy: the short term, the mid-range, and the visionary long term. The three different time frames are dealt with both simultaneously and sequentially, meaning that although the midterm is sequential and by definition comes after the short term, it defines the elements which are being tested in the short term and are backward engineered to their rudimentary form with technology and equipment that are available at the time. In the case of the vision, its necessity comes in the form of a future (arbitrary and hypothetical) anchor. In this anchor goals and targets are set, even if they are hypothetical at this point.

While there are urban strategies that get updated periodically, major urban visions are usually produced in greater intervals and therefore require visioning and future speculations and assumptions.

In the Transitional Design Methodology, it is assumed that a yearly update of all three phases occurs, this creates a cyclical design cycle, mimicking the idea of a design that is in constant flux, influx.




41 Radzikowska, Milena. Speculative Design: A to B through Z. 2020. Vimeo, https://vimeo.com/448099933.




## Phasing Strategy

### 1 Phase 1

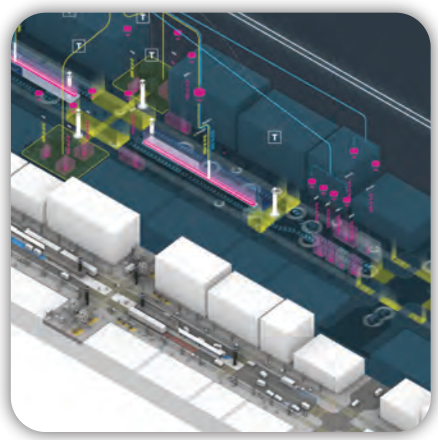
The first phase, which is implementable in the 'immediate' time-frame of 1-2 years. This phase sees the testing of local, isolated, and siloed digital technologies in the area of communication, surveillance, new mobility, and civic tech, this is done through pilot projects and incubation.

### 2 Phase 2

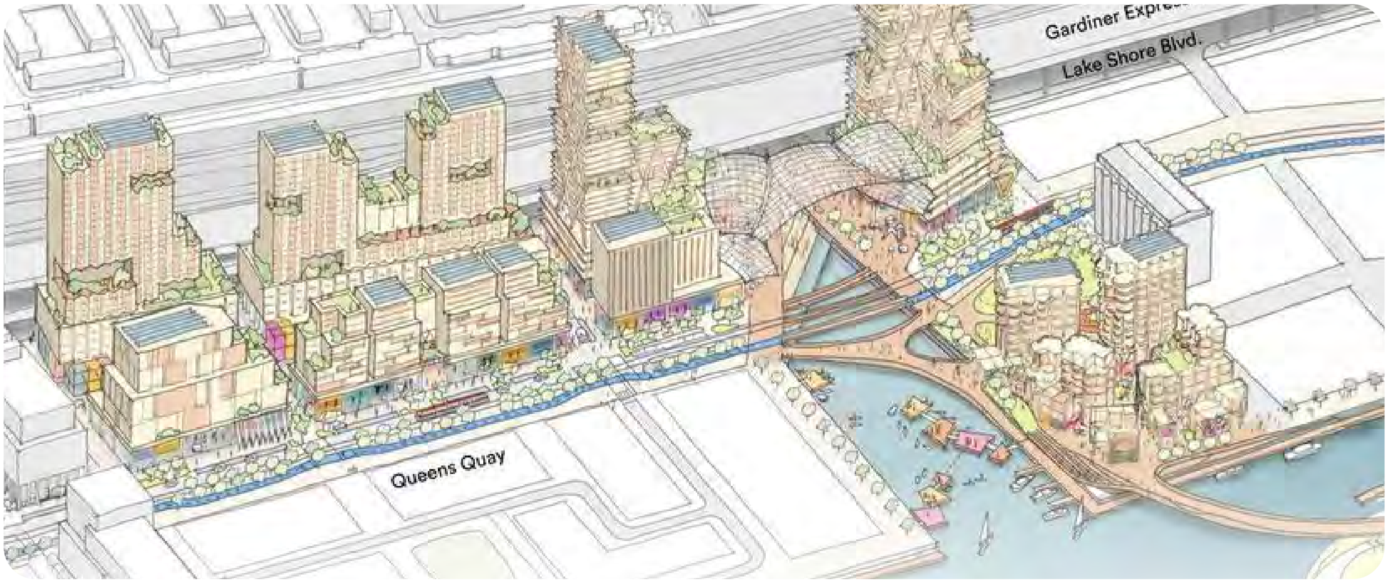
The second phase, in the mid-range of 5-10 years, coinciding with political mandates. This phase sees the concretization of successful piloting from the first phase. The number of mobility hubs throughout the city expands and a connected urban network is created, although limited at this stage.

### 3 Phase 3

The third stage is the visionary phase of a 25–35-year time span. It sees advanced connectivity where non-connected devices and vehicles are at minimum activity, while the majority of public transportation and private fleets are connected. In this vision, there is an ecosystem of interdependent activities using the urban system where the mobility hubs are embedded seamlessly with other urban planning mechanisms.



*Example of Virtual and Physical design for phases 1, 2, 3. Images taken from section 4.3.1.*




*Sidewalk Labs Toronto Quayside (discontinued) project, masterplan approach. Image: Sidewalk Labs*

## Lessons Learnt - Sidewalk Labs

Sidewalk Labs' discontinued Toronto Quayside project was proposed as a 'neighborhood of the future'.[42] Apart from the questionable tech-giant affiliation relation to city-building, it was criticized for data and privacy concerns.[43] In terms of urban design, it showcased an array of innovative design solutions such as intelligent paving or flexible curbs. Arguably, these may work within the masterplan approach of a confined urban district, however, the scalability to 'the rest' of the city and its public space has not been explored. For innovative urban design solutions to succeed, they need to be designed in a systematic, flexible (room for trial and error), scalable manner, as well as tested in everyday situations in different urban typologies, rather than in a confined Smart-city-themed urban laboratory scenario, which was Sidewalk Lab's approach.

## Covid Curbs

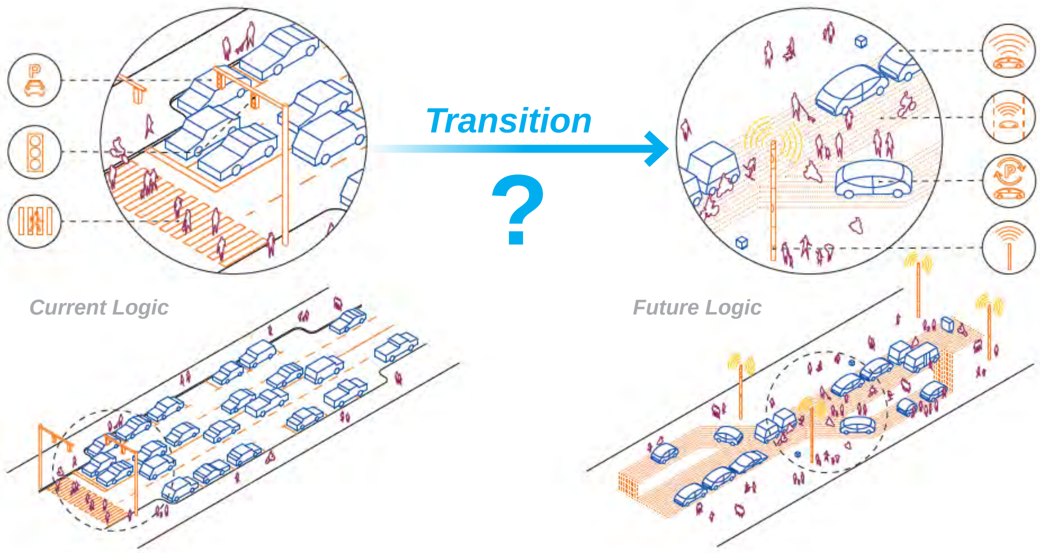
In the early months of the Covid-19 pandemic crisis, we have seen how many cities have made quick alterations to the public space in response to spatial constraints posed by new needs for social/physical distancing. Especially relevant to this research is the re-purposing of curb space for movement or permanence (see 4.3.3 for more). Many of these agile solutions are iterations of urban interventions attributed to 'tactical urbanism', a methodology that is appropriate for the informal or fast-tracking physical transformation of public space through piloting. Its agility gives it the flexibility to test out a new configuration of space in a short time without extensive planning in a non-binding way, responding well to unpredictability.



*Covid-19 curb space use for queuing (above), moving space (middle), seating area (below). Examples in Metro Vancouver area, summer 2020. Images: Y. Fogelson. See section 5.2 Case studies for more details.*

42 'Sidewalk Labs I A First Step toward the Future of Neighborhood Design'. Sidewalk Labs, https://www.sidewalklabs.com/blog/a-first-step-toward-the-future-of-neighborhood-design/.

43 Barth, Brian J. 'How a Band of Activists — and One Tech Billionaire — Beat Alphabet's "Smart City"'. Medium, 13 Aug. 2020, https://onezero.medium.com/how-a-band-of-activists-and-one-tech-billionaire-beat-alphabets-smart-city-de19afb5d69e.



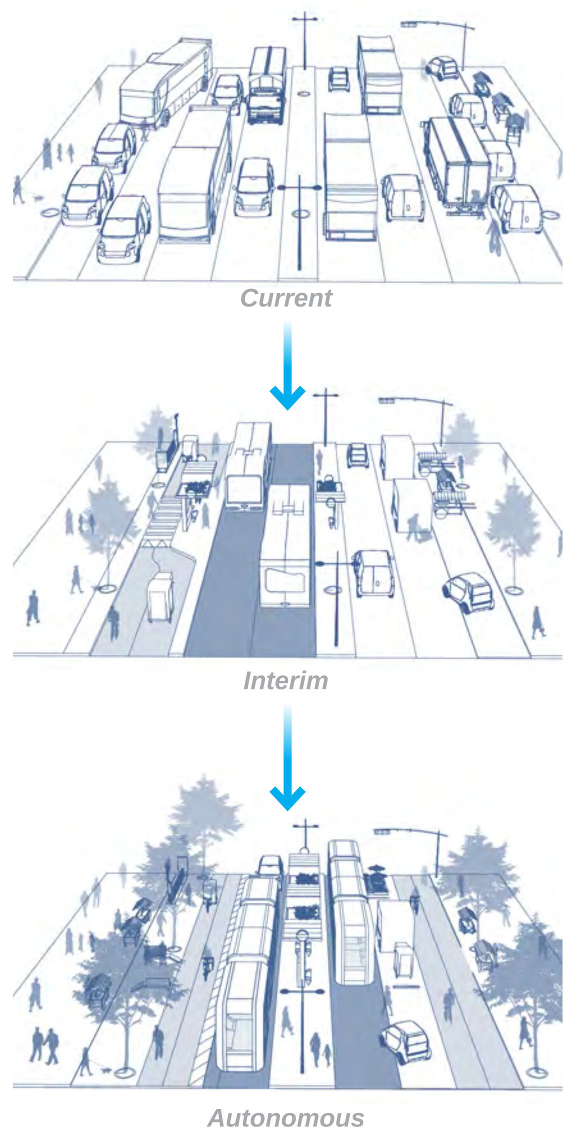

*Current logic versus an autonomous logic explored in detail, yet no provision for the transition.* Meyboom, A. L., and L. Vass. Driverless Urban Futures: A Speculative Atlas for Autonomous Vehicles. Routledge, 2019, p190-191.

## Driverless Urban Futures

There are different future visioning and design speculations on the future of the urban realm and the future of mobility. In the example of ‘Driverless Urban Futures’,[44] there is a comparison between current logic (of vehicles and their effect on land use) with a future autonomous logic (where AVs are a dominant part of the urban landscape). While the latter is explored in detail through different speculative designs, there is no provision on speculative or practical paths of how to get there. While speculative design helps cities imagine future scenarios, it is sometimes detached from the current reality, making it difficult to imagine the first steps that are needed to be taken to bridge the gap between today and the desired future. This research deals with this gap and focuses on digital transformation rather than AVs as the main driver of change.

## The Interim

NACTO’s Blueprint for Autonomous Urbanism[45] deals in depth with the reconfiguration of public space, in preparation and anticipation of autonomous mobility. It plays on the desire to make the autonomous future ‘people first’ (see also 4.3). In terms of the implementation process, it alludes to an interim phase between ‘today’ (car-oriented) and the autonomous future scenario.[46] This interim phase relies upon the assumption that collective mass transit will first receive prioritization before autonomous vehicles will potentially become adapted and widespread. However, it does not necessarily offer a wider urban mobility solution to offer more alternatives to private vehicle use (and ownership) which it seeks to replace. As a response, this research offers a proposal for an urban mobility solution, integrated with an urban design solution.



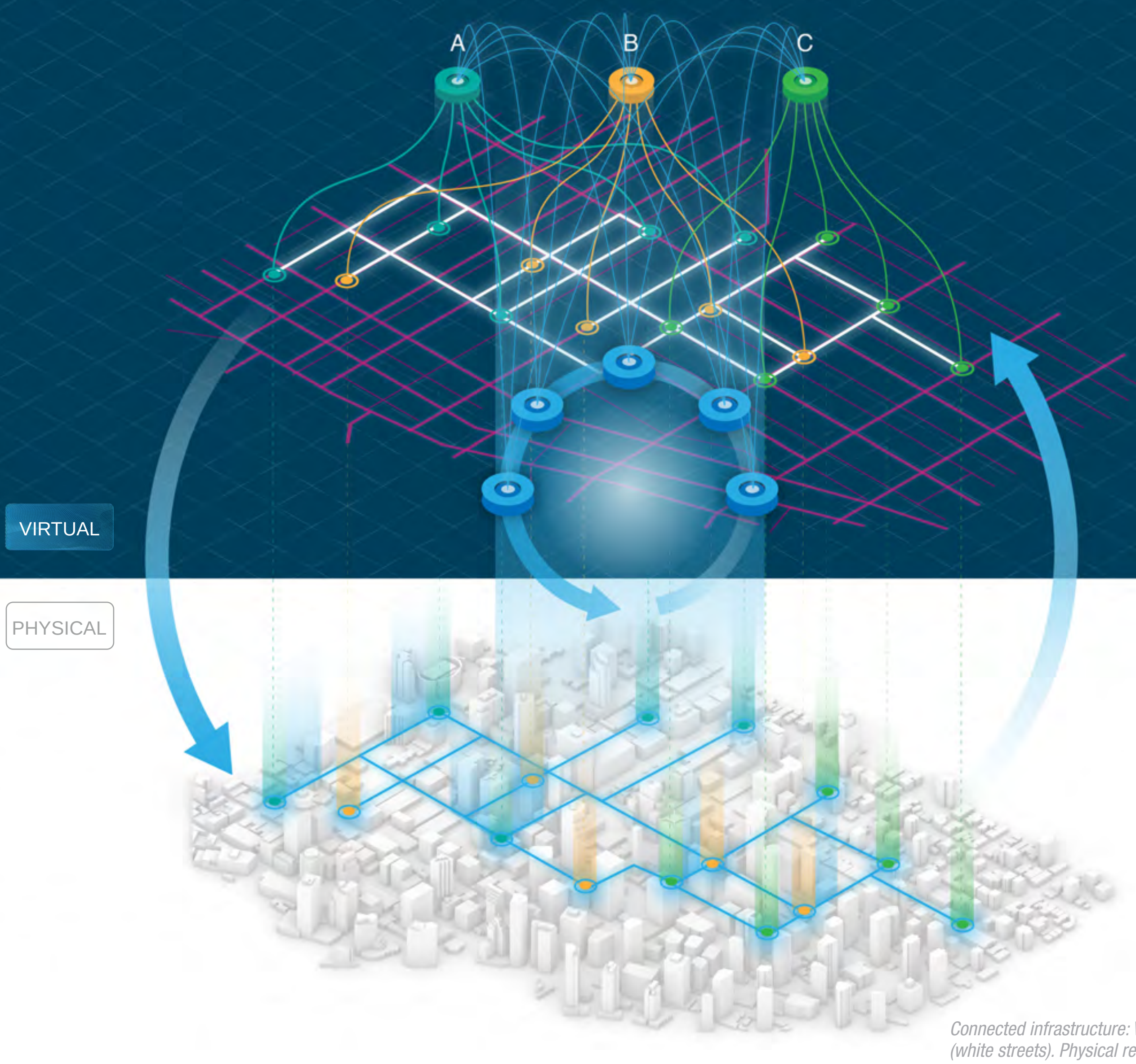

*From current logic to an autonomous logic, through an interim phase.* National Association of City Transportation Officials. Blueprint for Autonomous Urbanism: Second Edition. 5 Sept. 2019. nacto.org, https://nacto.org/publication/bau2. p 11

44 Meyboom, A. L., and L. Vass. Driverless Urban Futures: A Speculative Atlas for Autonomous Vehicles. Routledge, 2019.
45 National Association of City Transportation Officials. Blueprint for Autonomous Urbanism: Second Edition. 5 Sept. 2019. nacto.org, https://nacto.org/publication/bau2.
46 National Association of City Transportation Officials. Blueprint for Autonomous Urbanism: Second Edition. 5 Sept. 2019. nacto.org, https://nacto.org/publication/bau2. p 11

# 3.2

## Transitioning into Automation

The transitioning process into automation can be visualized through the 'Virtual-Physical Automation Spectrum' which this research sets as three levels. These range from rudimentary automation to potential artificial intelligence algorithms (virtual realm) controlling the physical realm. The evolution of digital urban networks is then explained in three levels: Silos, Networks, Ecosystem.




*Connected infrastructure: Virtual realm (white streets). Physical realm (blue streets). Different mobility services (colours) accessible by ecosystem of inter-connected networks (A,B,C)*

## *Virtual-Physical Automation Spectrum*

The evolution of digital infrastructure and digitization allows for a process of automation to occur, making the virtual realm increasingly more influential and important. The virtual realm is where the majority of transactions happen and with it, authority is shifting to virtually controlled apparatus.

With the assumption that there is a shift in control and power from human decision-making towards autonomous decision-making, serious ethical concerns arise. Looking at it from the dual lens (virtual-physical), one can imply that “cyberspace is colonizing the real space” . The use of the term ‘colonization’ can be understood in the context of a power struggle of one realm over the other. The process leading to granting algorithms final authority needs to be further studied, requiring ideas on how potentially negative outcomes may be avoided.

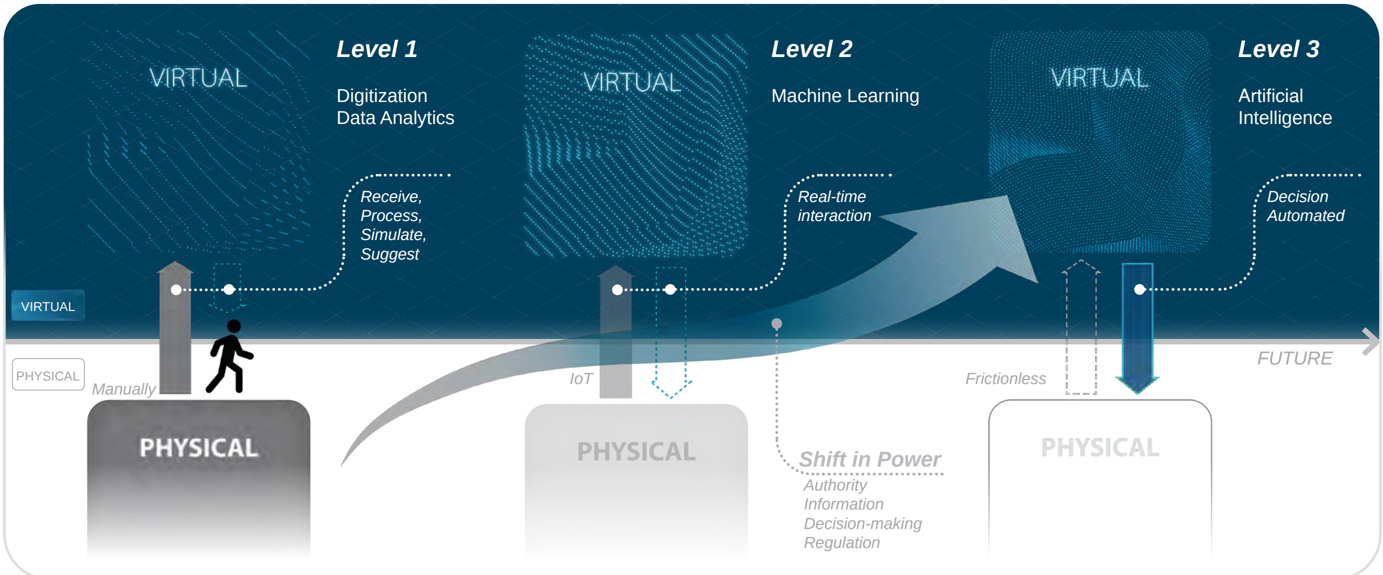
Every industry is creating a specific spectrum, relevant to its fields, for example, the SAE 5 levels of automation[47] for AVs, or Manufacturing Autonomy Levels (MAL)[48] in manufacturing and robotics.

“The spectrum of automation expands from simple rule-based automation to advanced cognitive and artificial intelligence automation.” What these spectra have in common is the removal of human interference or participation along the process. At the end of the spectrum, ‘full autonomy’ means that (all) decisions (virtually) on actions (physically) can be made by AI which (in theory) can teach itself (through the continuation of the machine learning process and cognitive artificial intelligence) the ‘right’ course of action, depending on the original task set initially.

The automation spectrum can be better understood visually as an extrapolation into two realms, the virtual and the physical. The oversimplified diagram depicts the interaction between the virtual realm and the physical realm. This oversimplified spectrum, devised for this research, has been divided into three levels of automation:

47 SAE International Releases Updated Visual Chart for Its “Levels of Driving Automation” Standard for Self-Driving Vehicles. https://www.sae.org/site/news/press-room/2018/12/sae-international-releases-updated-visual-chart-for-its-%E2%80%9Clevels-of-driving-automation%E2%80%9D-standard-for-self-driving-vehicles.

48 ‘Autonomous Production: Rise of the Machines’. Roland Berger, https://www.rolandberger.com/en/Insights/Publications/Autonomous-production-Rise-of-the-machines.html.




## *Virtual-Physical Automation Spectrum*

### 1 *Level 1*
*Rudimentary*

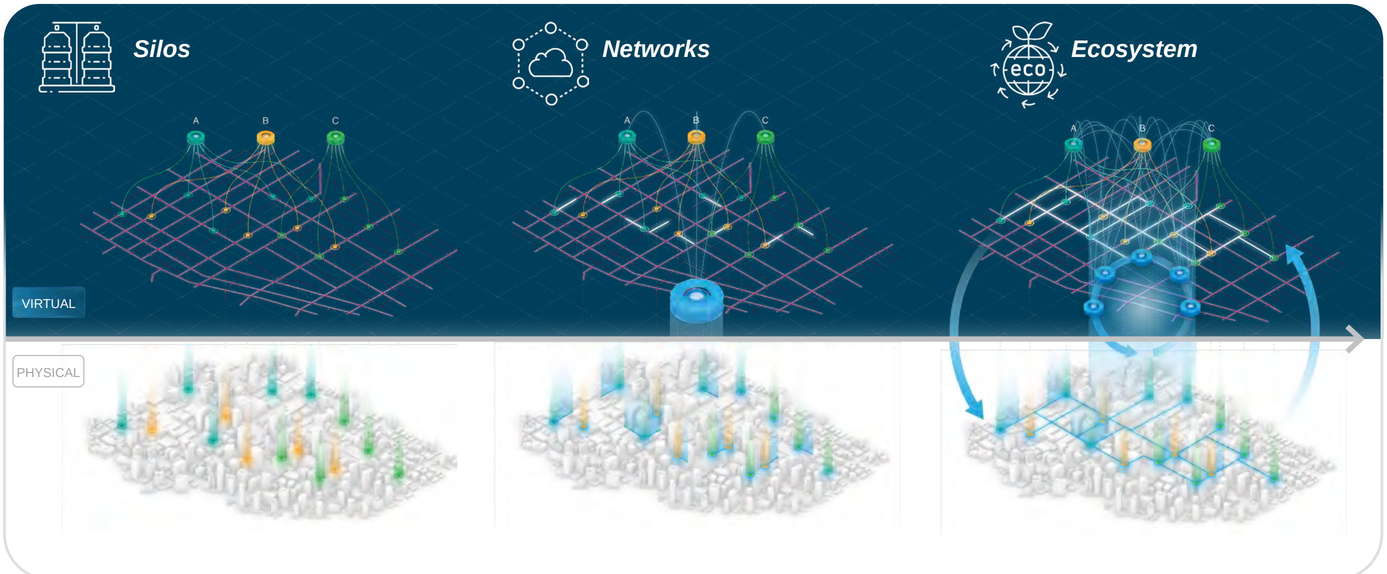
As automation is only rudimentary at this initial level, the physical realm is the dominant domain and does not rely on the virtual realm for its routine functioning. This stage is characterized by the capability of using data for analytics of usage and users over time and space. In this stage, computer simulations help humans process and analyze data to make better decisions and adjust physical infrastructure. Simulations may suggest points of attention by identifying outliers, however, simple automation performs only tasks that were predefined. In this phase, the physical city and its virtual counterpart, a Digital Twin, or a collection of Digital Twins act as vessels of data. The Digital Twin is harnessed for simulations, however, these are only models. Although data is transmitted and received in real-time, in general, the important decisions regarding actions in the physical world pend human approval or initiation, therefore decisions are not made in real-time.

### 2 *Level 2*
*Interaction*

Automation replaces some routine functions, with increasingly more tasks delegated to the virtual as completed tasks consistently outperform with no errors. There is a real-time dialogue between the virtual and the physical, data is processed through networks and kept under the supervision of humans. There is the use of machine learning to identify new patterns of usage and occupation of spaces, as well as identify other correlations in patterns that are not pre-coded, by artificial intelligence.

### 3 *Level 3*
*Automated decision making*

At this end of the spectrum, theoretically all transactions and actions are processed within the virtual realm. Artificial intelligence superiority implies that decisions are made in the virtual while ‘controlling’ (through operations and management) the physical realm remotely. There is a point where the physical realm has rendered itself ‘submissive’ to the virtual, making the virtual the ‘dominant’ point of authority, meaning that actions in the physical world are being controlled remotely in the virtual realm.




## Evolution of Digital Urban Networks

### 1 Silos

In the first level, the digital realm is composed of siloed networks and applications. Here we can imagine individual apps or services being offered to users directly (B2C), with no inter-mediator.

For example, one ride-hail app or car-share app is separate from another and the user contracts a service separately. Here uses can be joined and silos can be dismantled gradually.

The physical-digital platform is mainly web-based and accessible through mobile devices, while vehicles and urban infrastructure are not universally connected.

### 2 Networks

In the second level, silos are dissolved into a system of networks connecting users, services, and inter mediators. Here companies offering services to user may be plugged in a shared market place of network vessels.

For example in mobility, networks in the spirit of Mobility as a Service are formed, these enable linking users to mobility services. With dynamic, business models such as subscription or service bundling that adapts to current and local offerings, on-demand.

The physical-digital platform supporting this is ever-present with the proliferation of IoT technology embedded in the urban realm. There are accessible universal connections for urban infrastructure and vehicles.

### 3 Ecosystem

The third level evolves into an ecosystem of inter-dependent activities using overlapping networks that feed into each other in symbiotic relationships.

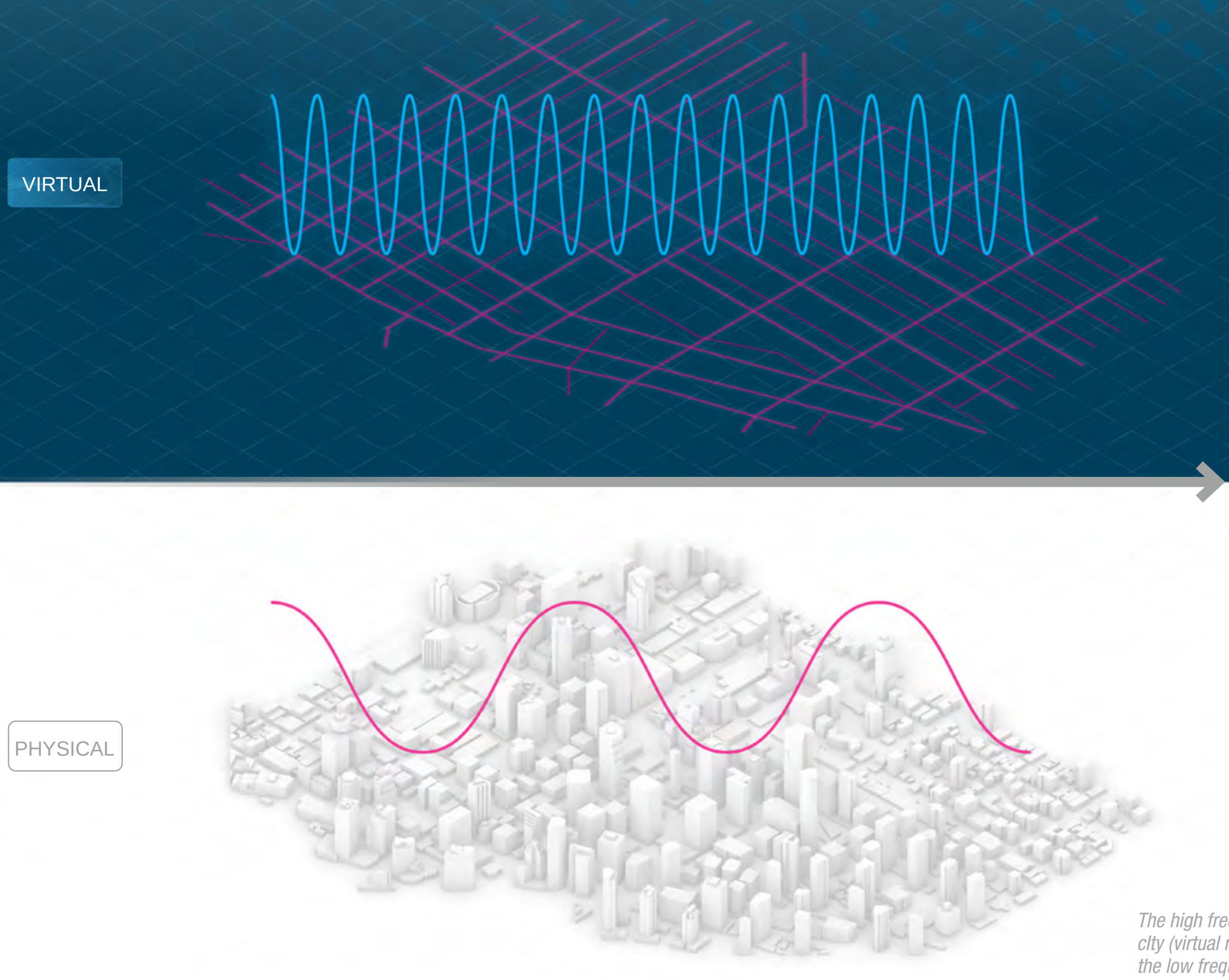
In terms of mobility, non-connected devices and vehicles are at a minority, while the majority of public transportation and private fleets are connected and can be incorporated in multiple shared mobility service networks offering a wide array of services.

The physical-digital platform is ubiquitous and synchronized with the virtual network. Connectivity is universal (like for example electricity is today).

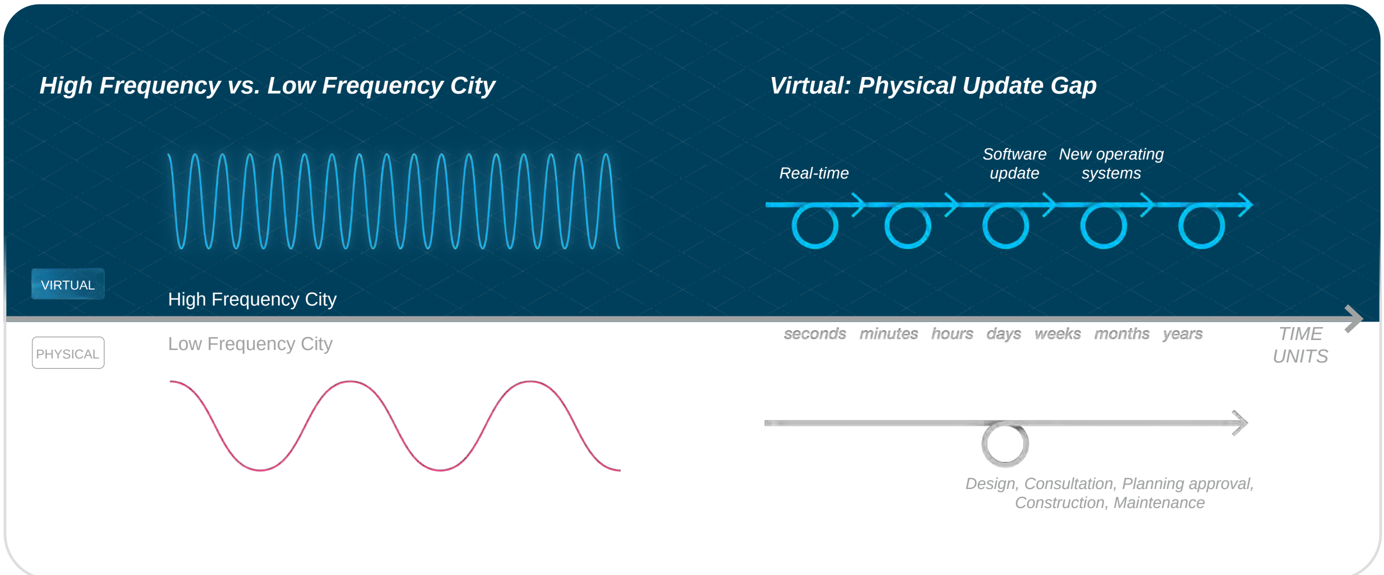
# 3.3

## Virtual : Physical Matching

The digital infrastructure updates at a faster rate than the physical urban infrastructure. This is expressed as different frequencies of the high-frequency city versus the low-frequency city. This section discusses the gaps between the two realms and how to bridge these gaps. It also discusses the possible consequences of mismatch.




*The high frequency city (virtual realm) vs. the low frequency city (physical realm)*




## High Frequency vs. Low Frequency City

*The High Frequency City in the virtual realm (top left) corresponds to frequent update cycles (top right). The Low Frequency City (bottom left) corresponds to slow update cycles (years) in the physical realm (bottom right)*

To better understand the discrepancies between the virtual and physical realm, we can look at the analogy used by Michael Batty in 'Inventing Future Cities'[49] to describe how the 21st century digitally connected city differs from its predecessor. The idea of the high-frequency city versus the low-frequency city is discussed, referring to data flow and the communication of data. However, this analogy can be taken further to represent the dynamics of the virtual realm (high frequency) versus the physical realm (low frequency).

In the low-frequency city, computer models or simulations of the city are used to produce data which is then analyzed and used to make better informed decisions relating to urban issues relating for example for planning and mobility. Still, in the low-frequency city, there is no continuous or real-time interaction between the physical infrastructure and the digital infrastructure, the data is collected periodically or yearly and there is no inherent intelligence in the analysis of this data.

In contrast, in the high-frequency city data gets collected and processed in real-time, it is analyzed and can be visualized for monitoring or research. Data gets updated frequently, whether through real-time sensors or usage data or as software update (changing the code to reflect a newer version). The updating of software can occur at any given moment in the high-frequency city, therefore much more frequent than in the physical realm.

Software updates can be done remotely, a single update can be simultaneously rolled out in millions of devices worldwide instantaneously. Unlike the hardware update, which requires a physical replacement, adjustment or modification, and physically accessing every device or sensor in its real-world geographical location.

49 Batty, M. Inventing Future Cities. MIT Press, 2018.

## *Virtual: Physical Matching & Innovation gap*

There is a significant gap between the update rate of digital urban related technologies (such as new mobility service apps) and the update rate of physical urban infrastructure. These act in different spheres, one in a high-frequency environment and the other in a low frequency.

We may refer to the time it takes to reconfigure a physical design of an element in the city as an ‘update rate’, as it has a temporal element in its definition. In the physical urban realm, in the public space, this could be any physical transformation of the street layout. Any built physical infrastructure whether private or public, requires planning, design, approval, financing, construction, and maintenance. This is a lengthy process that can explain why ‘updating’ the traditional, low-frequency city lends itself to an inherent delay in the update rate by virtue of its design process.

The question that arises is how to close the gap between these two spheres? To better match the virtual and the physical, it is necessary to either slow down the update rate of the virtual or speed up the update rate of the physical or equilibrate and adjust both.

Slowing down the digital advance can be exercised by policy and regulation of specific technologies, through limiting tech companies and organizations which stand behind the commercialization of these innovations. For example, limitation of ride-hail or e-scooter new entrants within a jurisdiction.

Cities learn from each other, assisting in preemptively creating regulation for short-comings of precedents in other cities. However, each geographical location has its unique challenges and setups which may not fit all.

If a certain city wishes to be at the forefront of innovation, it has to allow for a context in which precedents will happen within its jurisdiction. Therefore, a more calculated preemptive response needs to be incorporated into the interaction and partnerships with innovative new technology companies which may come for a short pilot project and leave or may stay for the long run, dominating a large share of the market in its category, whose consequences are therefore unpredictable.

To ‘speed up’ or to reduce the update time frame in the physical world, it is necessary to shorten current processes and allow room for testing for trial and error to occur. While for large-scale infrastructural projects (such as bridges, tunnels, new roads, new rapid transit lines) this may not be feasible, for existing infrastructure requiring street reconfiguration this becomes more feasible. Many cities are piloting agile ‘quick-fix’ solutions to street configurations, or deploy temporary interim solutions that do not require significant infrastructure change or lengthy planning approvals. These solutions follow the ‘Tactical Urbanism’ methodology which will be further explored in section 4.3, showing how to reduce physical update rate, thereby speeding up the process and better matching the virtual.

What are the consequences of mismatching the update rates of the virtual and physical? Mismatching can occur when a technology that requires predominantly virtual infrastructure becomes adapted in a disruptive way. Here the physical infrastructure is not up to date with the realities of new demands. This can be seen in the example of Airbnb or Uber being adapted preemptively before policy changes are made to regulate this new reality.

## *Incubation*

An idea that would integrate the development of applications, services, and physical digital infrastructure, is the idea of an incubator for innovation where individuals, groups, or newly formed companies can test their initial ideas and receive support, interaction, and form alliances with other local endeavors. An incubator provides a 'safe' space in which to operate and apply a trial-and-error approach. The physical space where these activities can be tested could be strategically selected designated curb spaces in different municipalities, which will need to be communicated to the general public as testing locations. These would be ideally spread out throughout a metropolitan area with an integrated transit system accounting for different typologies and urban situations.

If we take the logic of the space further towards the physical space in which their mobility and community ideas are being tested. We can think of a type of physical public space that will lend itself for the trial of diverse solutions within a predefined framework, to lower bureaucratic obstacles of conformity to city-wide regulations. These testing areas can be grouped into an area attending different demands of movement and connection of passengers, movement and distribution of goods, as well as civic related community activity area.

The design proposal in (Chapter 4) of a Mobility Hub distributes these zones within an overall urban logic which enhances the urban design of a specific street section while prioritizing the collective and shared mobility demands. In such a scenario, both digital technology, which requires physical presence, and physical infrastructure which requires a form of connectivity to a greater network logic can be tested, following the approximation of the virtual and physical realms discussed earlier.

For such a system to be accessible to innovations and new entrants, we could imagine a type of 'plug-in ecosystem' with a predefined interface that nevertheless provides flexible solutions. For each zone, this interface would be different but will allow unity within the category. For example, if one zone would want to test passenger movement solutions, it could designate a space for pick up and drop off, with its rules of usage, while also providing a platform for user interface and transaction, such as a terminal area. The different existing operating Transport Network Companies (TNC's) and new entrants would plug into the digital user interface system while following the rules in the physical space with potential vehicles (explored in further detail in 4.4.4). Another example is the e-commerce zone, functioning in a similar manner where movement and distribution of goods can be exchanged on a platform, where physical short-time storage solutions could be tested (explored in further detail in 4.4.5).

In terms of community building, a civic public space could act as an incubator for ideas that are being debated, discussed, and voted online in a virtual town hall of the local region, area, or neighborhood. These ideas can be exercised in this defined space, which would ideally work in a form of a plaza with some predefined facilities which encourage gatherings. An example of this is the Jim Deva Plaza in Vancouver's West End, where a former street has been transformed into a plaza, this plaza's virtual identity can be accessed online through a municipal website[50] or social media[51,52] , where the community can book and organize events in the space. This is just an initial low impact community-building mechanism, which could be expanded upon if local entrepreneurial activity such as street vendors or community markets can be built upon to harness both the physical and digital accessibility of the civic space.

50 Vancouver, City of. Jim Deva Plaza. https://vancouver.ca/streets-transportation/jim-deva-plaza.aspx.

51 'Jim Deva Plaza (@jimdevaplaza) / Twitter'. Twitter, https://twitter.com/jimdevaplaza.

52 Jim Deva Plaza I Facebook. https://www.facebook.com/JimDevaPlaza/.

# 3.4

# Piloting

The gap between the unsynchronized update rates of the virtual and physical realms can potentially be reduced by designing physical infrastructure that can be reconfigured in a short time frame. This type of infrastructure can be piloted in the physical realm through ‘Tactical Urbanism’ for the reconfiguration of public space. Conversely in the virtual realm, the ‘Minimum Viable Product’ approach to innovation shall be correlated to the limitations of the physical realm.


*Piloting of tactical curb space use, Robson St. Vancouver. Sep 2020. Image: Y. Fogelson*

## *Tactical Urbanism*

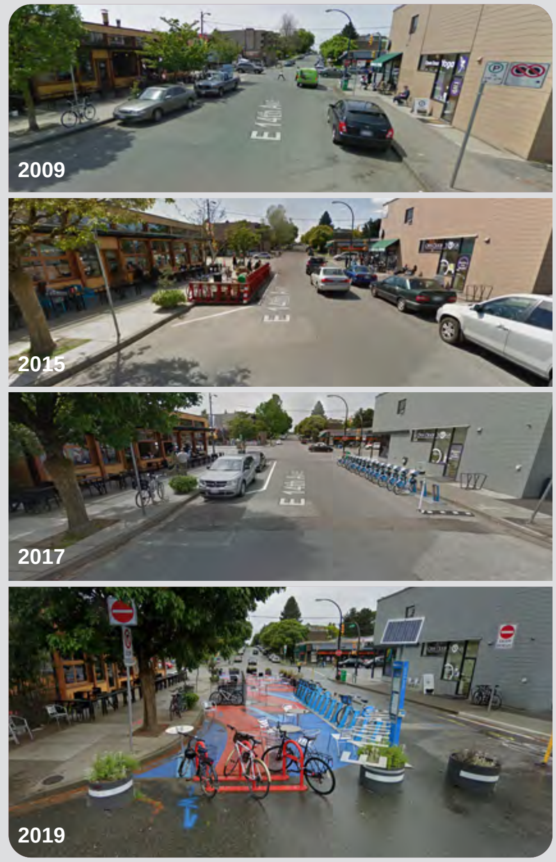
A method that allows trial and error and piloting in the public space is tactical urbanism, which has increasingly entered the mainstream domain of planning through the last decade, from a form of urban activism to a strategy that is used by municipalities to deal with trials at providing more people-centered design. In the context of the public space and the reconfiguration of existing space, especially to create quick solutions to road safety or activation of public space.

Tactical urbanism methodology, originating from activism led guerrilla urbanism, is currently used by many municipalities to update and change the public space more cautiously and incrementally, challenging the automobile status quo and managing to go forward with 21st-century adequate people-centric design proposals for the public realm. Both for transforming and distributing the public space for the movement as well as permanence and space activation and placemaking strategies. Using this methodology for implementing tactical projects is done through demonstration interventions, prototyping solutions through real-life piloting, flexible, adjustable, through low-budget, temporal, modular, removable, and movable materials. Projects include a political 'revert' option built into the design, in the case of dissatisfaction or backlash of users, population or constituency, one can return to the previous configuration, as all physical elements of the design are removable.

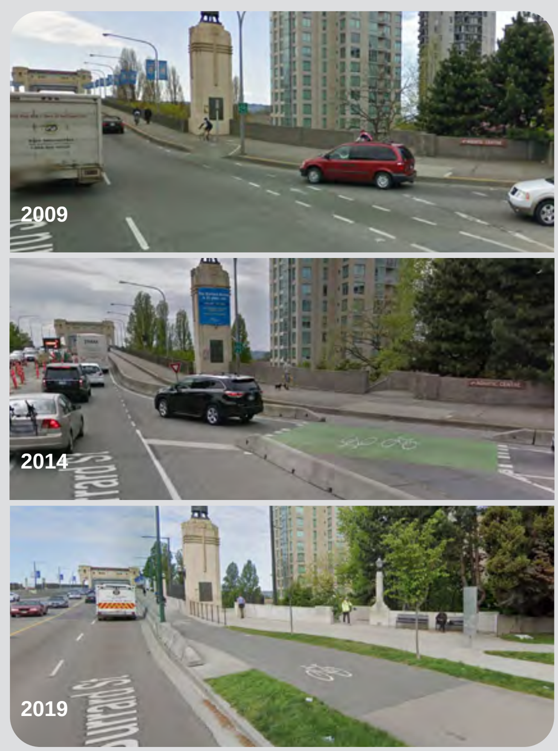
Agility is one of the characteristics of tactical urbanism, as low-key and low-cost 'Lighter, Quicker, Cheaper' according to PPS (Project for Public Spaces).[53] It is precisely its agility that gives it the flexibility to test out a configuration of space in a short time without extensive planning, whereafter it can be readjusted to fit real-time real-life demands as they arise.

Tactical urbanism (with its elements of temporality and agility), may help direct paths toward possible design solutions for an uncertain and unpredictable future, as we move towards mid-21st century disruption. This disruption is happening through a convergence of technologies of automation, communication, and renewable, at zero marginal cost. We will look at how these macro-trends may affect the physical space and the consideration of a new virtual space. Consequently, the discussion will point to how tactical methodologies may be used to accommodate these changes in the physical space. In turn, this may provide some guidance for designers and planners for approaching complex future projects with many question marks.

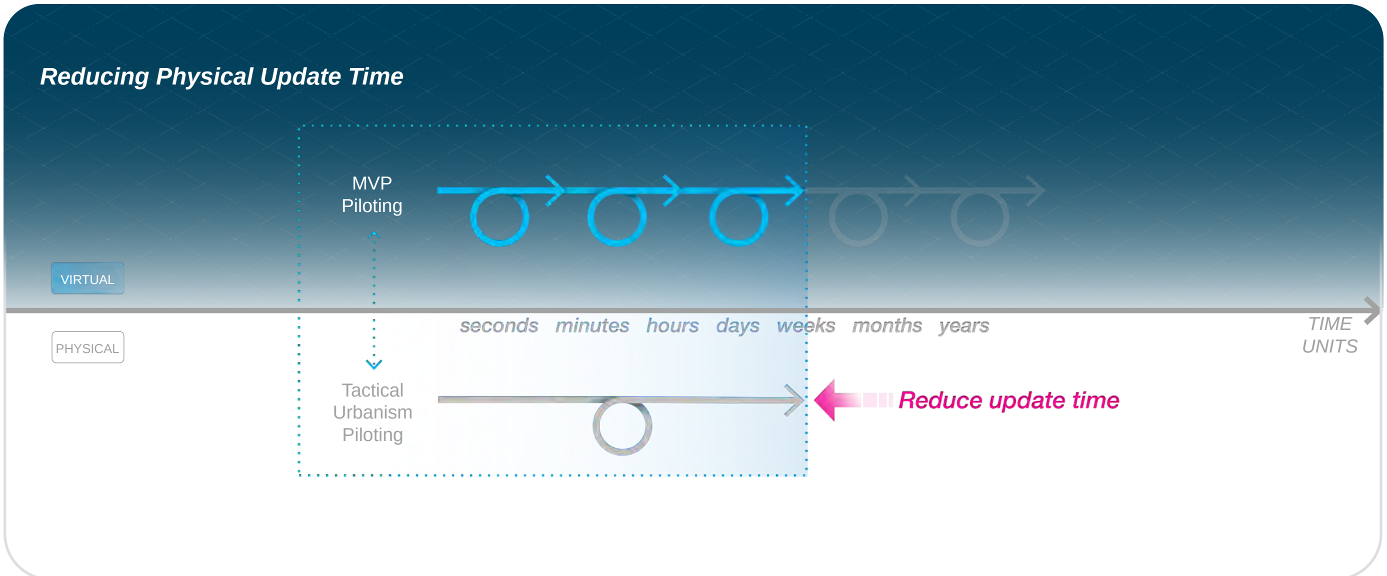
53 The Lighter, Quicker, Cheaper Transformation of Public Spaces. https://www.pps.org/article/lighter-quicker-cheaper.




*Alternating use of roads space re-allocation for parklet (2015), bike-share (2017), pop-up plaza (2019). E14th & Main St. Vancouver, BC / Images: Google Streetview*




*Incremental piloting of introducing bike-lanes on Burrard Bridge, Vancouver, BC / Images: Google Streetview*




*Reducing update speed of physical infrastructure through Tactical Urbanism piloting to match update speed of digital applications that follow MVP piloting methodology.*

## MVP : Tactical Urbanism

A feedback loop is a set of iterations used to validate or test an idea by receiving feedback from users or by evaluating a product, finally returning to the starting point, to make an informed decision on the next steps.

*"Feedback occurs when outputs of a system are routed back as inputs as part of a chain of cause-and-effect that forms a circuit or loop. The system can then be said to feed back into itself."*[54]

The Minimum Viable Product (MVP) idea follows the 'Lean Logic' from 'The Lean Startup' movement' based on a book by Eric Ries.[55] This is the logic on which many start-up companies, tech or otherwise, base their business model and growth is largely around the idea of testing out a new idea, innovation as a product or service, tested out with a specific group, or rolled out for public use. The product development strategy used is often referred to as a Minimum Viable Product (MVP) which *"...is a version of a product with just enough features to satisfy early customers and provide feedback for future product development."*[56]

Through feedback loops, the application of minimal rudimentary design iteration is tested, which brings the idea of piloting. After a feedback loop, a decision can be made on whether to proceed with the idea as is, make an iteration, or 'pivot', meaning re-assess the product of the model and try a new one.

After having discussed the concept of the MVP, one can argue that tactical urbanism is essentially the MVP of urbanism as it follows the same steps, processes, and feedback loops. In tactical urbanism, one deploys low budget, agile design solutions with minimum effort and cost, with the flexibility to be able to change and 'pivot' the design if necessary. The reconfigurations of space, even though of temporary character and materials, still oblige users to comply with the use of space, as if it was a permanent change.

54 'Feedback'. Wikipedia, 28 Feb. 2021. Wikipedia, https://en.wikipedia.org/w/index.php?title=Feedback&oldid=1009359530.
55 Ries, E. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business, 2011.
56 'Minimum Viable Product'. Wikipedia, 30 Mar. 2021. Wikipedia, https://en.wikipedia.org/w/index.php?title=Minimum_viable_product&oldid=1015087379.

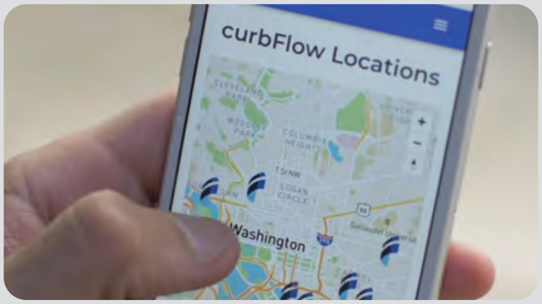
In this sense, tactical urbanism is a suitable urban transformation methodology to match new technologies that are being tested and piloted through the lens of technological solutions by companies, as well as public or social innovations. Through tactical urbanism, it is possible to decrease the time it takes to plan, design, approve and execute a physical transformation from years to a matter of months or even weeks, as could be observed in numerous cities during the initial months of the Covid-19 pandemic. If a framework is set within municipalities and transportation authorities to constantly monitor and adjust specifically known typologies of public space transformation, it can in theory be possible to further decrease the physical update time from months/ weeks to days or hours depending on the scale and complexity of the change. Furthermore, if the temporary infrastructure is designed to be re-configurable and modular in the first place, the constant modification of the design can be a built-in design feature.

The physical design should acknowledge the needs of the digital platforms, digital business models, management, operation and enforcement, and vice versa. Following the same logic, any design solution in the digital infrastructure, back-end or front-end, will have to acknowledge the physical space or infrastructural element as part of the design solution. This could include the placement of sensors and communication devices, a physical user interface to welcome the potential user, and provide low barrier access to the virtual service provided, such as a touch screen or payment stand.

The matching of the virtual and physical infrastructure and update of the configuration of hardware and software occurs in a process where both realms are thought of in unison. The matching of the update rate and feedback loops between the virtual and physical realms occurs therefore through, on the one hand, the slowing down of the virtual update rate to take into account its physical counterpart in the design process. On the other hand, in the physical realm, through the speeding up of reconfiguration possibilities of flexible and easily adjustable design solutions, following the tactical urbanism methodology.

One example which uses piloting both digitally and physically is Curbflow, a mobile application for delivery unloading or ride-hail pick-up drop off zones. The pilot designated testing areas of a section of the curb space, that can be used through booking with the Curbflow App. The asphalt of these curb space areas is painted, as well as identified by portable barriers that include information about the pilot and information about downloading of the App. There are also parking posts stating ‘App Check-in Loading Only’.[57] The enforcement is done locally by Curbflow steward, and cameras are being tested as well. The pilot is being tested in nine locations in Washington DC in collaboration with the Department of Transportation as a ‘DDOT Research Zone’.[58,59] It is also being tested in Columbus OH[60] in the USA.

What is interesting in this pilot, is that it can be, in theory, expanded and modified according to successes of early pilots, as well as further implementation of the technology. Thereby, it emulates tactical urbanism methodology in the physical realm, while adapting to changing updates of its software possibilities and rolling out of potential new features.





*Piloting of curb space for drop off and delivery zone accessible through Curbflow App. Piloted in Washington DC and Columbus OH, USA.*

Images: Top: https://www.traffictechnologytoday.com/news/study-shows-success-of-washington-dcs-kerb-management-program.html | Bottom: https://www.universitydistrict.org/news/2019/11/18/new-loading-zones-come-to-university-district

57 ‘New Loading Zones Arrive’. University District, https://www.universitydistrict.org/news/2019/11/18/new-loading-zones-come-to-university-district.

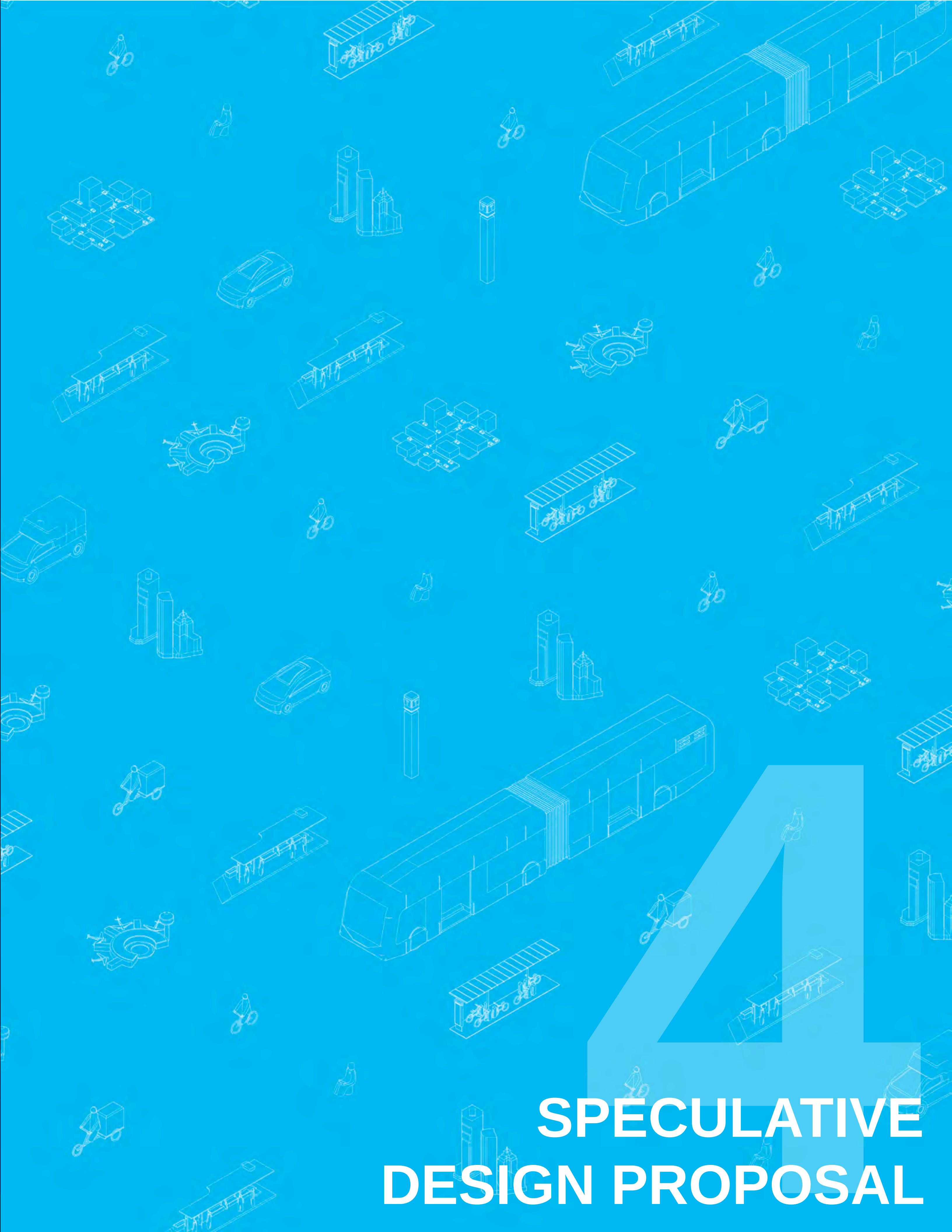
58 ‘CurbFlow Pilot Reduced Double Parking in DC by 64%’. Smart Cities Dive, https://www.smartcitiesdive.com/news/curbflow-pilot-reduced-double-parking-in-dc-by-64/567268/.

59 Aratani, Lori. New Parking Technology Aims to Manage Curb Space Virtually - The Washington Post. 2020, https://www.washingtonpost.com/local/trafficandcommuting/new-parking-technology-aims-to-manage-curb-space-virtually/2020/08/29/d69275f2-e881-11ea-bc79-834454439a44_story.html.

60 City of Columbus. Press Conference: City & Curbflow Launch New Loading Zone App 11/18/19. 2019. YouTube, https://www.youtube.com/watch?v=zVWijGS-6ds.

# 4

***Chapter 4*** *lays out a speculative design proposal for a hypothetical situation in the urban realm. The design follows through from the scale of a metropole, with its city-wide digitally connected transportation and 'Mobility Hub Network', with its different urban typologies. In the local scale, 'Mobility Hub Design' is explored in an incremental phasing strategy using the 'Transitional Design Methodology' explored in Chapter 3. The design focuses on the street scale and investigates an innovative curb space redesign that is simultaneously digitally connected. The different components of the Mobility Hub are investigated and broken down into phases. The components include: Transit + Micromobility; Civic Space; Vision Zero; Pick-Up Drop Off; E-Commerce; and E-Fleet.*



# 4

# SPECULATIVE DESIGN PROPOSAL

# 4.1

## Macro Vision

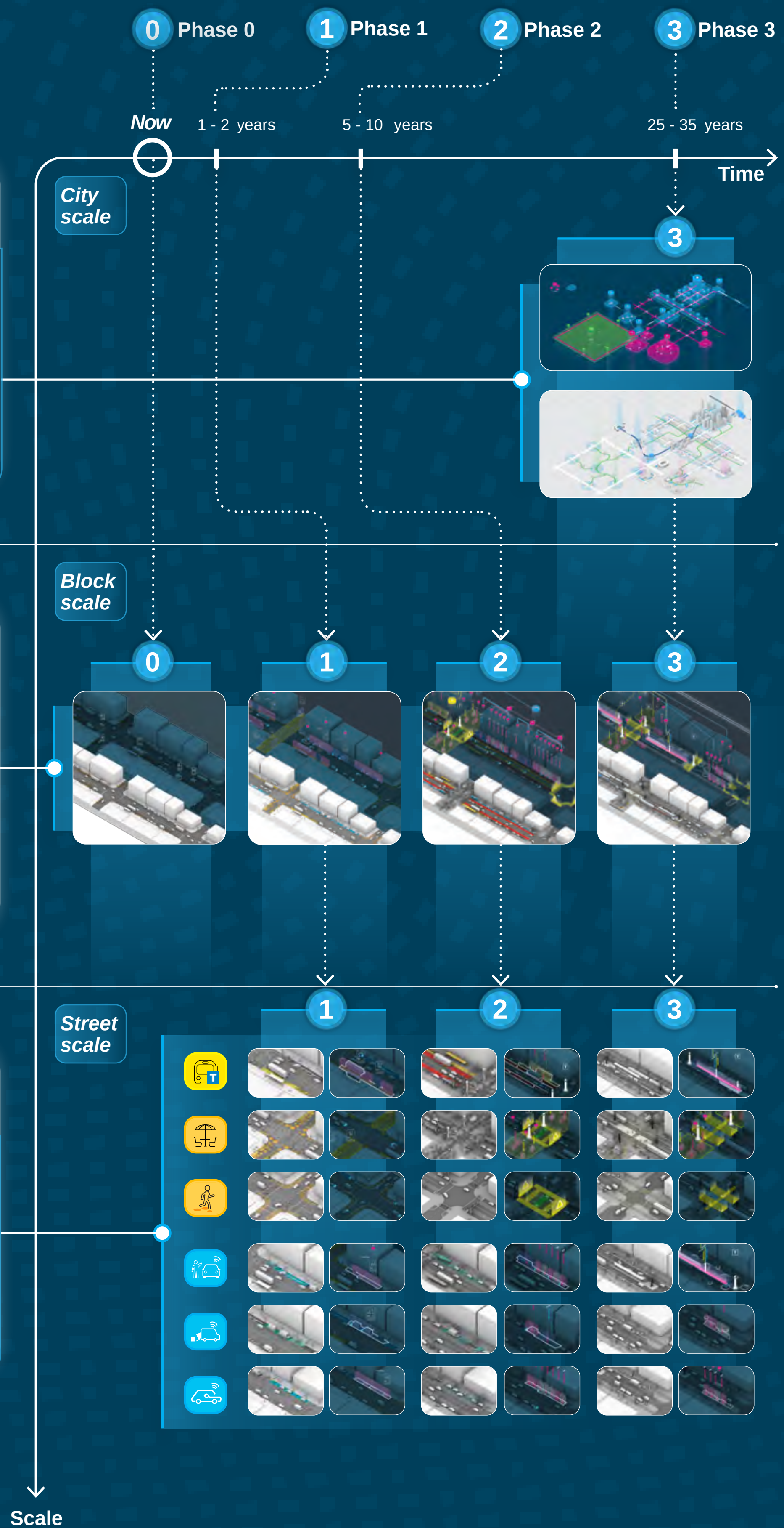
The future vision portrayed in this hypothetical design speculation is based on the topics discussed in previous chapters. There is an assumption of a reality where there is an accelerated process of digital transformation of the public space, as explained in Chapter 2. The designs in this chapter include visualizations of the physical and virtual urban realms. These are depicted over phases corresponding to the 'Transitional Design Methodology' laid out in Chapter 3.

In 4.1, design assumptions are discussed. While in 4.2 the city-wide scale is looked at through the lens of a Mobility Hub Network. In 4.3 the phasing strategy is utilized to explore the design of a Mobility Hub in the local level. In 4.4 the local scale is further unpacked into the different design components, each investigated through different phases, in both the physical and the virtual realm.


*Image taken from section 4.3.5, Phase 3.*

## From Macro to Micro





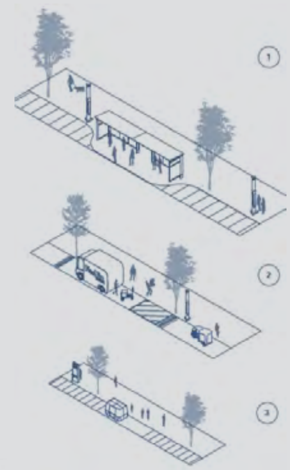
## *Curbside Priority & Use*

The shift towards a more connected digitized city, as well as a move towards 'autonomous urbanism' will inevitably result in adaptation and the redesign of the physical urban realm, more specifically the street network in the public space and the use of road space, curb space and sidewalks. This transition can be used an opportunity to set new priorities in the way that the public space is designed and to challenge the automobile status quo through the creation of a new hierarchy. As proposed in NACTO's Blueprint for Autonomous Urbanism document, "People come first in the autonomous age".[61] Here there is an inverted pyramid where people walking, cycling and lingering in the public space receive a clear priority in terms of a dedicated space and resource investment. In the second tier, the prioritization of high capacity on-street transit is seen as the only path to allow continued growth in cities without resulting in congestion. In the third tier, freight and delivery services are given priority, it is envisioned that these will be consolidated in specific zones, as well as supported by smaller vehicles, autonomous delivery, as well as e-cargo bikes. Finally, private vehicles and parking are given less space and their use is deprioritized through dedicating less space for on-street parking.

The samee logic of space dedication is visible in the provisions of "Who Gets Curbside Priority?",[62] an inverted pyramid diagram that puts bus, transit and bike first; freight and delivery second; and individual trip vehicles last.

The BAU document looks at the concpet of a flexible zone allowing for dynamic curb space use throughout different times of the day[63]: transit and drop-off at rush hours, temporary patios and street vendors at lunch, delivery of good at neight time or between hours. This can be achieved by coding the curb with time-based regulations.

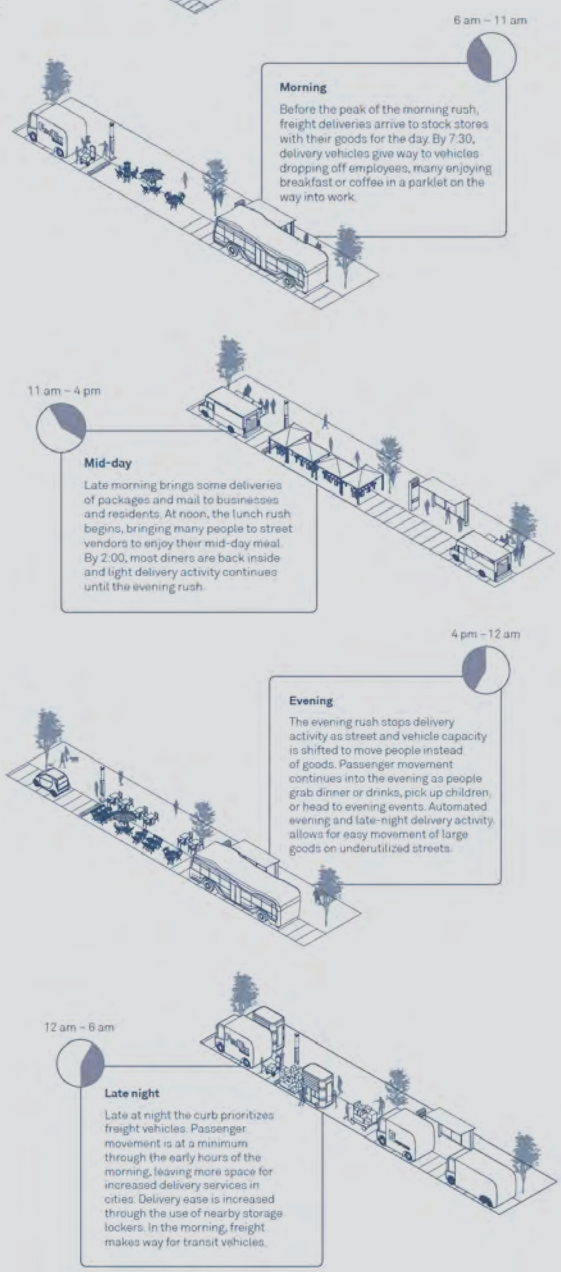
Finally, the BAU document discussed the nedd for 'Coding the Curb'and suggests that: "*Cities should begin by inventorying curbside uses and regulations, and using new technologies like LIDAR to collect and automate data. Owning and managing curbside asset data is the number one way that cities can assume control over the future of the curb, especially as private sector actors begin to catalog curbside data for their own traffic management.*"[64]




*Who gets curbside priority?*

*1. Transit,*
*2. Frieght*
*3. Individual trip vehicles.*

*NACTO BAU2, p117*




*Dynmic curb space use at different times of day, NACTO BAU2, p120-121*

61 National Association of City Transportation Officials. Blueprint for Autonomous Urbanism: Second Edition. 5 Sept. 2019. nacto.org, https://nacto.org/publication/bau2, p13

62 National Association of City Transportation Officials. Blueprint for Autonomous Urbanism: Second Edition. 5 Sept. 2019. nacto.org, https://nacto.org/publication/bau2, p117.

63 National Association of City Transportation Officials. Blueprint for Autonomous Urbanism: Second Edition. 5 Sept. 2019. nacto.org, https://nacto.org/publication/bau2, pp 119-121

64 National Association of City Transportation Officials. Blueprint for Autonomous Urbanism: Second Edition. 5 Sept. 2019. nacto.org, https://nacto.org/publication/bau2, p120

*From Portals to Places concept, Project for Public Spaces*

## *Community Mobility Hub*

The Community Mobility Hub typology was chosen to be expanded upon in this report as it is considered a special interesting case. It has urban design considerations, potential for public space activation, it contains a mix of public transit, micromobility, as well as new mobility services of movement of passengers or goods. This transit-based mobility hub that is nestled with public space is in a walkable location with amenities. It can typically confine itself to the immediate environs of an intersection or within an urban block. The added public space allows for community gathering place and activities, while it creates a visual identity to the particular mobility hub in question. Integration between modes is considered in the location of transit stop, micromobility docking stations, PU-DO, e-commerce, as well as e-fleet storage space.

The Community Mobility Hub which will be explored in this section is part of a city-wide network, part of an array of mobility hubs along a corridor for instance, then broken down into components.

## *Neighbourhood Portals*

What makes the Community Mobility Hub unique, is that it is not only anchored around transit (like most of the mobility hubs proposed in section 4.2), but also anchored around the daily community needs and daily activities such as local grocery stores, local cafes and gathering and meeting places. These are activities that can be combined as part of the daily commute, 'on-the-way' to work or back home, therefore strengthening the logic between connection to other parts of the city with the local community activities of its local residents. This idea comes from the 'From Portals to Places' initiative by PPS (Project for Public Spaces) which thinks of bus stops beyond their transport functionality and extends them as 'neighbourhood portals'.[65,66]

65 Reimagining Transit Hubs and Transfer Points | Publications — Project for Public Spaces. https://www.pps.org/product/reimagining-transit-hubs-and-transfer-points.

66 Gulati, Nidhi. How a Humble Bus Stop Can Anchor a Whole Neighborhood. 2019, https://www.pps.org/article/how-a-humble-bus-stop-can-anchor-a-whole-neighborhood.

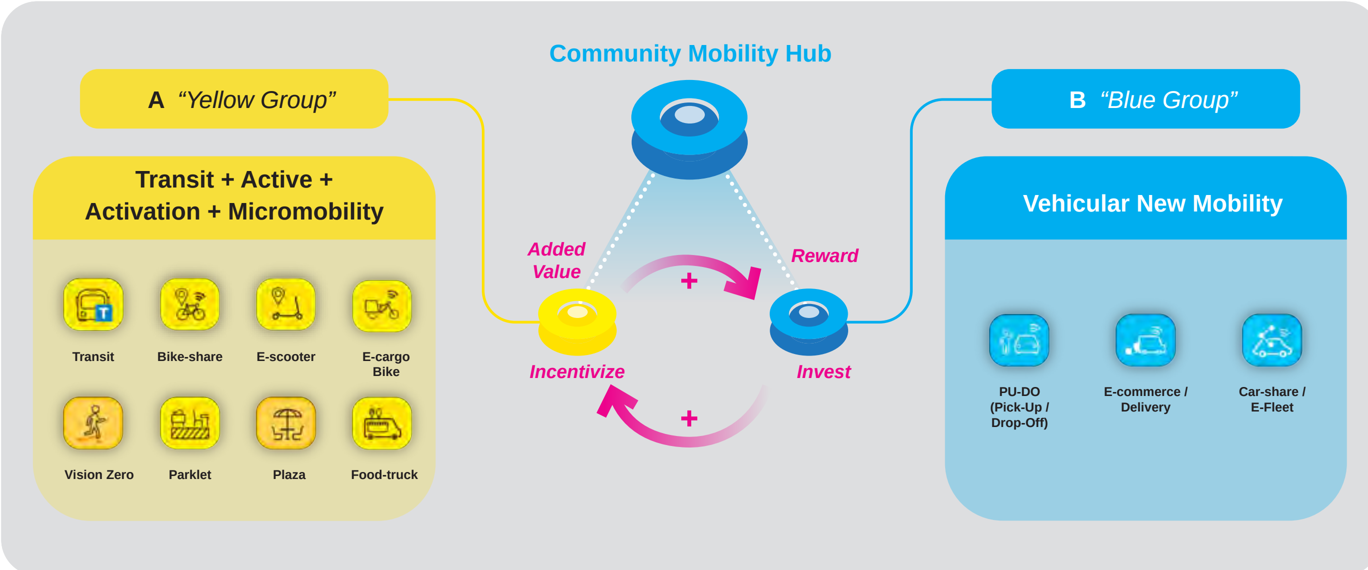

MaaS + Wayfinding user interface

## *MaaS Enabled & Transit Anchored*

Mobility as a Service, as a concept, is an essential piece on which the design proposal builds upon. As a successful implementation of MaaS will depend on finding a model incorporating public transportation and private TNCs (Transportation Network Companies), there may be different local models for different metropolitan regions. For this desired scenario, a pro-transit MaaS system is imagined, one which is anchored around transit. This is achieved in the virtual sphere through seamless integration across platforms and most importantly in the automated payment method (such as monthly subscription, or pay-as -you-go) which make it feasible to include modes such as bike-share for example within any leg of a journey, with no perceived additional cost to the user. More importantly, this design proposal sets out to translate the integration between modes in the physical urban design. This is done for example through the integration of a bike-share station at the bus stop responding to pre-reservation demand to facilitate mode transfer. Ride-hail, car-share facilities are also included in the design, around a clear lay out including wayfinding, reminiscent of train stations. The ideas of the mobility hub have been largely associated with MaaS, currently more common in the station forecourt areas and in the vicinity of transit stations.

## *Physical : Wayfinding / Virtual: UI / UX*

Imagine a network of city-wide interconnected mobility hubs providing diverse mobility services. These should be provided to any user, whether through the use of a connected device, or without a device through the use of on-site service facility. It should be ideally designed as a comprehensible user-friendly setting. This can be achieved through wayfinding – physically, as well as virtually through UI/UX (user interface / user experience) accessed via connected devices (mobiles, e-bikes, vehicles, touchscreen ticket machine, etc). The mobility hubs can resemble the wayfinding and symbolism of a transit station (both physically and digitally) as part of the regional rapid transit system, and therefore can be depicted by a ‘subway style map’.




## *Symbiotic Logic and Circular Growth*

The different uses of the mobility hub have been broadly divided into two groups: the first (yellow) being the 'Transit + Active + Activation + Micromobility' group, the second (blue) being the 'Vehicular New Mobility' group. The first group is in the public interest of incentivizing use of public transportation, walking, cycling, as well as activation of public spaces for gatherings, or expanding sidewalk space or modifying intersections for safe crossing (Vision Zero), this group needs to be subsidized and incentivized by the public sector. On the contrary, the second group caters to vehicular use, whether private or corporate, it includes ride-hail, ride-share, car-share and e-commerce related activity. The second group is more susceptible to market dynamics. Although bike-share and micromobility can be included in the private sphere, they are located in the first group, for their positive environmental impact. There is a type of symbiotic relationship between the two groups, one feeds the other by making the location more 'attractive'. Here the first group brings added value (public real estate) to the location, this in turn raises the frequency of its users, which can be incorporated in the market dynamic, rewarding the second group. This reward can be captured and used to invest back in the funding and improvement of public space and uses of the first group. Hereby, circular growth can be leveraged by a systemic approach to economic development.

*Left: Yellow Group: Transit + Active Mobility + Activation of Public Space + Micromobility.*

*Center: Community Mobility Hub Symbiotic logic 'Blue Group' incentivizing 'Yellow Group', in turn added value rewards 'Blue Group'.*

*Right: Blue group: Vehicular New Mobility*


## *Assumptions on the Digital Transformation*

*Data emission in public space, see section 2.2*

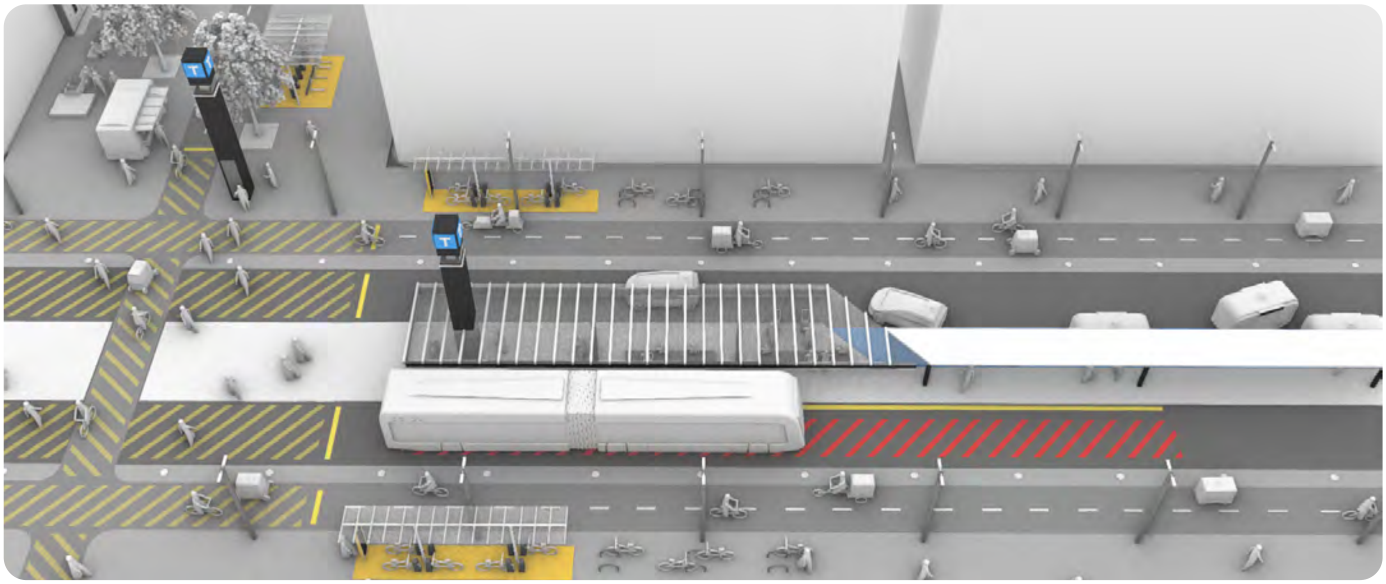
In this scenario, there is the assumption that the process of digital transformation, with its expansion and disruption, is inevitable and cannot be undone or stopped. Therefore, there is a decision to utilize this innovative transformation in order to leverage it to achieve policy targets of mobility, equity, health and sustainability.

With respect to urban design, the digital transformation should be utilized to benefit the creation of people-oriented public spaces, transforming car-centric designs. It should be used to help prioritize the design of walkable communities with pedestrian-friendly infrastructure and micro-mobility options. It should also be used to help improve road safety by adhering to 'vision zero' goals.

With respect to citizen engagement, the digital transformation should be utilized to enhance the civic process and civic spaces. It can make placemaking tools and community participation more widely available and enable the wider access to utilization of the public space by citizens as a communal space with catered activities.

The Data Economy has a logic based on data collection and production. Data that is gathered, mined and harvested should support implementation of new design solutions, while at the same time addressing the collective needs of the greater population, regarding privacy and access to services of movement of passengers (and goods) using public and private modes of shared mobility, as well as access to public amenities and civic spaces. In this context, it is important to prevent the unethical use of personal and collective data for commercial benefit, related to mobility services and services using geo-localization in public spaces.

Innovative digital connectivity combined with data economy logic should be used towards the testing and implementation of innovative curb space re-design, which in turn can accommodate the deployment of new communications and monitoring technologies.



Transit and micromobilty in focus of design proposal. Image taken from 4.3.5 Phase 3

## *Investigated Scenario: Pro-transit, People-first, Digitally Connected City*

In order to define the direction for innovation and transformation, an overall future design vision is needed. One which hypothesizes a possible yet desirable future scenario, over a probable one. The future vision explored in this research, proposes a pro-transit, people's first, new mobility integrated, MaaS-enabled, digitally connected design. It does this in the macro level by the invention of a city-wide network of mobility hubs which are interconnected and function as a network system (see section 4.2). In the outset of the future design vision, we can imagine an increasingly automated world with a form of autonomous urbanism playing out based on connected devices including mobile phones, AVs, delivery bots and physical urban infrastructure. In this vision phase, we can also imagine that the mobility network can be integrated within a wider eco-system of private and public services beyond the basic provision of mobility needs.

The speculative design proposal in this section lays out design solutions for different mobility hub typologies (section 4.2), as well as zooming in on the different design components of such a mobility hub (section 4.4). These design components are based on re-use of curb space and road space physical infrastructure.

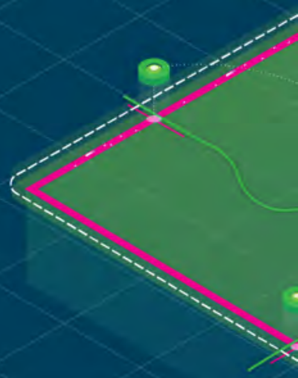
# 4.2

# Mobility Hub Network

The connected metropolis is built up of zones and different mobility hubs. The zones consist of special districts with their particular urban typology and their unique mobility needs. These include dense downtown areas, urban centers, commercial urban transit corridors, which could include a variety of smaller coordinated mobility hub hot spots.

Other mobility hubs can be in locations such as campuses, shopping centers and other large traffic generation areas or institutions which are responsible for the generation of trips, as an origin and destination. Here we can also reimagine possible alternative mobility in a suburban setting with mobility hubs which are adapted to this specific unwalkable environment.

The connected city is served by an array of different mobility hubs which will be laid out in this section. As the scope of this research does not allow exploring all typologies, one mobility hub typology, the Community Mobility Hub, will be fully unpacked into its different components and phasing strategy (explained in sections 4.3 and 4.4).

## Transit Oriented Mobility Hubs

The special urban zones, as well as the different urban transit related mobility hubs, are imagined to be planned, operated and managed under oversight of the regionaltransit authority and local government.

A Urban Zones
- Urban Corridor Zone
- City Center Zone
- Urban Center Zone

B Urban Transit Mobility Hub
- Airport MH
- Major Train Station MH
- Mass Transit MH
- MH Without Mass Transit
- Community MH
- New TOD MH

## Private Partnerships

Some locations lend themselves to private-public partnerships, especially in locations such as the aforementioned shopping centers, campuses, hospitals, stadiums, etc. Here, once the demand arises, the institution could manage, operate and fund the mobility hub(s) on whose land it will be installed.

C Traffic Generator Mobility Hub
- Shopping Center MH
- Event Pop-up MH
- Campus MH
- Traffic Generator

## Suburban Zones

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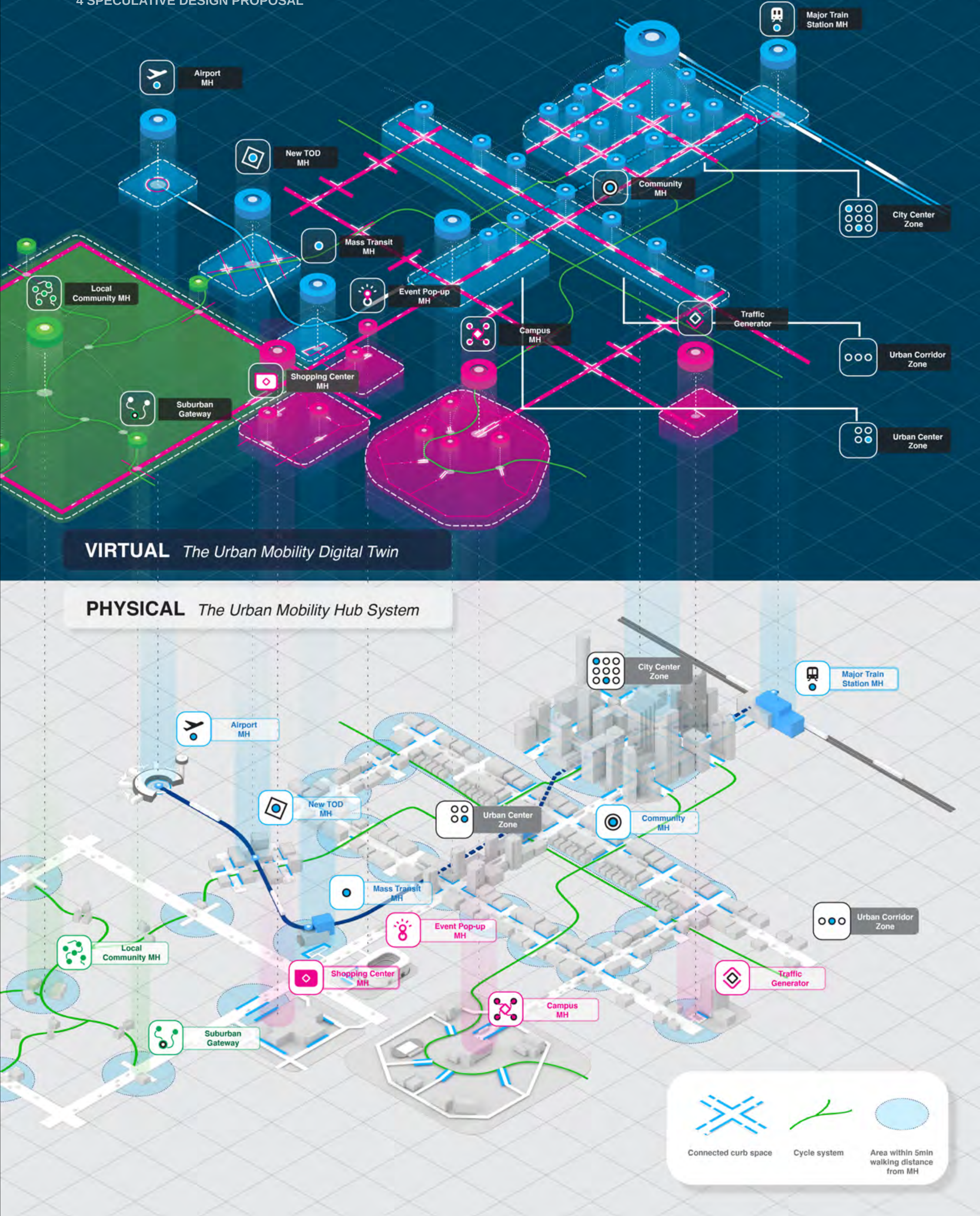
D Suburban Zones
- Suburban Gateway
- Local Community MH


VIRTUAL The Urban Mobility Digital Twin
Major Train Station MH
Airport MH
New TOD MH
Community MH
City Center Zone
Mass Transit MH
Local Community MH
Event Pop-up MH
Traffic Generator
Campus MH
Urban Corridor Zone
Shopping Center MH
Suburban Gateway
Urban Center Zone
PHYSICAL The Urban Mobility Hub System
City Center Zone
Major Train Station MH
Airport MH
New TOD MH
Urban Center Zone
Community MH
Mass Transit MH
Urban Corridor Zone
Event Pop-up MH
Local Community MH
Shopping Center MH
Traffic Generator
Campus MH
Suburban Gateway
Connected curb space
Cycle system
Area within 5min walking distance from MH

# Mobility Hub Typologies: Urban Typology (Zones)

## Urban Typology (Zones)

In many major cities, especially in the Canadian context used as the base for this research, the most prevalent urban typologies can be found. These include (usually a single) city center downtown core area; multiple urban centers as sub centers or neighbouring municipalities; linear commercial corridors based upon transit. All of the urban typologies characterize themselves as walkable well connected areas, serving the metropolis.

### City Center Zone *Downtown Typology*

**The dense core urban center, a downtown is characterized by its high walkability, multiple mass rapid transit stops, high generator of trip destinations and origins.**

**New Mobility**: In such a setting the mobility hub functionalities of predominantly PUDO and e-commerce delivery are spread throughout the core along designated curb space. Shared fleet storage and charging spaces are predominantly designated within a network of publicly accessible private locations (such as parking garages and residential buildings). Shared micromobility occupies curb space, 'pavement to plazas' as well as established public spaces.

**Virtual Zoning**: Enforcement, Revenue, Geofencing
Curb Space usage: PU-DO usage fees, e-com utilization
Congestion charge, LEZ, ULEZ, ZEZ
Off-street E-charge and storage of fleet vehicles

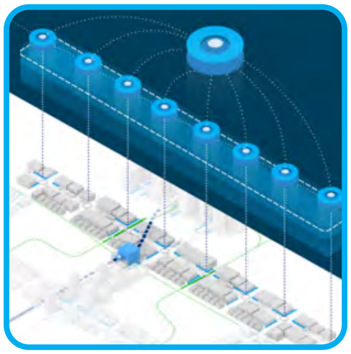
### Urban Center Zone *with / without rapid transit station*

**An urban area in the metropolitan context, 'uptown' or 'midtown' characterized areas, usually functions as a local centrality. Has high walkability, multiple transit options, yet not always a mass transit station. High density residential areas adjacent.**

**New Mobility**: In such a setting the mobility hub functionalities of PUDO, e-commerce delivery are centralized around one or two major avenues, or on feeding side streets in designated curb space. Shared fleet storage and charging spaces located in designated curb space as well as publicly accessible private locations. Shared micromobility occupies curb space, 'pavement to plazas' as well as established public spaces, adjacent to transit.

**Virtual Zoning**: Enforcement, Revenue, Geofencing
Curb Space usage: PU-DO usage fees, e-com utilization
Congestion charge, LEZ, ULEZ, ZEZ

### Urban Corridor Zone *with / without rapid transit station*



**A commercial corridor based around rapid transit. Has high walkability, medium-high density along the corridor and residential areas adjacent.**

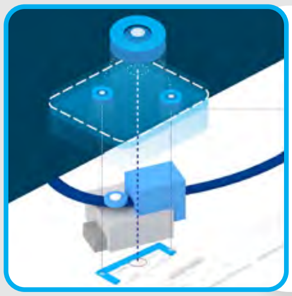
**New Mobility**: Uses of PUDO, e-commerce delivery are centralized along the corridor in designated curb space corresponding to each local mobility hub on the route. Where curb lane is used for other uses such as peak-hour traffic, new mobility uses located in feeding side streets in designated curb space. Shared fleet storage and charging spaces located in designated curb space as well as publicly accessible private locations. Shared micromobility occupies 'pavement to plazas' at community mobility hubs, as well as curb space adjacent to transit.

**Virtual Zoning**: Enforcement, Revenue, Geofencing
Curb Space usage: PU-DO usage fees, e-com utilization
Congestion charge, LEZ, ULEZ, ZEZ
On-street E-charge and storage of fleet vehicles

# Mobility Hub Typologies: Urban Transit Mobility

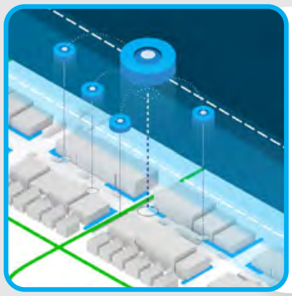
## Urban Transit Mobility Hub

Urban transit related mobility hubs, can be projected, coordinated by municipalities and transportation authorities in order to organize and systematize the bulk of mobility needs or urban areas. Below are specific mobility hub typologies related to transit.



### Mass Transit MH

This MH is located at mass-transit stations of heavy or light rail usually. This MH allows integration between different transpiration modes strategically located around station entrances to secure seamless integration, both through a MaaS type UI integration, as well as physically through urban design and wayfinding. The different modes in the integration include transit, micromobility and e-fleets.



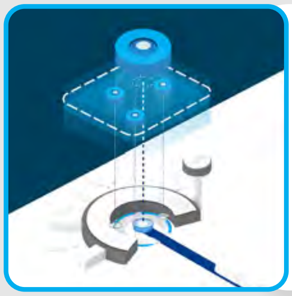
### Community MH

*without /*
*with rapid transit station*

The Community Mobility Hub, is a transit-based MH that is nestled with public space in a walkable location with amenities. It can typically confine itself to the immediate environs of an intersection or a within an urban block. The added public space allows community gathering place and activities, while it creates a visual identity to the particular MH in question. Seamless integration between modes is considered in the location of transit stop, micromobility docking stations, pick-up drop off, e-commerce, as well as e-fleet storage space. This typology will be explored in Ch 4.3)

### Major Train Station MH

In many major cities, intercity and suburban rail travel make central train stations a location of first encounter with the city, acting as an urban interface. As such, wayfinding and digital connectivity options should play a large part in the design layout of a MH in this context. Here integration with PU-DO and micromobility is important and should build up on existing integration with other modes of transit such as light rail and buses.



### Airport MH

Airports are unique points of first contact with the city. Airports today largely operate with the idea of MH in mind with special integration with transit to the city, as well as extensive and geofenced PU-DO areas, sending passengers to specific zones. Further provisions can be made regarding e-fleets, as well as facilitation of use of digital services (such as e-kiosks and digital service awareness zones) for international arrivals with limited local internet connection possibilities which is a necessity for some mobility services.

### New TOD MH

Transit Oriented Development encourages for the redevelopment of new high density or commercial districts which are often designed with completely new infrastructure and streetscape. The idea here is to integrate the MH facilities in the new design and acquire new development proposals in proximity to the station to these facilities embedded in the urban design masterplan. This includes increased provisions for micromobility lanes and infrastructure both on private as on public space. Finally, e-fleet accommodation both on- and off-street integrated into a single network.

# Mobility Hub Typologies: Traffic Generator Mobility Hub

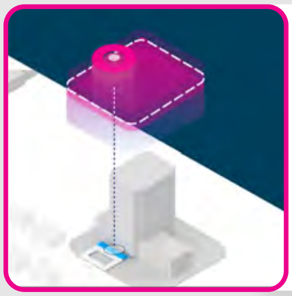
## Traffic Generator Mobility Hub

Additional mobility hubs can be located at large institutions, shopping centers, stadiums, hospitals and other traffic generating uses. These can function under responsibility of their institution whether private or public, with overview and coordination of municipal and transportation authorities.

### Pop-up MH (Event)

*without /*
*with rapid transit station*

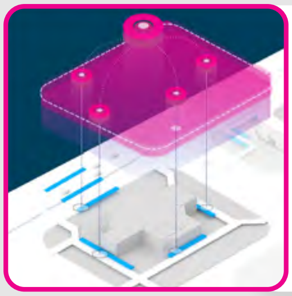
A Pop-Up MH can be deployed for a specific occasion which attract large crowds and generates traffic in a specific predefined time, date and duration. This MH could be used in relation to activity in stadiums, convention centres, concert halls and other locations with peak uses correlated to a specific program, the MH could additionally include parades and specific annual events. It can be composed of a set of movable infrastructure which can replicate a virtual temporary addition the entire MH network, analogues to a ‘pop-up subway station’.



### Traffic Generator MH

*without /*
*with rapid transit station*

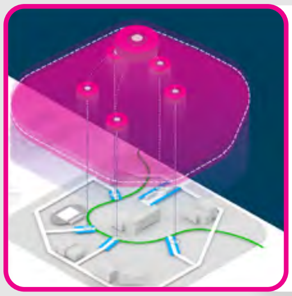
This is a general name for a MH within a location or institute that generates traffic on a daily basis throughout the day. Here we can imagine hospitals, health centres, hotels or educational facilities (other than university campuses). This MH is usually limited and can be operated by the institution at hand, nevertheless it needs to adhere to transit and municipal MH related regulations.



### Shopping Center MH

*without /*
*with rapid transit station*

Shopping centres generate increased amount of traffic. Many regional shopping centres have multiple entrances and roadway systems, therefore this MH can be spread out with inter-connected hot-spots at strategic locations such as entrances and transit stops, as well as new testing of delivery technology and experimentation with new public spaces to accommodate transfers.



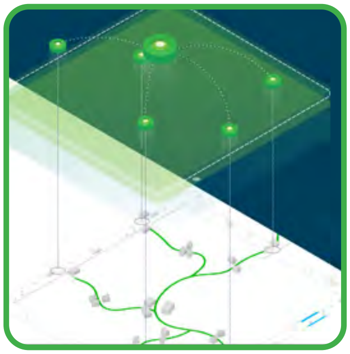
### Campus MH

*without /*
*with rapid transit station*

University (or other) campuses, whether within the urban fabric or isolated, generate substantial year-round traffic as a destination and origin of trips. Campuses are well served by transit and often have walkable environments where micromobility can be integrated within a larger network. As such, the campus MH can benefit from the integration of lighter modes connecting to the city-wide system seamlessly. In this case the institute should be responsible for a local mobility plan to be implemented with the MH facilities as an anchor.

# Mobility Hub Typologies: Suburban Zone

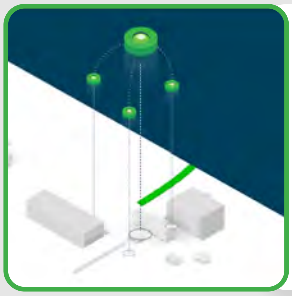
## Suburban Zone



**A low-dense suburban setting with low walkability, may have 'transit deserts' with transit only at main arterial roads and does not permeate the low density residential zones with frequent transit service. This area characterizes itself with commercial activity along corridors with an abundance of off-street parking.**

New Mobility: E-com and PU-DO not designated. Shared fleet, pooling, shuttles and incentivized shared micromobility used to respond to 'last miles' demands. These are located at hotspots mobility hubs adjacent to transit, as well a local community distribution centers.

Virtual Zoning: Enforcement, Revenue, Geofencing, Operational mobility district. Deployment of local micromobility and shuttle systems can be provided by private partnerships, adhering to municipal and transit MH regulations.



### Suburban Gateway

*without /*
*with rapid transit station*

This MH can be located along main arteries with frequent transit routes and serves to connect this transit corridor with the immediate localities beyond walkable distance of around 2 km (a little above the 'last mile'). Here micromobility and shuttle services can be deployed to serve local low-density residential areas. These services can be deployed through partnerships, nevertheless, they need to adhere to municipal and transit authority MH regulations.

### Local Community MH

This MH is different in that it is not necessarily connected to transit, however, it serves locations within the 'transit desert' which function as community gathering spaces, such as parks, schools or community centres. These can be integrated in a local zone which coordinated the micromobility and shuttle system within the zone, in connection to 'Suburban Gateway MHs'.

# 4.3

# Mobility Hub Design

## *Virtual & Physical*

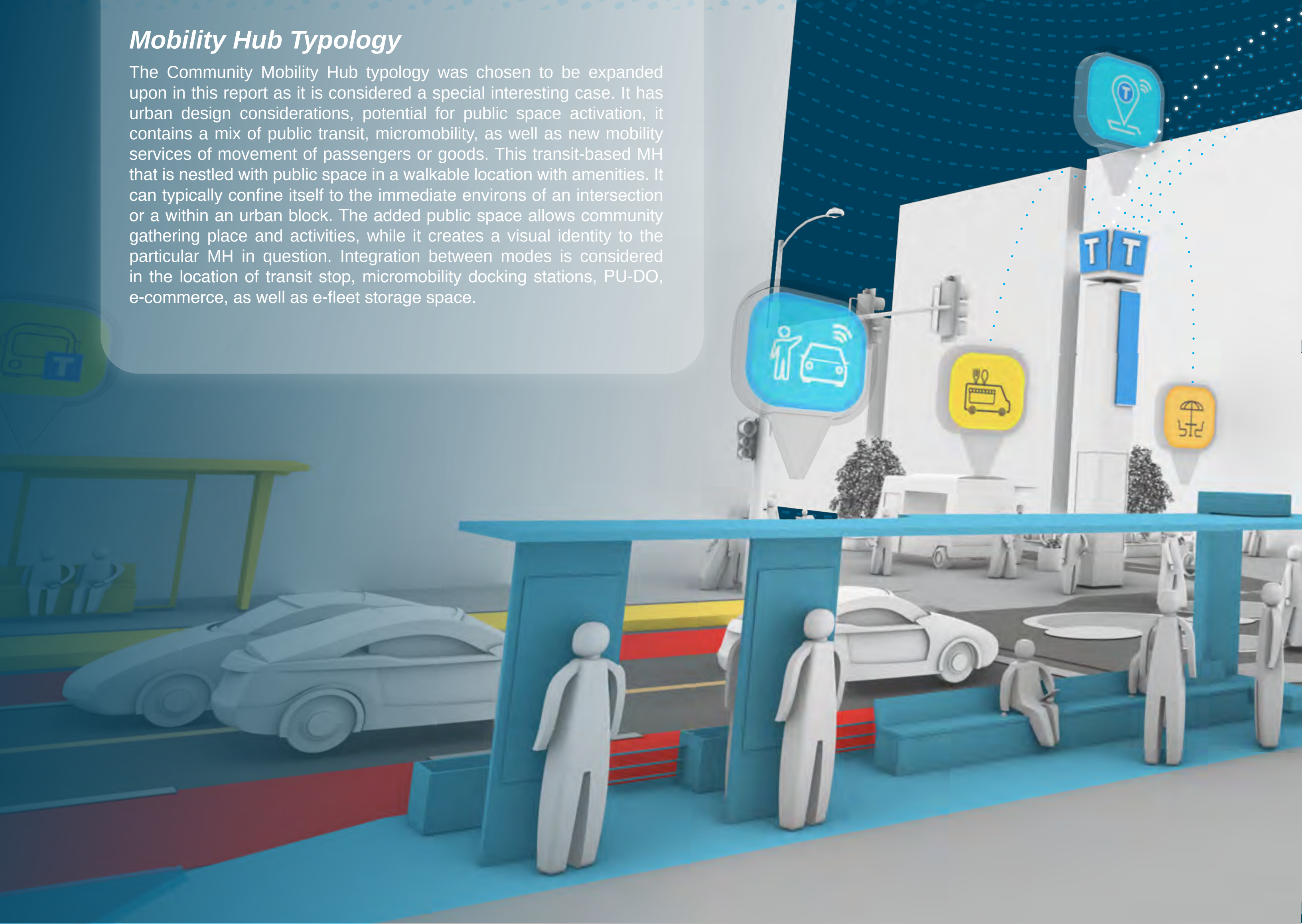
The speculative design proposal provides a dual visualization systemization which includes the physical design version and its counterpart in the virtual realm, the digital twin. Visualizations in this section include both realms “side-by-side” for better comparison and understanding of the design in each of its phases.

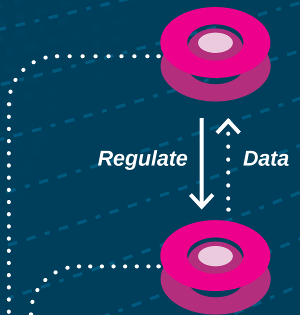
## *Transitional Urban Design*

The design process follows the transition strategy (explored in chapter 3) which is investigated in four time-frames: The current situation (Phase 0); The piloting phase (Phase 1); The concretization phase (Phase 2); The long-term vision (Phase 3). Each of these phases is broken to their physical and virtual counterparts. This phasing strategy supports built-in testing as its feature, during a period of adoption to new mobility and the digitization of public space. It may help with agile response to a constant state of transitioning, therefor requiring a Transitional Urban Design approach.

## *Mobility Hub Typology*

The Community Mobility Hub typology was chosen to be expanded upon in this report as it is considered a special interesting case. It has urban design considerations, potential for public space activation, it contains a mix of public transit, micromobility, as well as new mobility services of movement of passengers or goods. This transit-based MH that is nestled with public space in a walkable location with amenities. It can typically confine itself to the immediate environs of an intersection or a within an urban block. The added public space allows community gathering place and activities, while it creates a visual identity to the particular MH in question. Integration between modes is considered in the location of transit stop, micromobility docking stations, PU-DO, e-commerce, as well as e-fleet storage space.



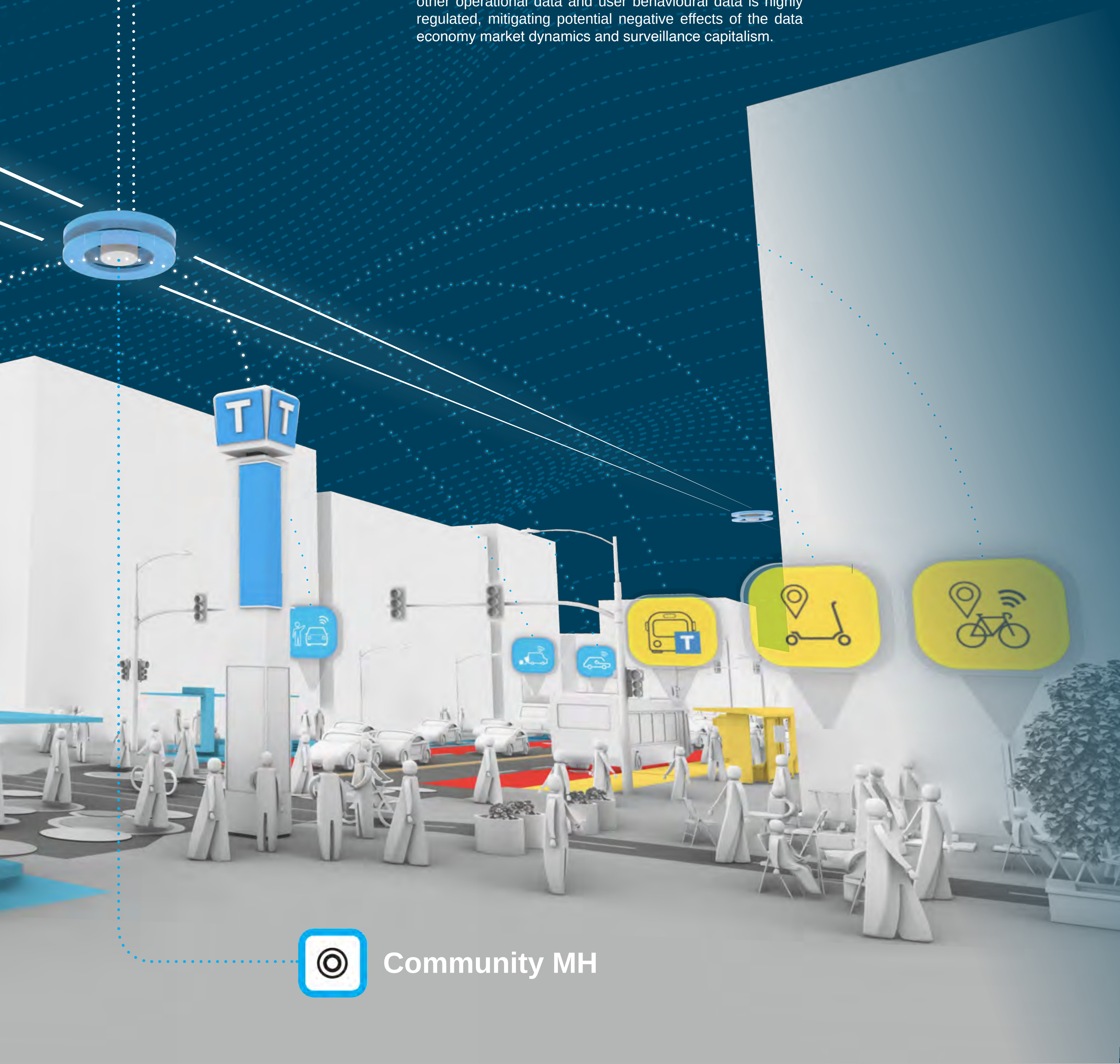



## CITY

The Mobility Hub is connected to a set of real-time virtual zoning layers, with coding of the virtual urban realm with its regulations pertaining digital use of public space. Regulation is coded for every geofenced physical space, including charging and enforcement.

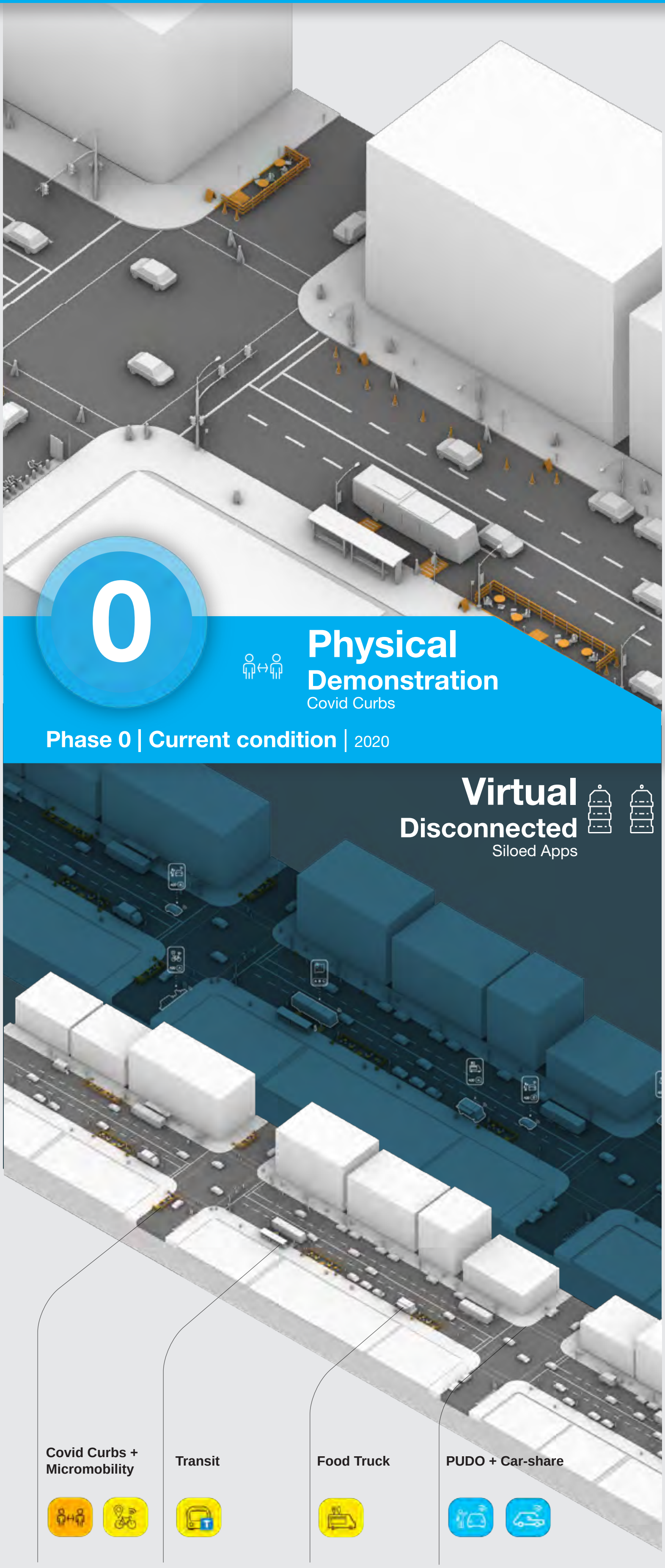
## TSPs

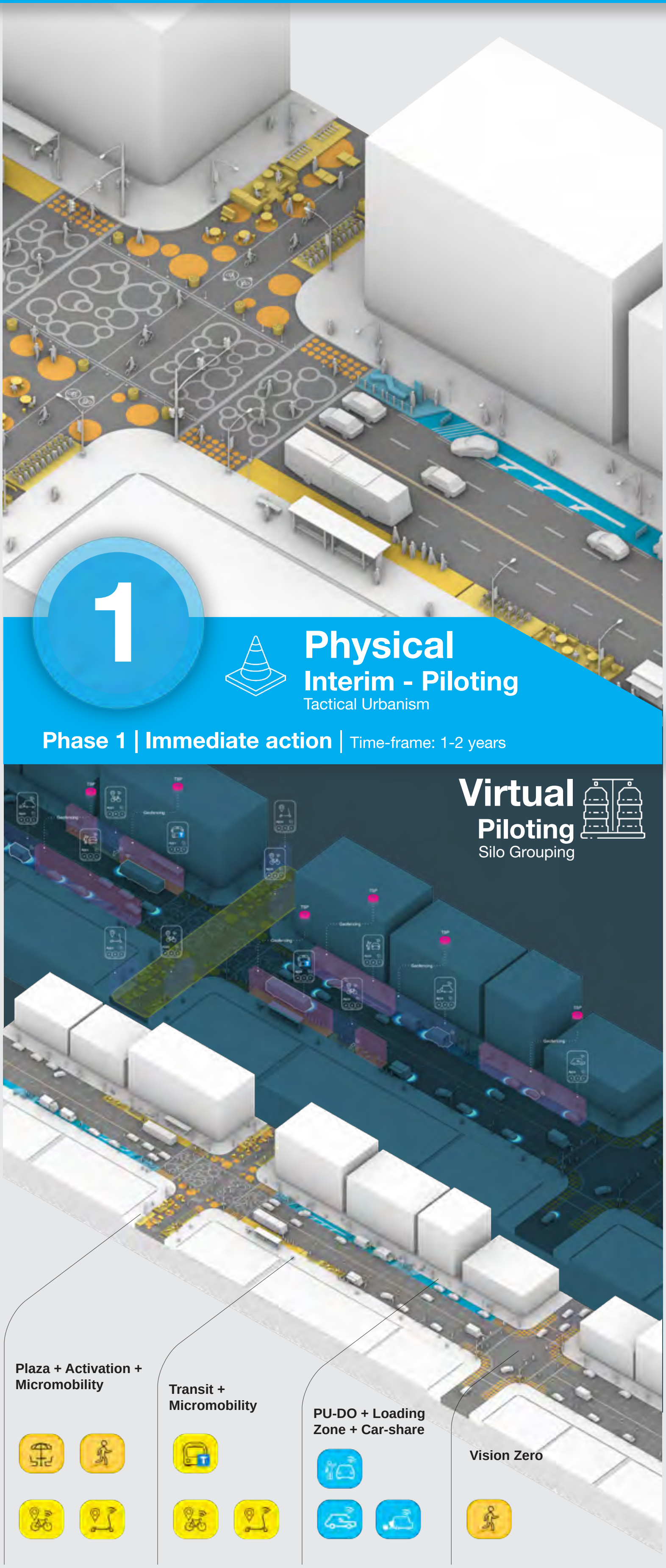
The Transport Service Providers are connected to the MH through a platform-based system, here the essential data necessary for optimal mobility functioning is controlled, while other operational data and user behavioural data is highly regulated, mitigating potential negative effects of the data economy market dynamics and surveillance capitalism.



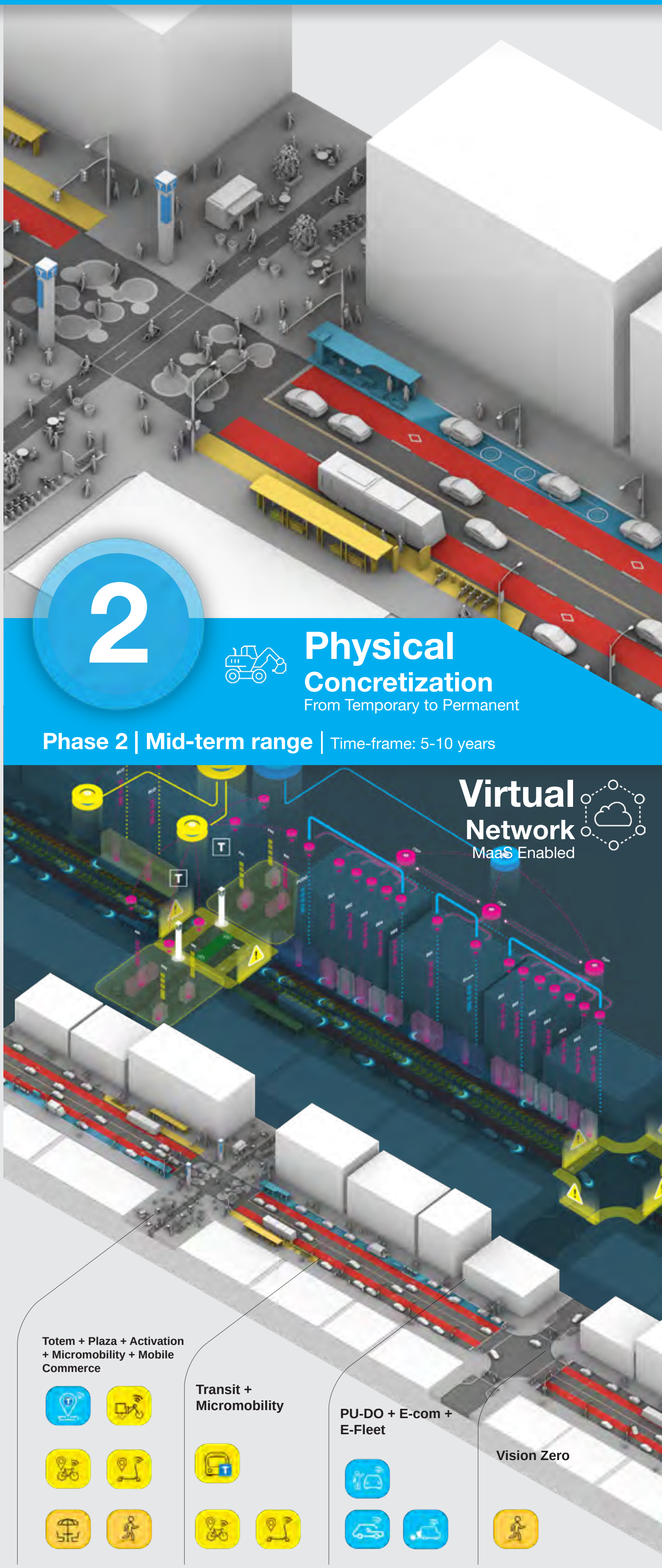
# Transitional Design Strategy

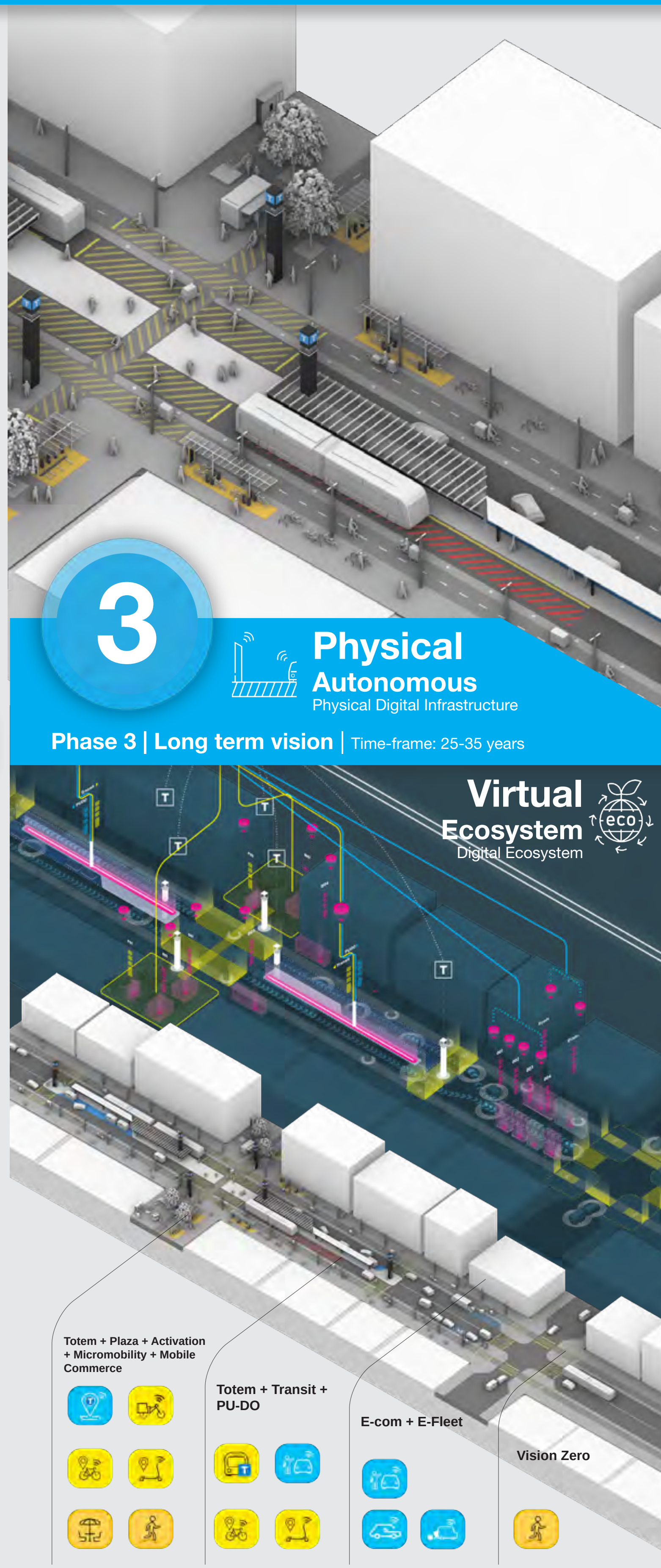
## Phases 0 & 1 Overview



# Phases 2 & 3 Overview



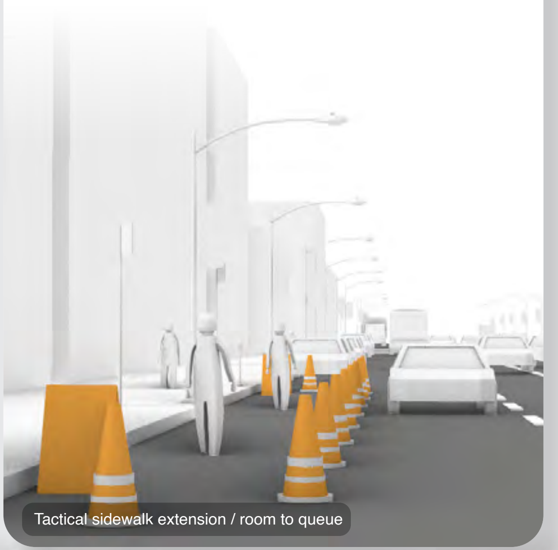



# 0 Phase 0

## Current Condition / Covid Curbs

Phase 'Zero' refers to the initial automobile-oriented condition. However, rather than a 'before' scenario, the zero stands for the initiation of light tactical solutions as part of 'open streets' and physical distancing measures responding to the Covid-19 pandemic. These can be seen as 'demonstration projects' and can be implemented in an ephemral charachter, with the possibility to remove interventions whenever required.

The tactical solutions include, pop-up plazas, sidewalk extentions, patios, room for queueing, curbside pick-up, as well as tactical bus curb-height docks. For more examples on case studies utilizing the aforementioned solutions, see 5.21, 5.2.3, 5.2.4.



Tactical sidewalk extension / room to queue

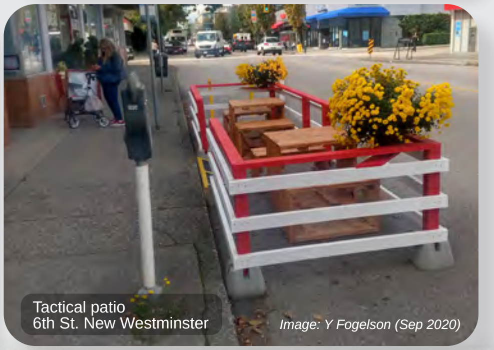

Tactical sidewalk extension
6th St. New Westminster
*Image: Y Fogelson (Sep 2020)*

Tactical bus platform
Lonsdale Ave, North Vancouver
*Image: Y Fogelson (Sep 2020)*


Tactical room to queue
W4th Ave, Vancouver
*Image: Y Fogelson (May 2020)*

Tactical curbs
Lonsdale Ave, North Vancouver
*Image: Y Fogelson (Sep 2020)*

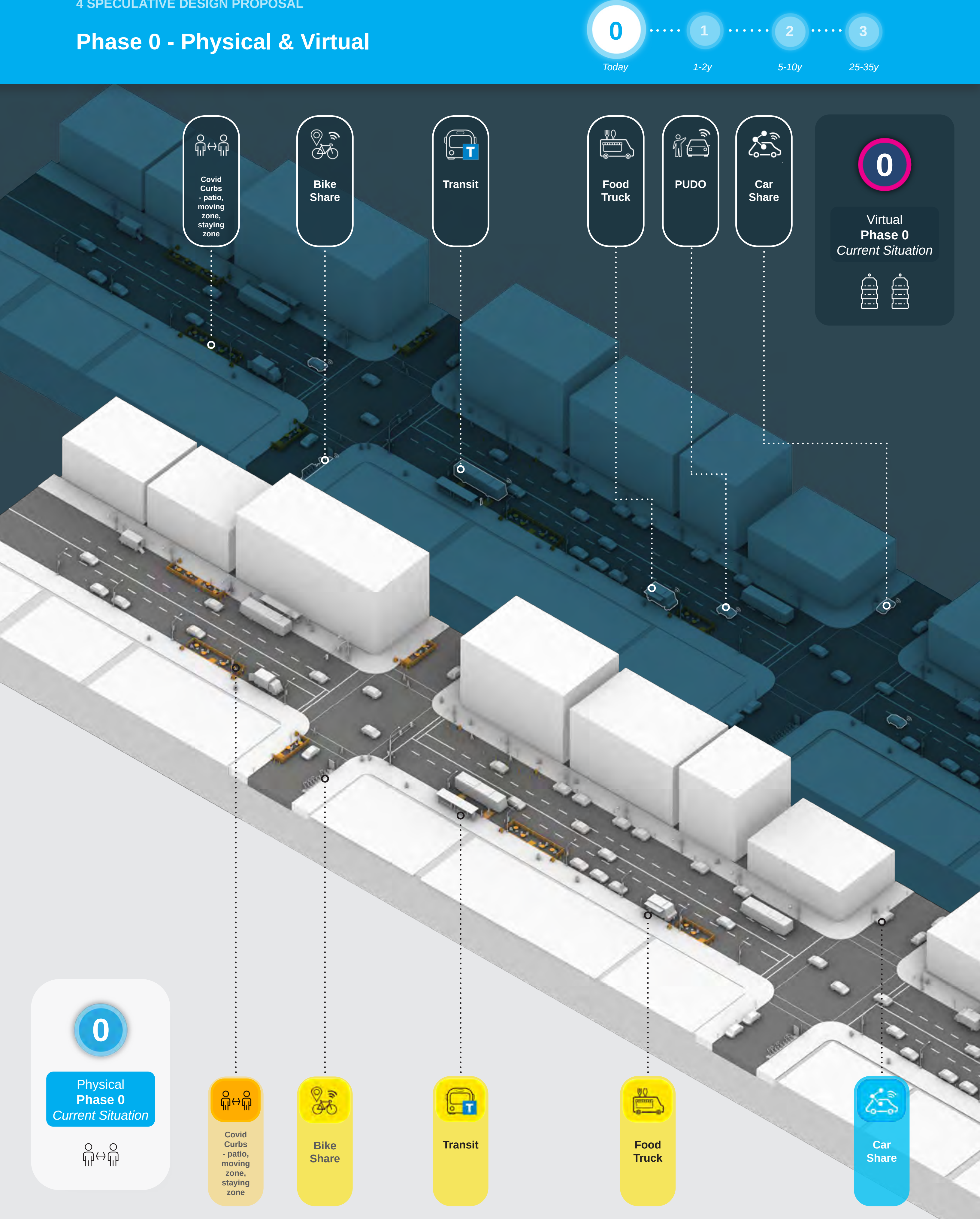

Tactical loading zone
Robson St. Vancouver
*Image: Y Fogelson (Sep 2020)*



Tactical patio
6th St. New Westminster
*Image: Y Fogelson (Sep 2020)*


Tactical curbs during Covid pandemic
Lonsdale Ave, North Vancouver

# Phase 0 - Physical & Virtual



1

# Phase 1

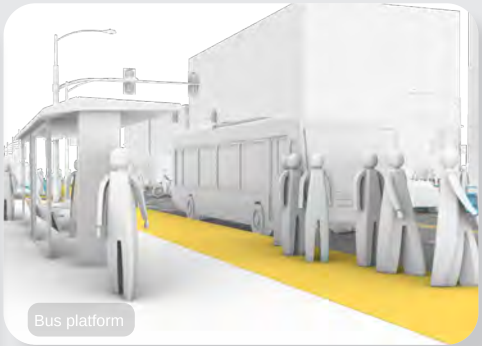
## Immediate Action - Piloting

The first phase refers to the immediate action that can be taken (planning and execution) within the time frame of 1-2 years. In this phase we can imagine piloting of tactical physical solutions, coupled with trial of new technological and new business models in the virtual realm.

Amongst the physical interventions of the 'Yellow Group' (4.3.1) are tatcical pop-up plazas, parklets and patios, food trucks, bike-share docking stations, cycle lanes, tactical curb extensions, Vision Zero intersection reconfigurations, as well tactical bus bulbs.

For the 'Blue Group' (4.3.1) we can imagine a waiting area pick-up drop-off parklet, loading zone with parklet, as well as dedicated car-share spaces.

All interventions can be adjusted, reconfigured and optimized as part of the piloting project.



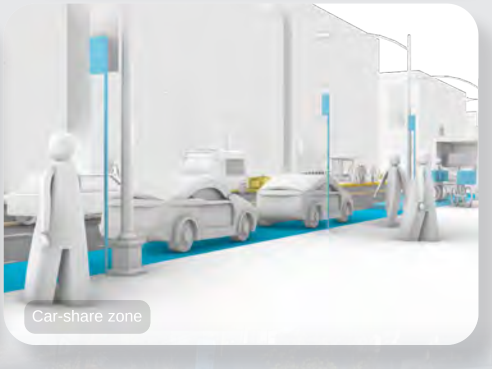
Bus platform

PU-DO zone

Plaza & bike street

E-com zone

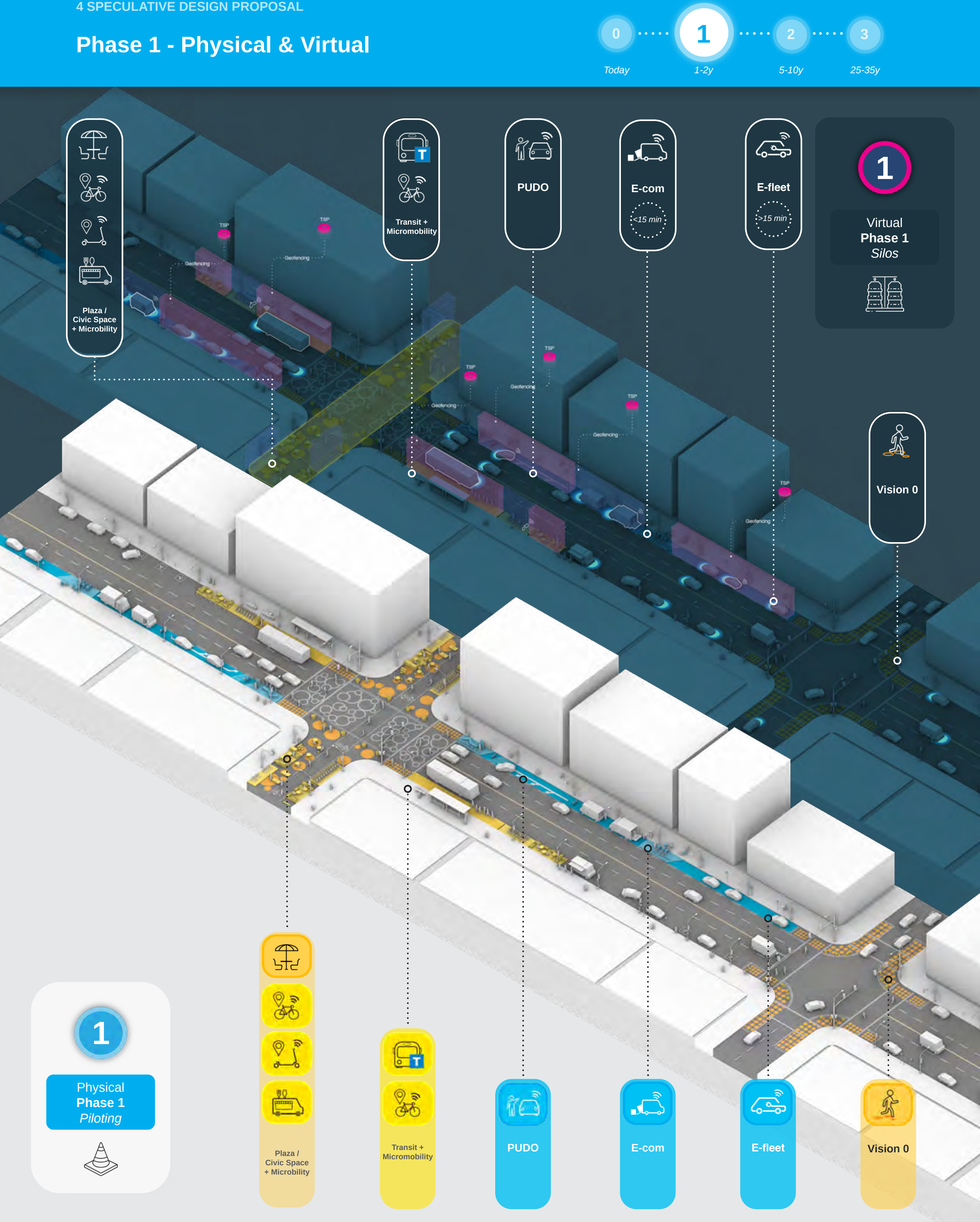
Sidewalk extension



Car-share zone

Pop-up plaza & bike street
E14th / Main St. Vancouver

# Phase 1 - Physical & Virtual



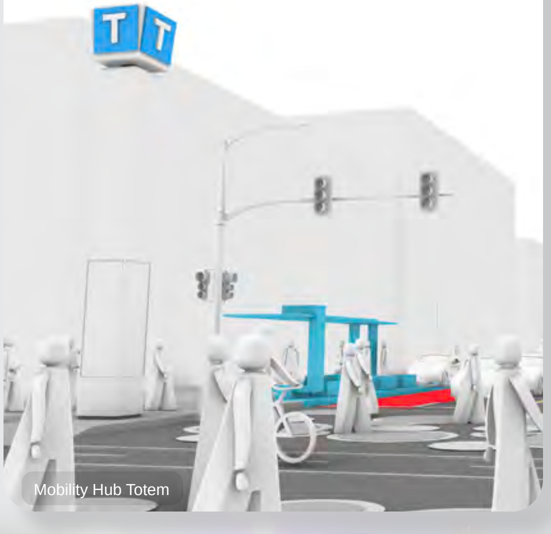
# 2 Phase 2

## Concreteziation

The second phase refers to a time-frame of 5-10 years, as the 'Concretization' stage, consolidating the successfully tested and publicly supported changes from the piloting phase. A streetscape renewal project incorporates temporary spaces from the previous phase as 'permanent' requiring infrastructural change.

At the heart of the 'Yellow Group' (4.3.1) lies the transit anchor in the form of upgraded bus stops integrated with micromobility options, as well as a civic space with a plaza incorporating designated bookable space for communal activity, food trucks and street vendor.

The 'Blue Group' (4.3.1) consist of a pick-up drop-off sheltered terminal, an e-commerce loading zone with parklet and transfer facilities to last-mile solutions, as well as dedicated spaces designated for E-fleets with EV charging.



Mobility Hub Totem


Bus platform

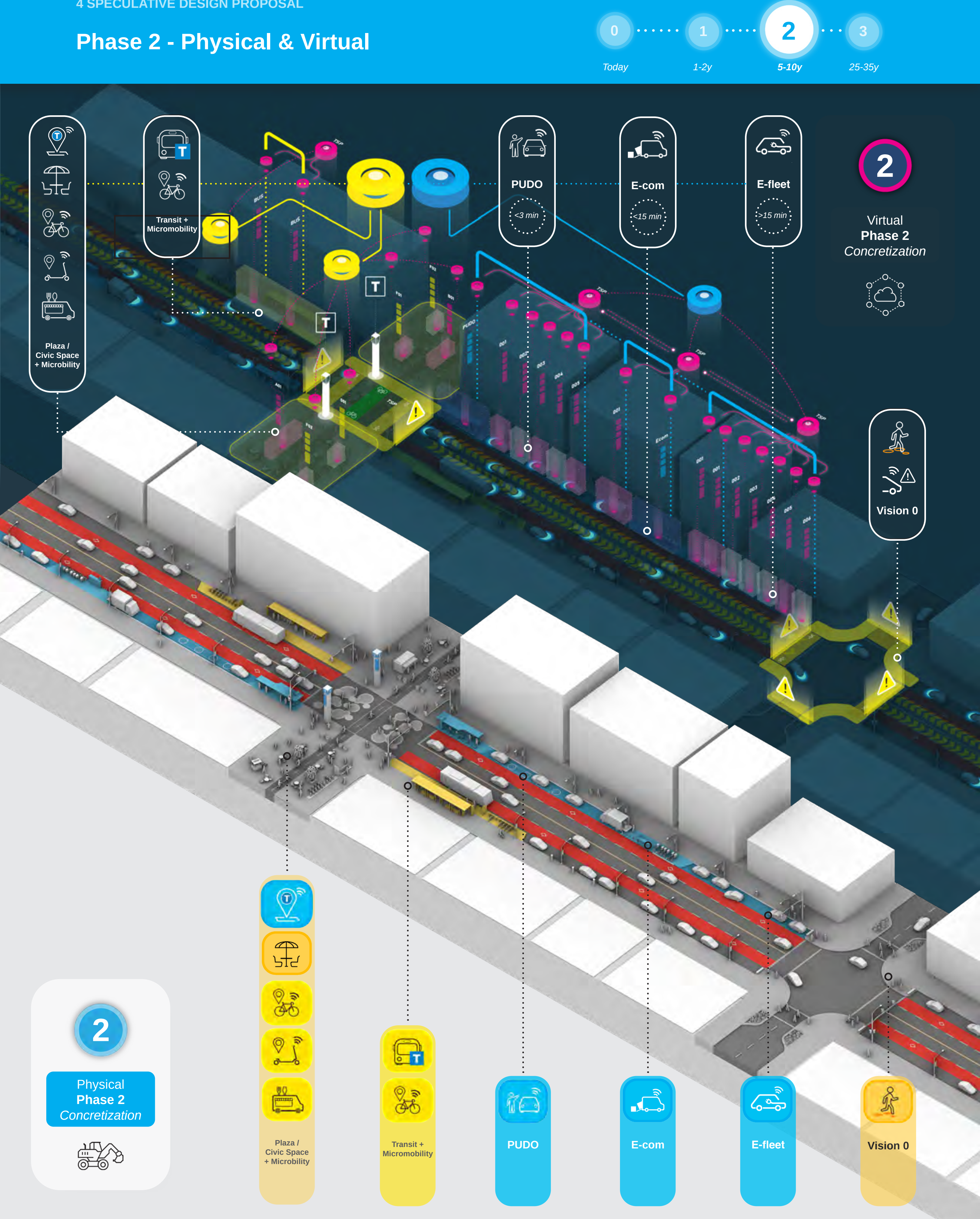

PU-DO terminal


E-com zone


Plaza

Public space activation
Jim Deva Plaza Bute/Davie St. Vancouver

# Phase 2 - Physical & Virtual



3

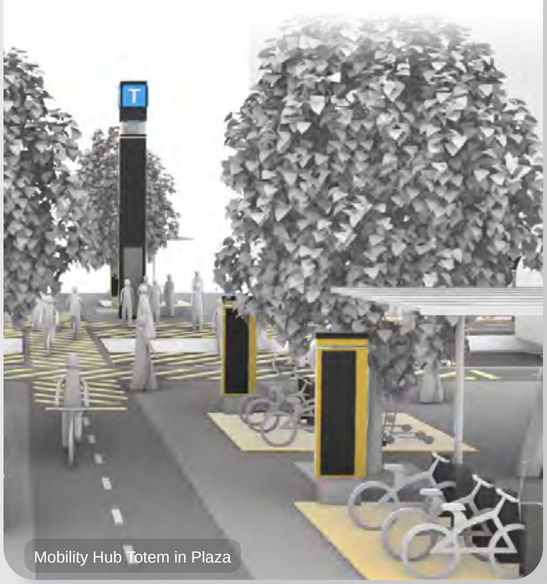
# Phase 3

## Autonomous

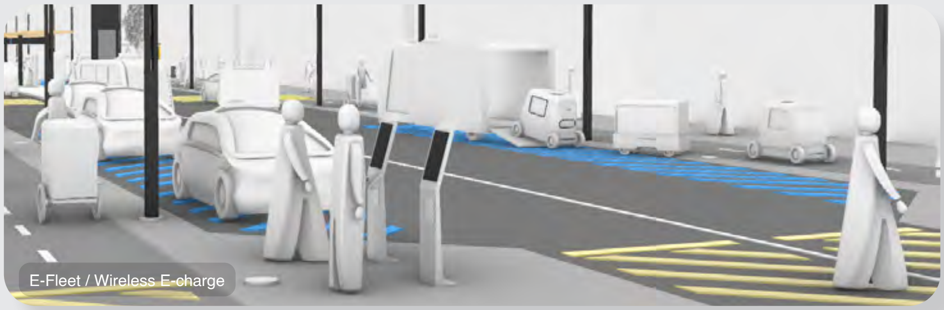
The third phase refers to a long term time-frame of 25-35 years, as the vision where possible desirable scenarios can play out. The streetscape is adapted to autonomous urbanism and is anchored around (rapid) transit. The BRT-style bus terminal in the median is doubled as a PU-DO terminal for private shuttles and other mobility services.

The plaza from phase 2 expands the idea of designated bookable space for communal activity, varied mobile commerce slots, with 'virtual address' lockers, micromobility and e-cargo bike facilities.

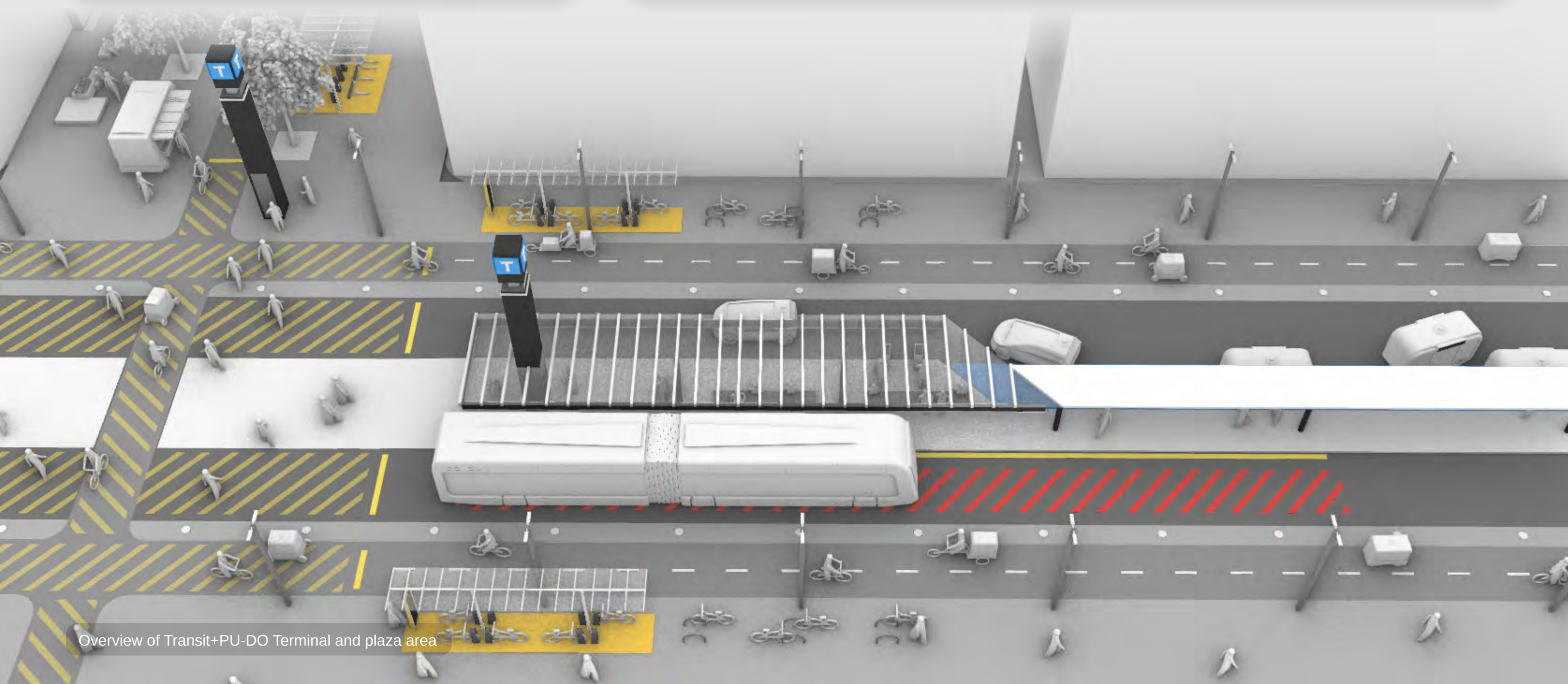
E-com space and E-fleet designated spaces include wireless charging, are limited in space and follow market logic for booking and usage.


Mobility Hub Totem in Plaza

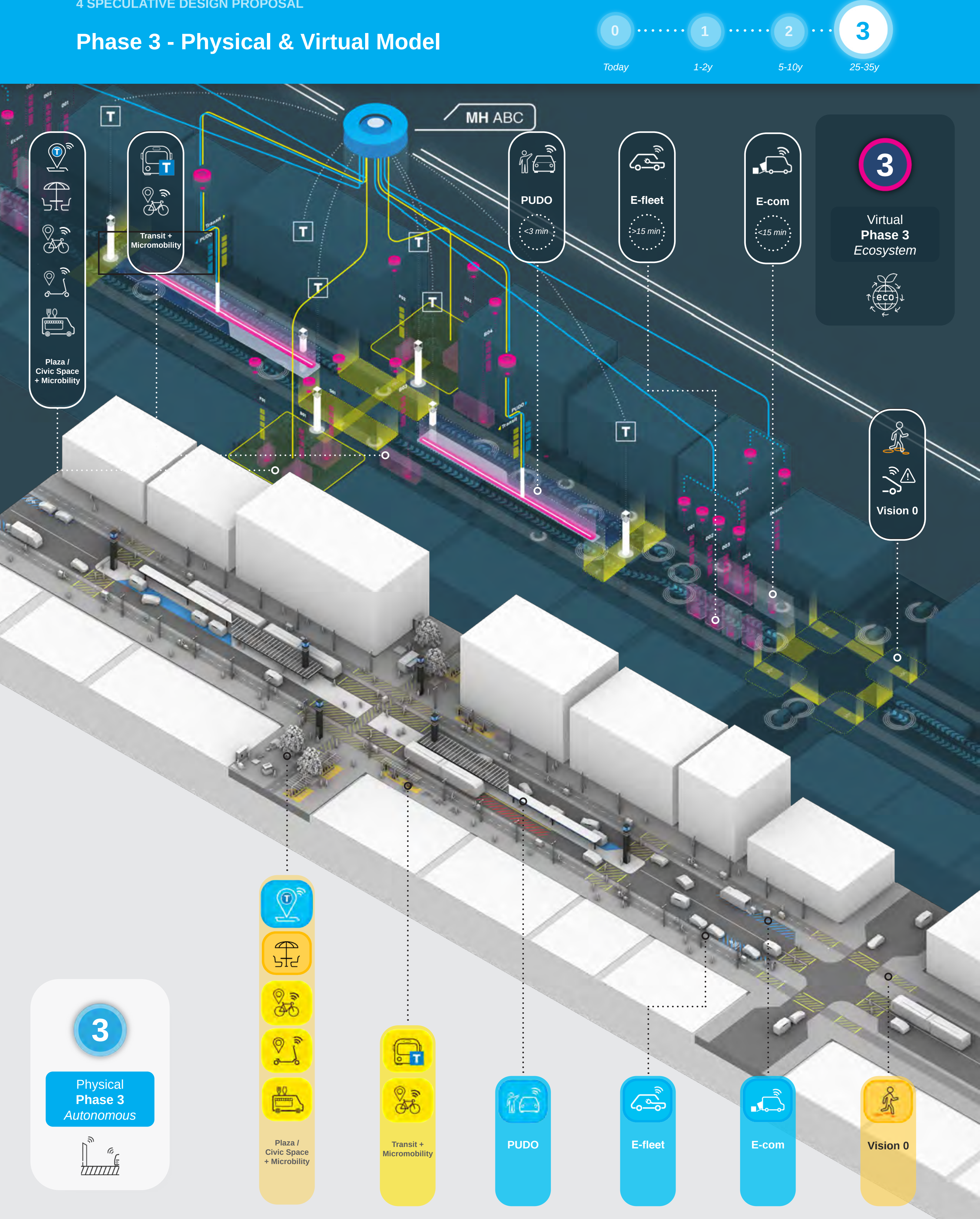

Transit + PU-DO Terminal


E-Fleet / Wireless E-charge


Plaza


Overview of Transit+PU-DO Terminal and plaza area

# Phase 3 - Physical & Virtual Model



# 4.4

# Mobility Hub Components

The mobility hub requires the interaction between the different mobility modes and their physical supporting infrastructure, in this section the concept gains a deeper inspection by further braking down its working components and looking at these separately. The components shown span three phases (1-2-3) with relevant references or precedents, each is shown in both its physical and virtual models.

Furthermore the components are divided into two groups:

**Transit + Active + Activation + Micromobility** *(“Yellow Group”)*

**Vehicular New Mobility** *(“Blue Group”)*

## *"Yellow Group"*

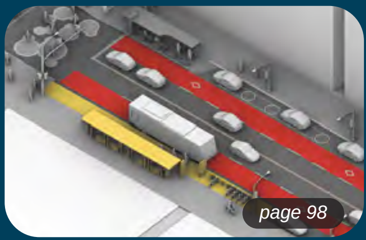
**Transit + Active + Activation + Micromobility**

**Phase 1** Immediate | 1 - 2 years

**Phase 2** Concretization | 5 - 10 years

**Phase 3** Autonomous | 25 - 35 years

### 4.4.1 Transit+ Micromobility

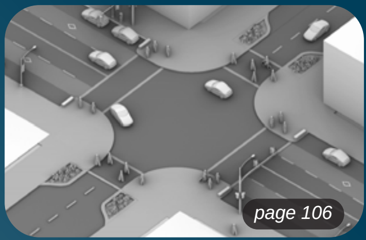





### 4.4.2 Civic Space




### 4.4.3 Vision Zero



## *"Blue Group"*

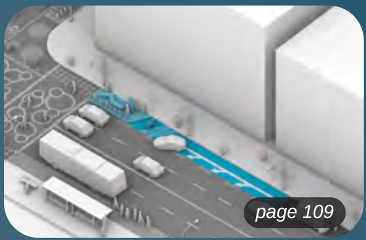
**Vehicular New Mobility**

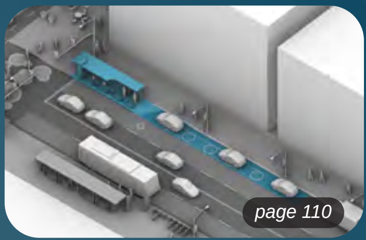
**Phase 1** Immediate | 1 - 2 years

**Phase 2** Concretization | 5 - 10 years

**Phase 3** Autonomous | 25 - 35 years

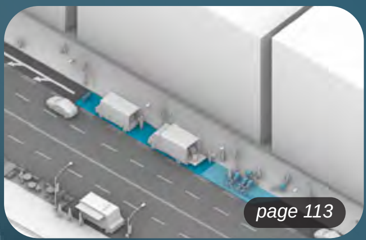
### 4.4.4 PU-DO

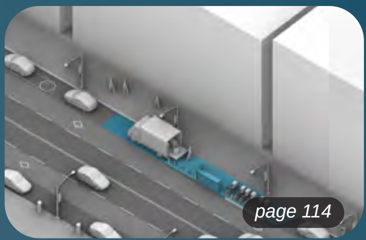




### 4.4.5 E-Commerce

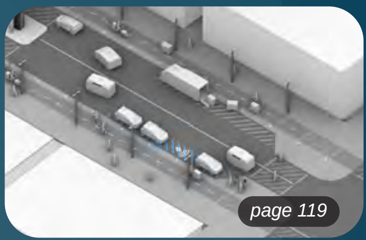




### 4.4.6 E-Fleet

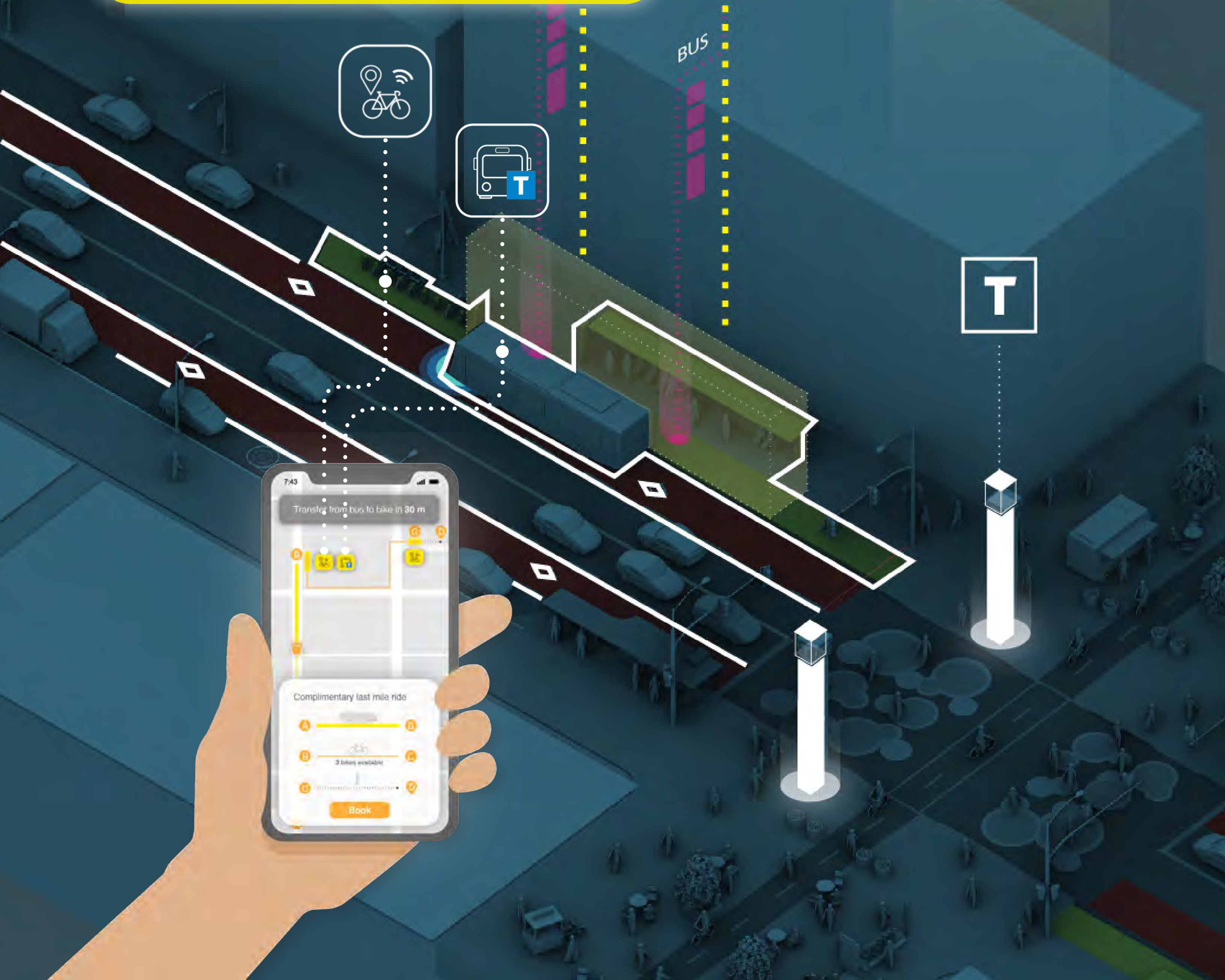




# 4.4.1

## Transit + Micromobility

The main component which the Mobility Hub is anchored around is transit, serving as the backbone to connection to other modes. Here, micromobility compliments bus trips as first and last mile solutions and is integrated with the bus stop. This physical seamless integration between the modes is also promoted virtually through MaaS platforms enabling integration of payment methods and joint operations between operators into a single multi-modal trip. In the example explored in this section there is a transition from a bus stop platform extension (bus bulb) in phase 1; to an upgraded bus stop and dedicated bus lane in phase 2; to finally a BRT-style integrated terminal solution in the visionary third phase.



# Transit + Micromobility

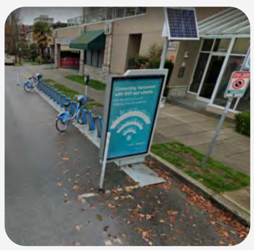
0 Today · 1 1-2y **Immediate** · 2 5-10y · 3 25-35y

## PHYSICAL

Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

- Tactical bus platform curb extensions ('bus bulb') to sidewalk level. If necessary, a bus island bulb to accommodate the bike lane with attention to safety regarding potential conflict between cyclists and passengers boarding bus conflict.
- Bike-share docking station occupying curb space, adjacent to bus stop, or clearly visible from stop
- Bicycle parking for non-bike-share

*Tactical bus platform* New York, USA
Image: ZICLA - https://www.zicla.com/en/blog/transitcenter-why-tactical-transit-is-the-next-big-thing/

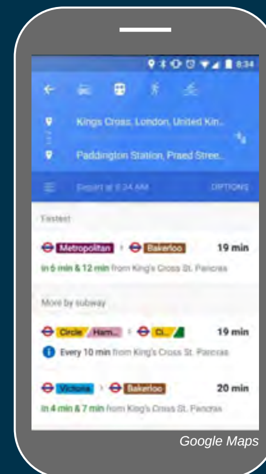


*Mobi Bike Share Station* Vancouver, BC
Image: Google Streetview

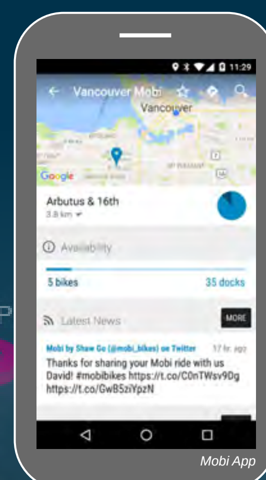
## VIRTUAL

Silos · Network · Ecosystem

- Apps in silos (bike-share, other micromobility and route-planning apps)
- Route planning and navigation apps feed from available open-source data on real-time bus arrival information and connections.
- No ticketing option for public transport, Expansion of piloting with smart card integration with other modes.
- Testing of geofencing technology in buses and public transportation to limit speed, send alerts and other safety and optimization features.



*Google Maps*



*Mobi App*

# Transit + Micromobility

0 Today · 1 1-2y · **2** 5-10y · 3 25-35y

**Concretization**

## PHYSICAL

Tactical - Pilot Project · **Project-Concretization** · Connected Autonomous Vision

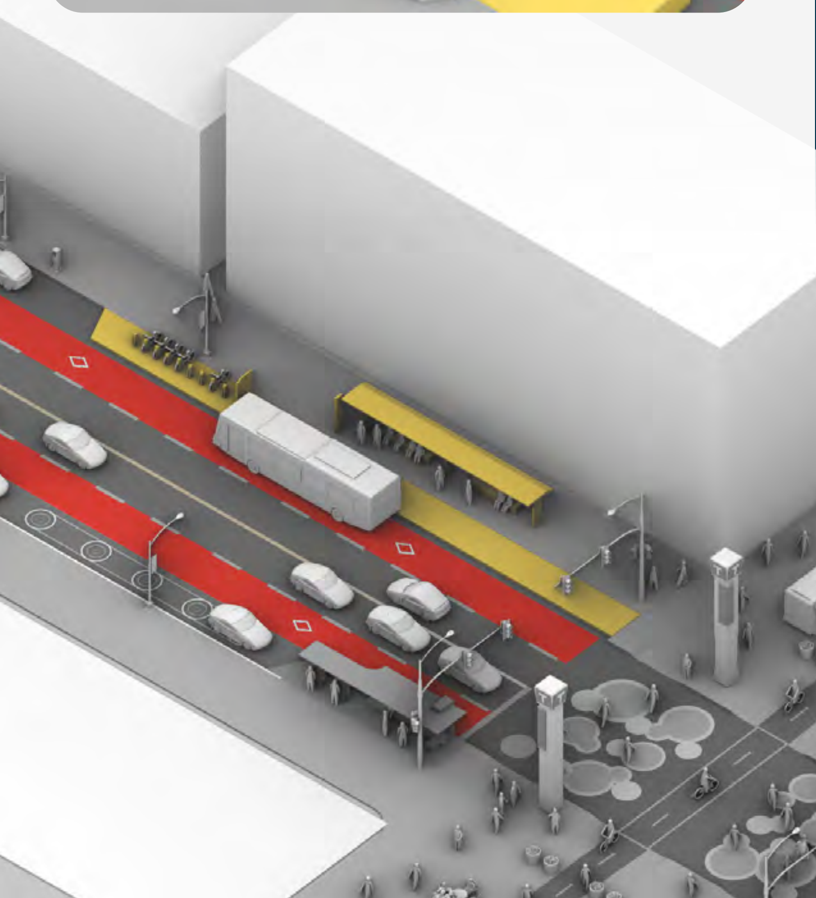
- Bus platform extensions from phase 1 become permanent sidewalk extensions. Possibility of bus-parklet layout to integrate with bike docking station.
- MaaS seamless integration is expressed in the physical design.
- Interactive bus stop with transit ticketing stands.
- Transit totems in plaza help with location identification, user orientation and wayfinding.

*Bus stop parklet* Albany CA, USA

Image: Bus-Parklet study - https://www.actransit.org/website/uploads/Bus-Parklet-Study-Manual-FINAL-12.26.18.pdf

*Bike-share + bus stop* Zhuzhou, China

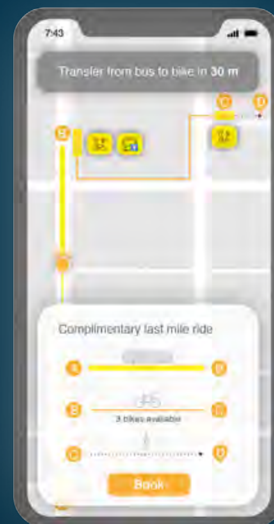
Image: Li Shan ITDP CN - https://photos.fareast.mobi/photo?id=10965

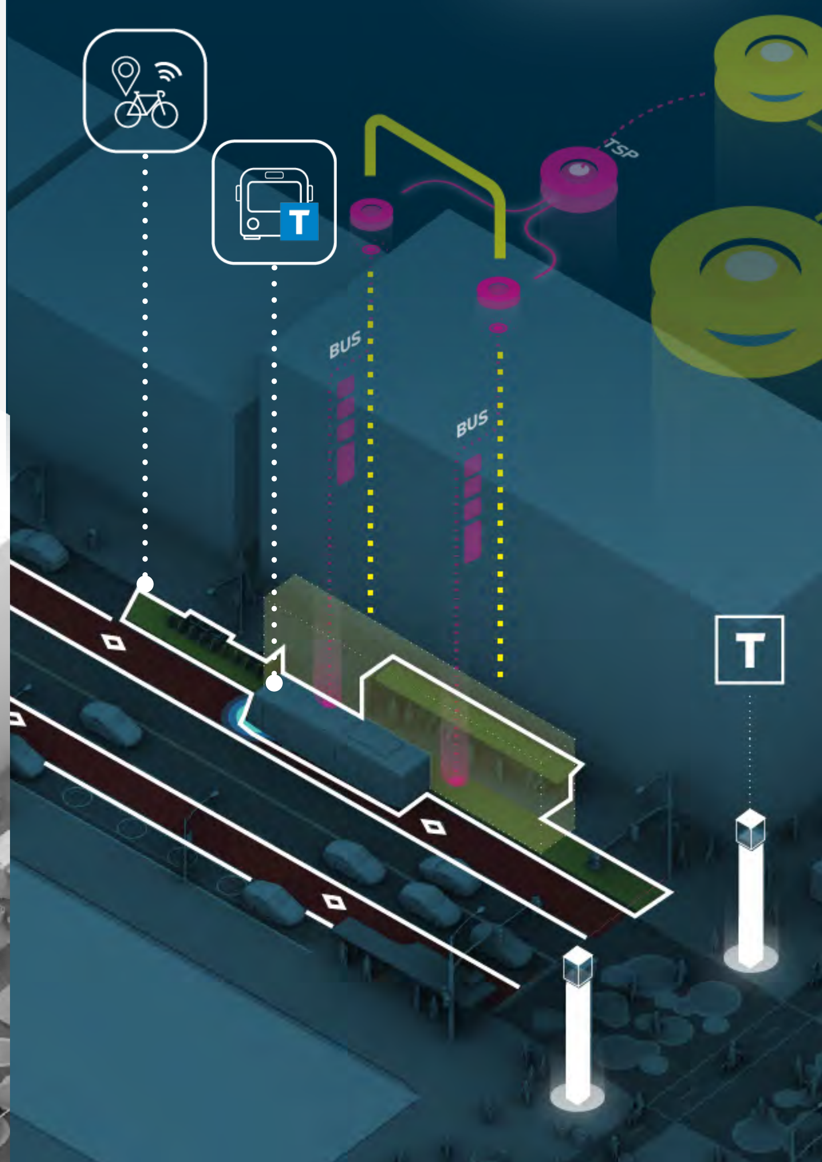


## VIRTUAL

Silos · **Network** · Ecosystem

- MaaS - integration of public transportation with other modes for multi-modal trips seamlessly integrating micromobility and transit under an integrated booking and payment system.
- Expansion of geofencing testing and operational implementation in buses and public transportation.



# Transit + Micromobility

0 Today · 1 1-2y · 2 5-10y · **3** 25-35y **Vision**

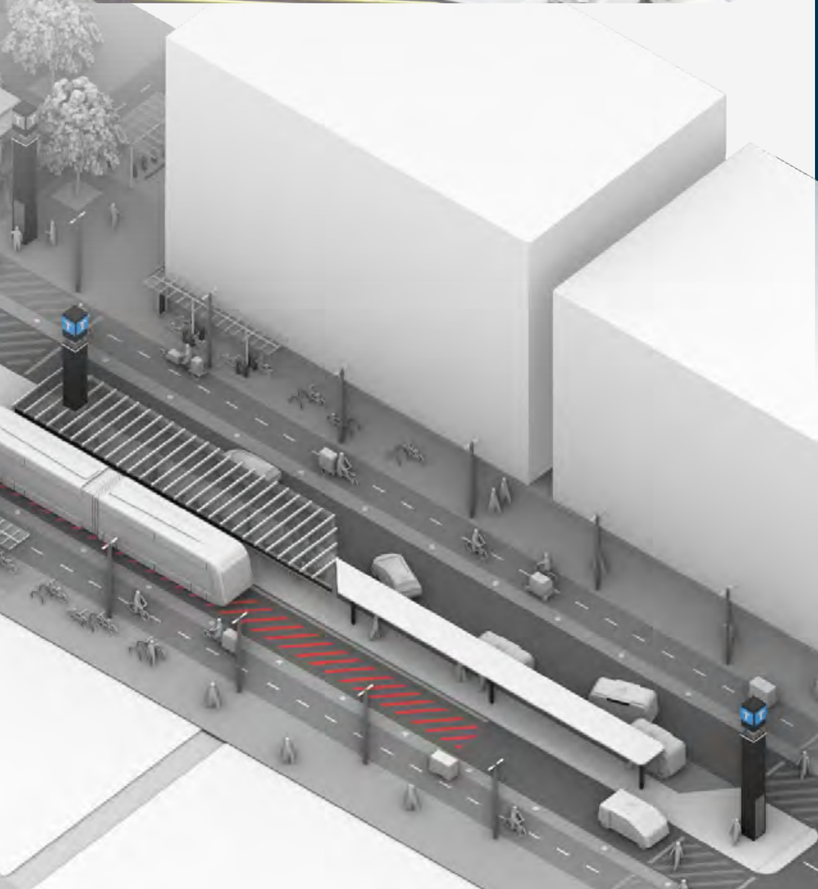
## PHYSICAL

Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

- New configuration with a BRT / LRT style transit station, relocated to the median of the street. Transit terminal shared with PU-DO in opposite directions (see 4.4.4).
- Micromobility reallocated to plaza and along cycling infrastructure.
- IoT and sensor technology embedded in infrastructure, poles and totems.
- Totems integrated within transit terminal with mobility services information and ticketing point.


*Autonomous bus testing* Gothenberg, Sweden
Image: Li Shan ITDP CN - https://photos.fareast.mobi/photo?id=10965

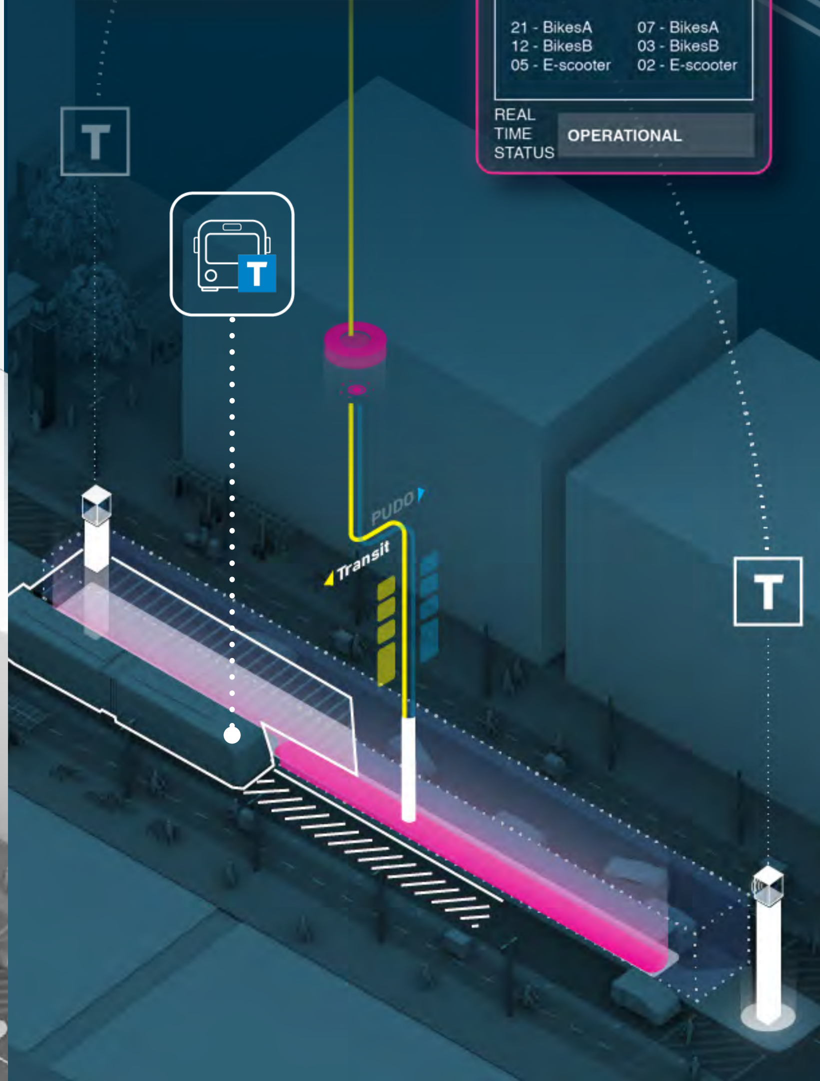
*BRT Busway system* Nantes, France
Image: https://housing.wiki/wiki/File:Nantes-brt.png



## VIRTUAL

Silos · Network · Ecosystem

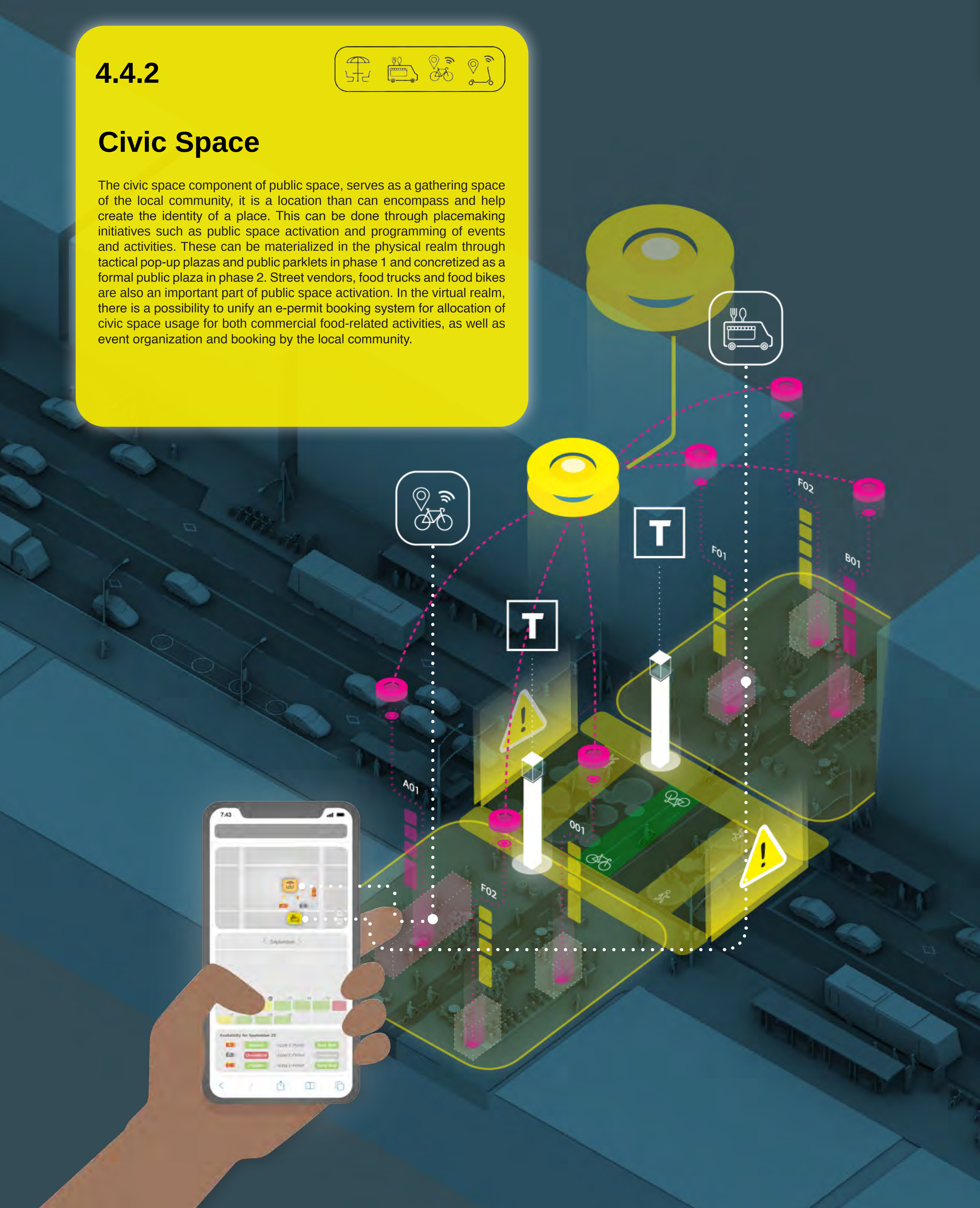
- Fully integrated transportation network with autonomous transit system.
- Mobility Hub component of transit to provide open-source data of real time scheduled transit activity.
- Mobility Hub component of micromobility to provide information on the different modes and their availability which can be used by an ecosystem of services of mobility in a network of MaaS providers.
- Remotely regulated terminal activity and autonomous buses, similar to rapid transit stations.

## 4.4.2

# Civic Space

The civic space component of public space, serves as a gathering space of the local community, it is a location than can encompass and help create the identity of a place. This can be done through placemaking initiatives such as public space activation and programming of events and activities. These can be materialized in the physical realm through tactical pop-up plazas and public parklets in phase 1 and concretized as a formal public plaza in phase 2. Street vendors, food trucks and food bikes are also an important part of public space activation. In the virtual realm, there is a possibility to unify an e-permit booking system for allocation of civic space usage for both commercial food-related activities, as well as event organization and booking by the local community.



# Civic Space

0 Today · **1** 1-2y **Immediate** · 2 5-10y · 3 25-35y

## PHYSICAL

Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

- Road space of cross street is transformed into a pop-up plaza with tactical solutions of paint and removable planters and, benches, tables and chairs.
- Reserved space for cycle path marked on ground and separated with planters.
- Bike-share and other micromobility docking stations or designated parking areas for dockless fleets.
- Designate space for street vendor or food truck in or near plaza.

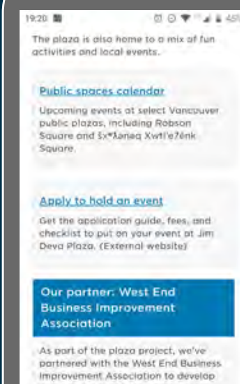
*Bute & Robson plaza* Vancouver, BC
Image: Y. Fogelson

*E14 Ave & Main St* Vancouver, BC
Image: Y. Fogelson

## VIRTUAL

Silos · Network · Ecosystem

- Booking space for events can be done manually through dedicated municipal website and social media or through BIA media.
- Food truck allocation app trial of geofenced permitted zones.
- Micromobility apps in silo, corresponding to their own bike or e-scooter fleet.
- Piloting of an e-permit booking system.




*Jim Deva Plaza Webpage*
https://vancouver.ca/streets-transportation/jim-deva-plaza.aspx


*Foodtruck App (Snabb App)*

# Civic Space

0 Today · 1 1-2y · **2** 5-10y · 3 25-35y

**Concretization**

## PHYSICAL

Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

- Concretization of interim plaza from previous phase, integrated in a streetscape plan.
- Designated space for micromobility docking stations, areas for dockless fleets.
- Designated space for street vendor, food truck, food-bike, or mobile AV cafe.
- Placemaking and local identity activities and programming of events. Opportunity for community public artwork.
- Transit totems in plaza help with user orientation and wayfinding.

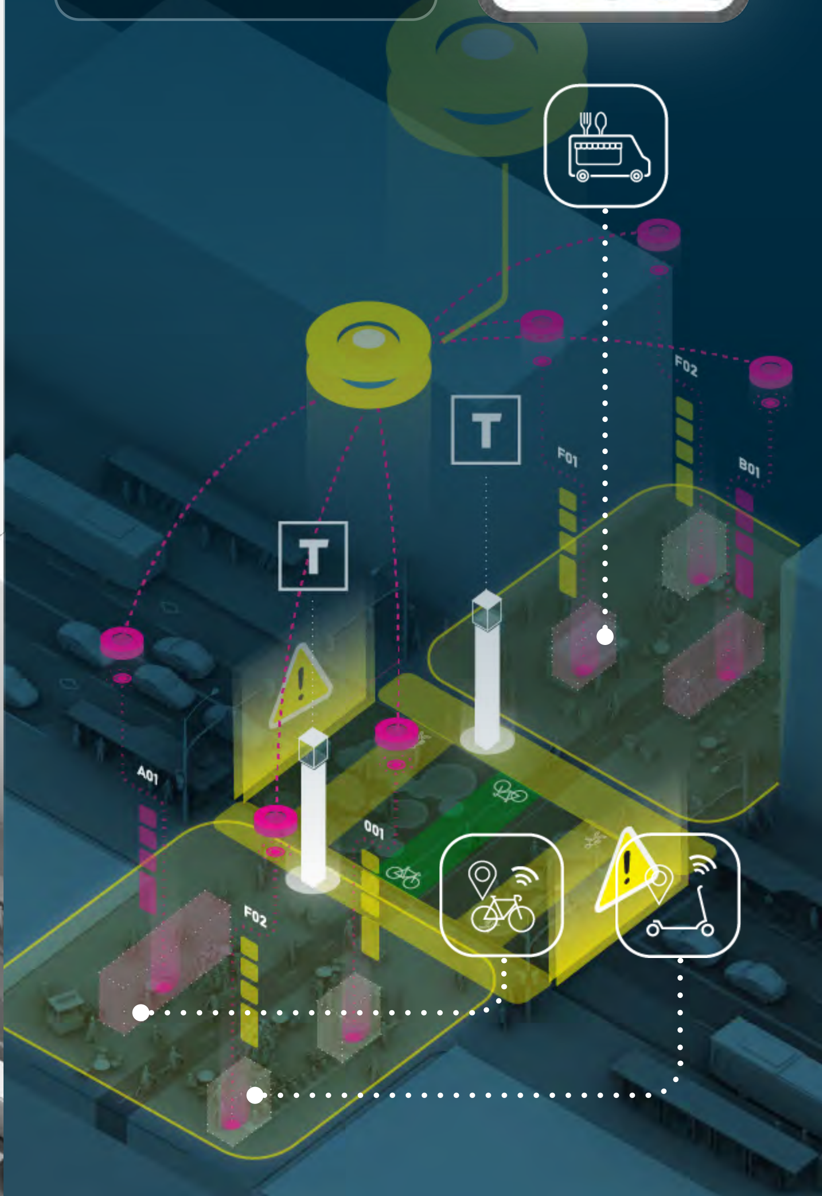
*Jim Deva Plaza, Davie / Bute St.* Vancouver, BC

image: Y. Fogelson

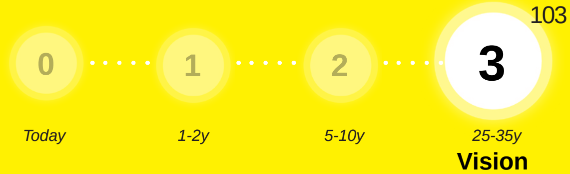
## VIRTUAL

Silos · Network · Ecosystem

- Opportunity to unify an e-permit booking system for allocation of civic space usage for both commercial food-related activities, as well as event organization and booking by the local community. This system can be linked to a schedule booking system overlooked by municipality or BIA of specific location.
- Coding of space to include safety crossing zones with Vision Zero provision (see 4.4.3)



# Civic Space




## PHYSICAL

Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

- Plaza design adapted to growing micromobility cycle infrastructure.
- Expanded, designated sheltered space for micromobility docking stations, areas for dockless fleets.
- Designate space for street vendor, food truck or mobile AV cafe.
- Transit totems in plaza help with user orientation, wayfinding and mobility services information and ticketing point.

## VIRTUAL

Silos · Network · Ecosystem

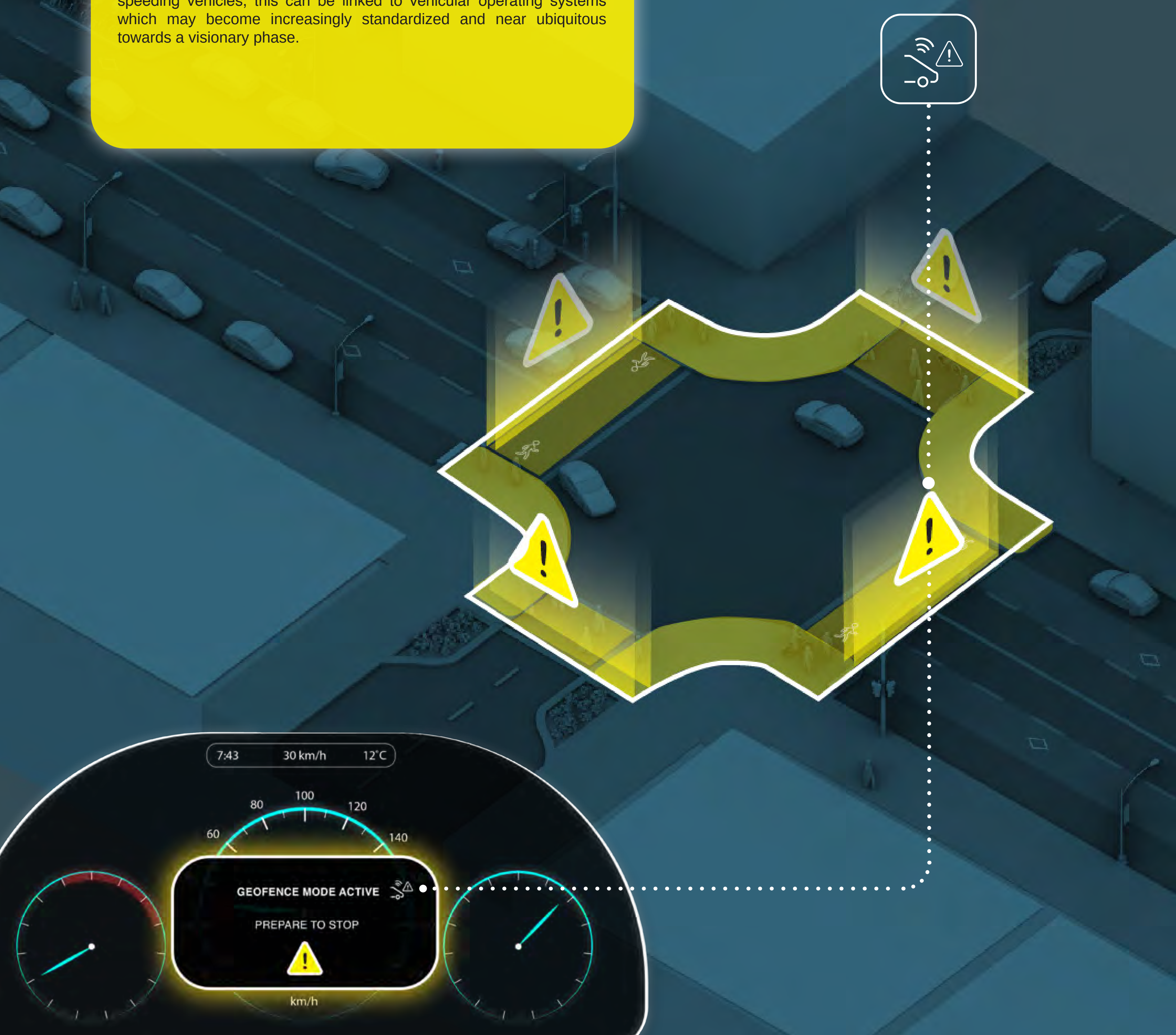
- E-permit system expanded to any temporary commercialized use of public space. Enforcement through geofencing registration of space occupation in duration and time of day.
- Booking and charging system compatible with curb space booking system. Uses favouring community or activation of space can be prioritized, while revenue from commercial uses can be reinvested in local maintenance and improvement.

## 4.4.3

# Vision Zero

The Vision Zero initiative seeks to eliminate all traffic fatalities and severe injuries while increasing safe, healthy, equitable mobility for all. The investigated road safety improvement measures focus on intersection improvement by reduction of crossing distance for pedestrians, this is achieved by extending the sidewalk on behalf of the curb space, creating ‘bulb-outs’.

In terms of digital infrastructure, in the first phase cameras and sensors can be trialled to document and analyze near-miss incidents between vehicles and pedestrians and cyclists. In a second phase, geofencing of intersections can be coded with regulations such as slowing or stopping speeding vehicles, this can be linked to vehicular operating systems which may become increasingly standardized and near ubiquitous towards a visionary phase.



0 Today · 1 1-2y **Immediate** · 2 5-10y · 3 25-35y

# Vision Zero

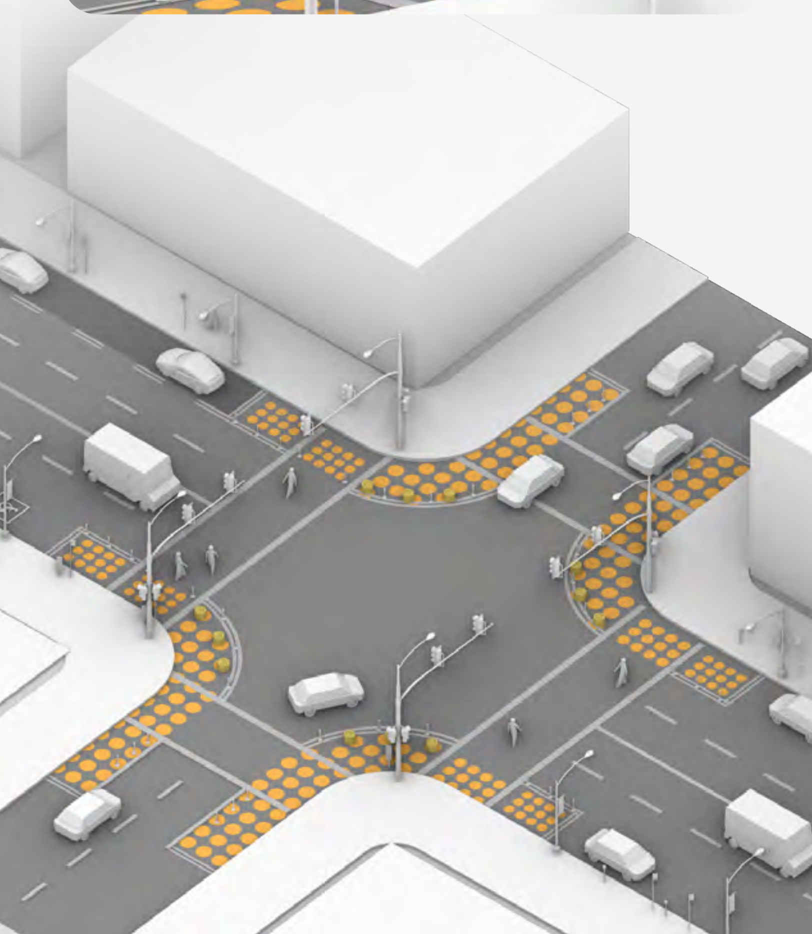
## PHYSICAL

Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

- Tactical 'bulb outs', sidewalk intersection corner extensions are marked with paint and bollards. Crossing distance for pedestrian is shortened, speed-reducing vehicles turning, reducing potential vehicle-pedestrian conflicts.
- Digital infrastructure such as cameras or sensors can be tested.

*Tactical transformation into pedestrian space* Rionegro, Colombia
Image: BID Ciudades Sostenibles - https://blogs.iadb.org/ciudades-sostenibles/es/peatonalizacion-para-la-salud-ciudadana-metodologias-participativas-y-experimentales-del-piloto-en-urbanismo-tactico-rionegro-calle-consciente/

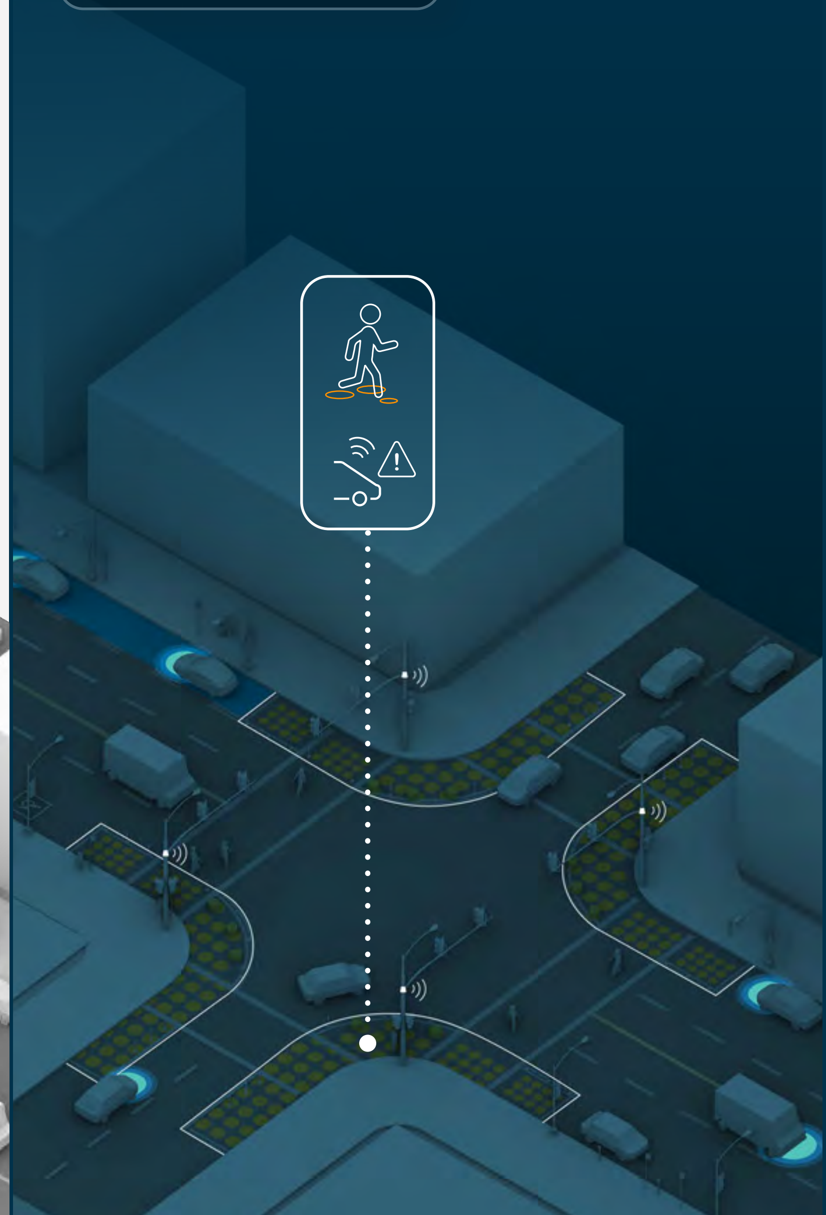
*Tactical intersection* Austin, TX, USA
Image: https://www.smartcitiesdive.com/ex/sustainablecitiescollective/tactical-urbanism-city-streets/1147275/



## VIRTUAL

Silos · Network · Ecosystem

- Data generated from cameras and sensors analyzing traffic flows, can identify near-miss incidents can be used to simulate and different street layout or traffic light timing.



# Vision Zero



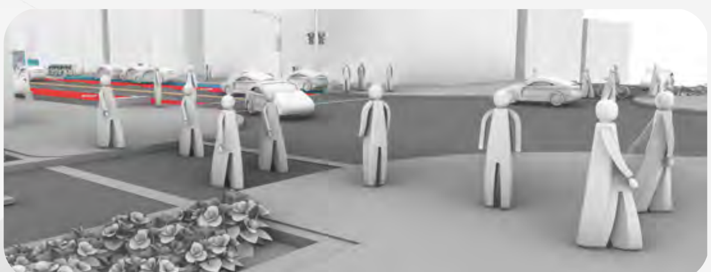
## PHYSICAL

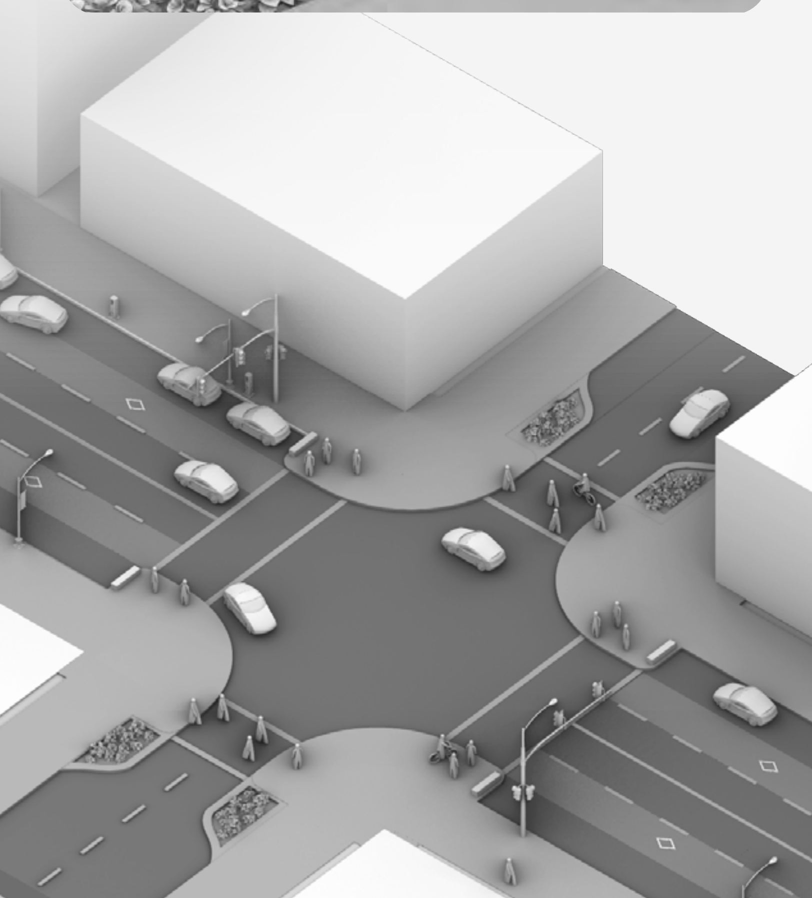
Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

- Intersection redesign based upon previous layout experimentations.
- Digital infrastructure and sensors incorporated in smart pavement, posts and traffic lights.
- Rain gardens or other greenery and sitting areas can be incorporated in 'gained' space immediately adjacent to the intersection.

*Rain garden bulb out* Victoria, BC
Image: Google Streetview

*Redesign of street, shared street* Seattle, WA
Image: Y. Fogelson

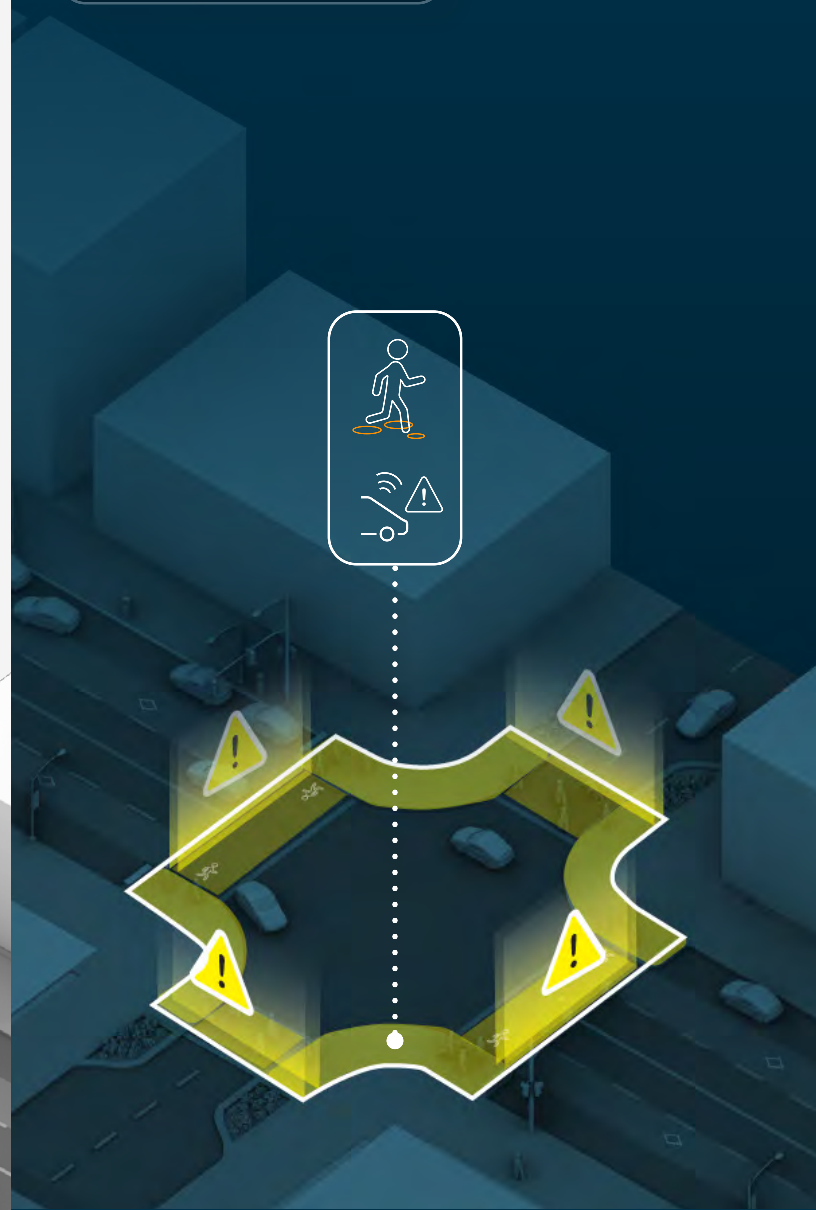




## VIRTUAL

Silos · Network · Ecosystem

- Geofencing of intersections can be coded with regulations. Predictive pre-emptive alerts, based on trajectory movement of vehicle and its environment, can be sent in real-time to vehicles with operating systems compatible with geofencing road regulation coding.



# Vision Zero

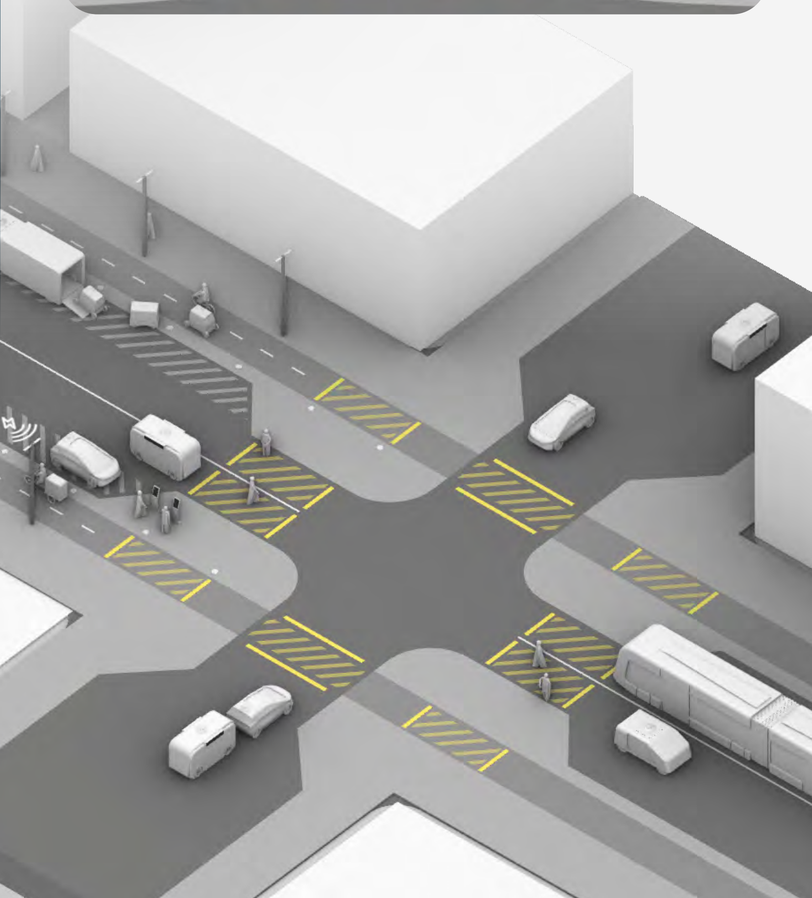


0 Today · 1 1-2y · 2 5-10y · **3 25-35y Vision**

## PHYSICAL

Tactical - Pilot Project · Project-Concretization · **Connected Autonomous Vision**

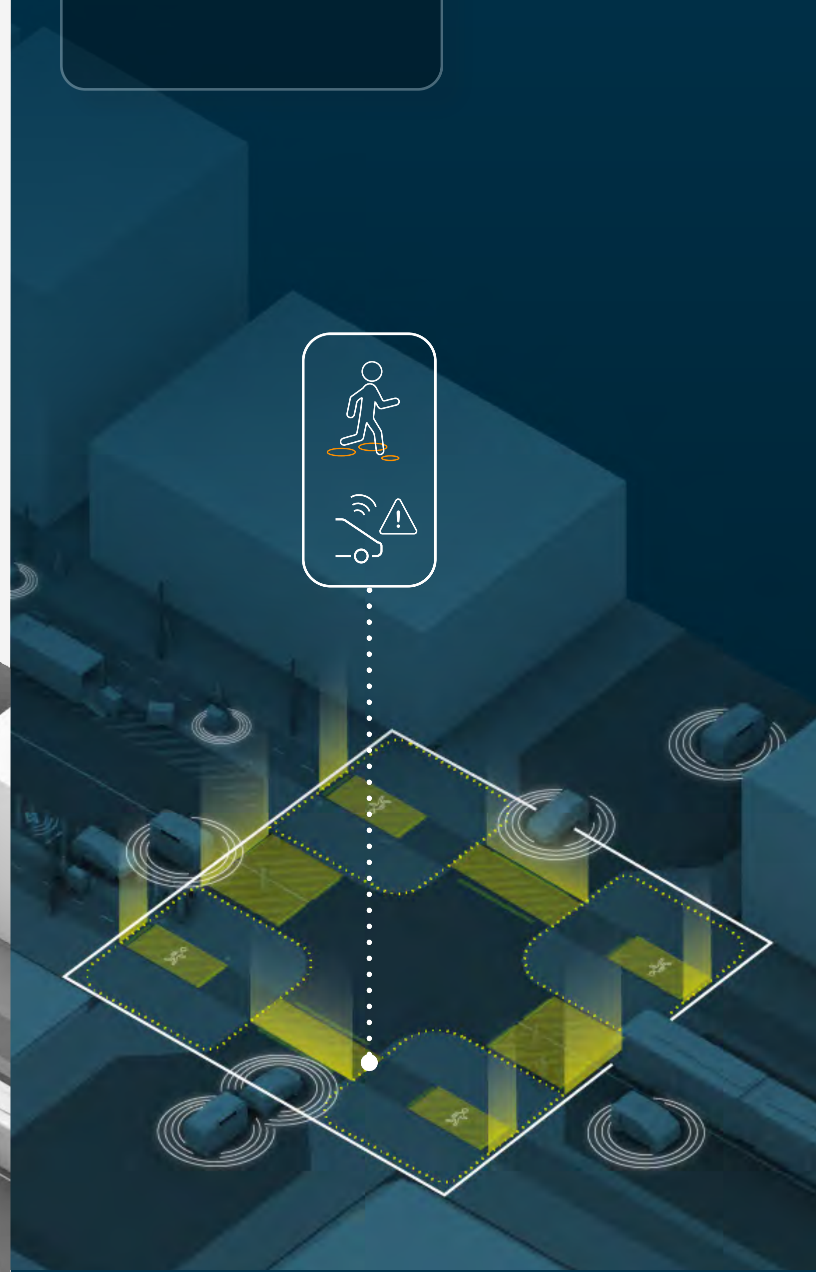
- Intersection adapted to future layout with additional designated space for micromobility infrastructure, ideally on both sides of street.
- Crossing zones can include new ground signalization mechanisms and installed sensors and ground lights.
- Opportunity for curbless streets.



## VIRTUAL

Silos · Network · **Ecosystem**

- AV Vehicular operating systems may become near ubiquitous. This allows local override of remote driving system feeding off real-time data from embedded infrastructure, to increase safety and avoid vehicle-pedestrian or cyclist conflicts.



# 4.4.4

## PU-DO Terminal

With the increase adoption of ride hail services, the demand for PU-DO (pick-up / drop off) zones has increased in urban areas. PU-DO zones can be curb space that is limited to a permanence of maximum 3 minutes, implying the presence of a driver in or near the vehicle. These areas can be used by any private vehicle or service of passenger movement such as taxis and van-share or car-pooling services. The first phase proposes designating a 1-2 curb space parklet as a waiting area. This is coupled with geofencing regulations of allowed pick-up or drop-off locations within a specific radius or with a specific corridor. In the second phase the parklet becomes a small sheltered 2-3 curb space sized terminal, with booking / check-in stands for passengers which are not using an app or mobile device. In the visionary phase, the PU-DO unites with the transit terminal in the median of the street. The PU-DO terminal in the future may include autonomous taxis, autonomous shuttles, car-pool, van-pool or other shared vehicular modes.

# PU-DO Terminal

0 Today · 1 1-2y **Immediate** · 2 5-10y · 3 25-35y

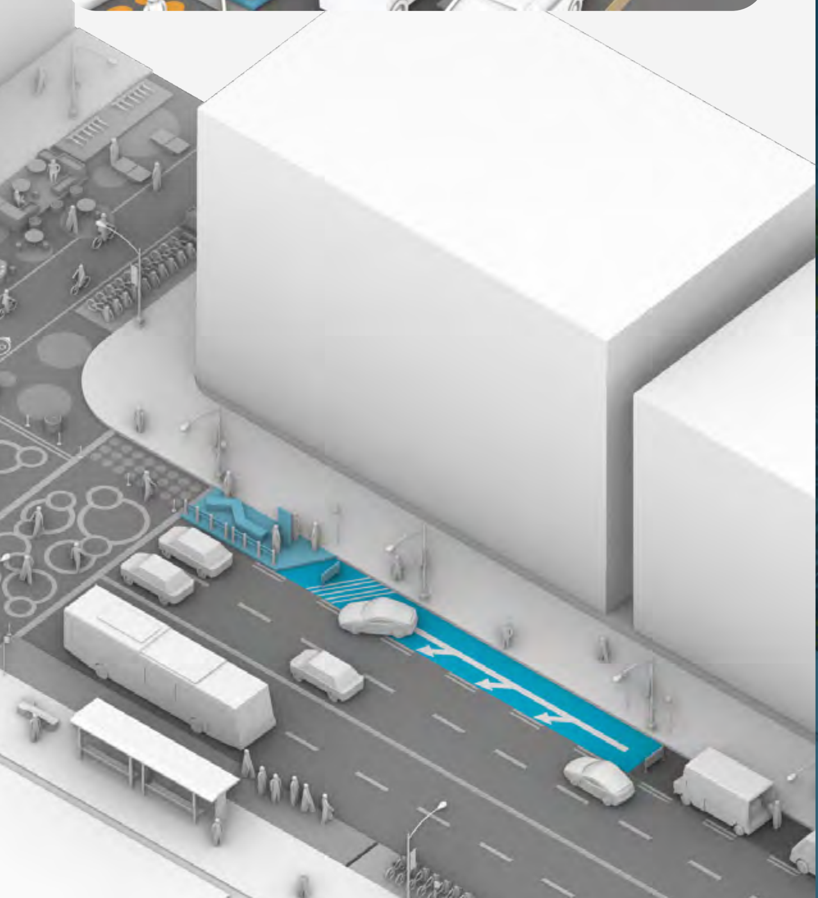
## PHYSICAL

Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

- Dedicated curb space for pickup and drop off zone of 3-5 parking spaces.
- Designating a 1-2 space parklet as a waiting area for passengers waiting for their ride. Parklet can include information board about services and wayfinding.

*Parklet for sitting* Vancouver, BC
image: Y. Fogelson

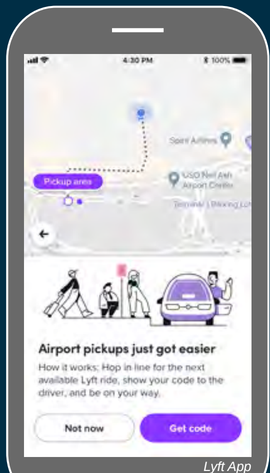
*3min Pick-up drop-off* Seattle, WA
image: Y. Fogelson



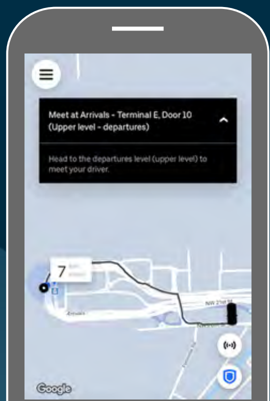
## VIRTUAL

Silos · Network · Ecosystem

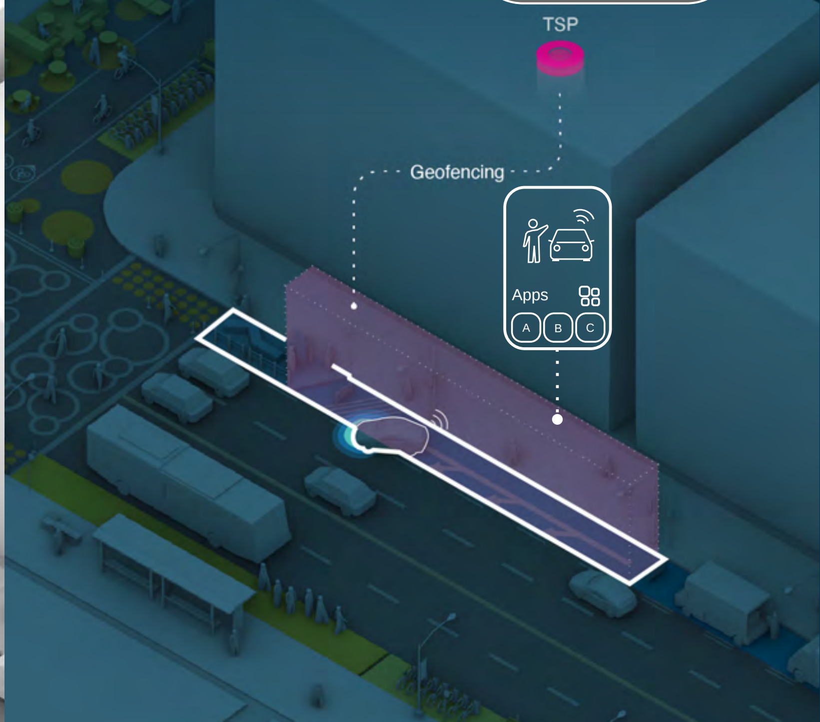
- Apps in silos of different TNCs.
- Piloting of geofencing along corridor to regulate PU-DO by sending passenger to pick up location. Drop off at terminal only for drivers to terminate transactions of rides.
- Piloting of dynamic drop-off usage fee by time of day, duration, location and contribution to congestion.
- Optimization and scenario building through curb space use analytics.




*Lyft App*




*Uber App*



# PU-DO Terminal

0 Today · 1 1-2y · **2 5-10y Concretization** · 3 25-35y

## PHYSICAL

Tactical - Pilot Project · *Project-Concretization* · Connected Autonomous Vision

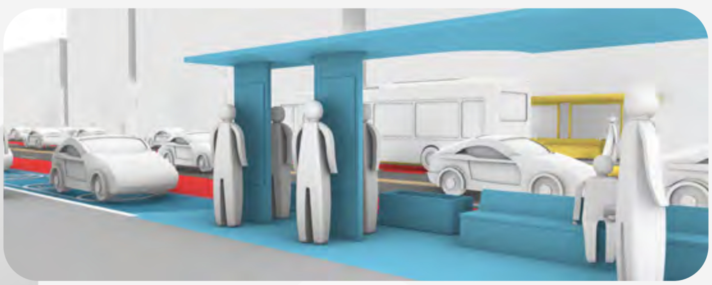
## VIRTUAL

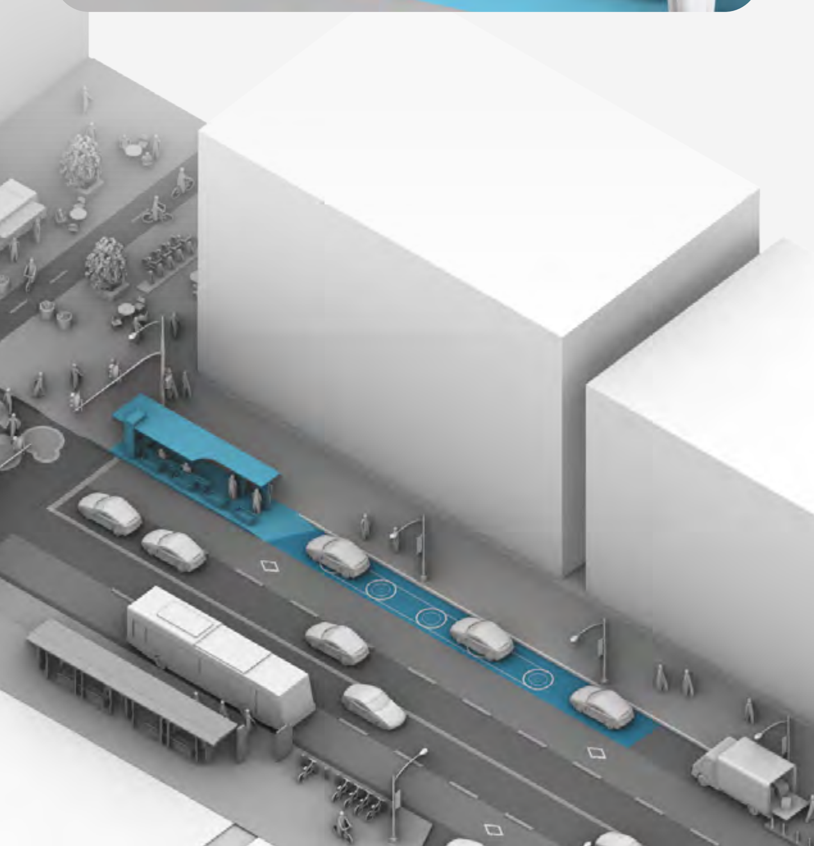
Silos · *Network* · Ecosystem

- Previous parklet is transformed into a small sheltered 2-3 parking space sized terminal.
- Integration of non-company specific generic digital kiosks for a wide variety of MaaS services.
- Kiosks or booking / check-in stands allow hailing, booking a trip and payment amongst participating local shared / ride-hail mobility services, taxis, para-transit, van pool, etc. Digital kiosks serve passengers which are not using an app or mobile device.

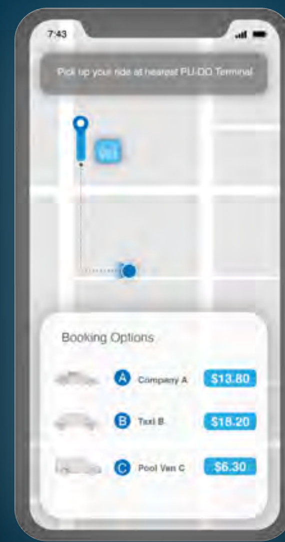

*Uber phoneless booking* YYZ, Toronto, ON
image: Uber - https://www.businessinsider.com.au/how-to-take-uber-without-a-phone-toronto-airport-kiosk-2019-8

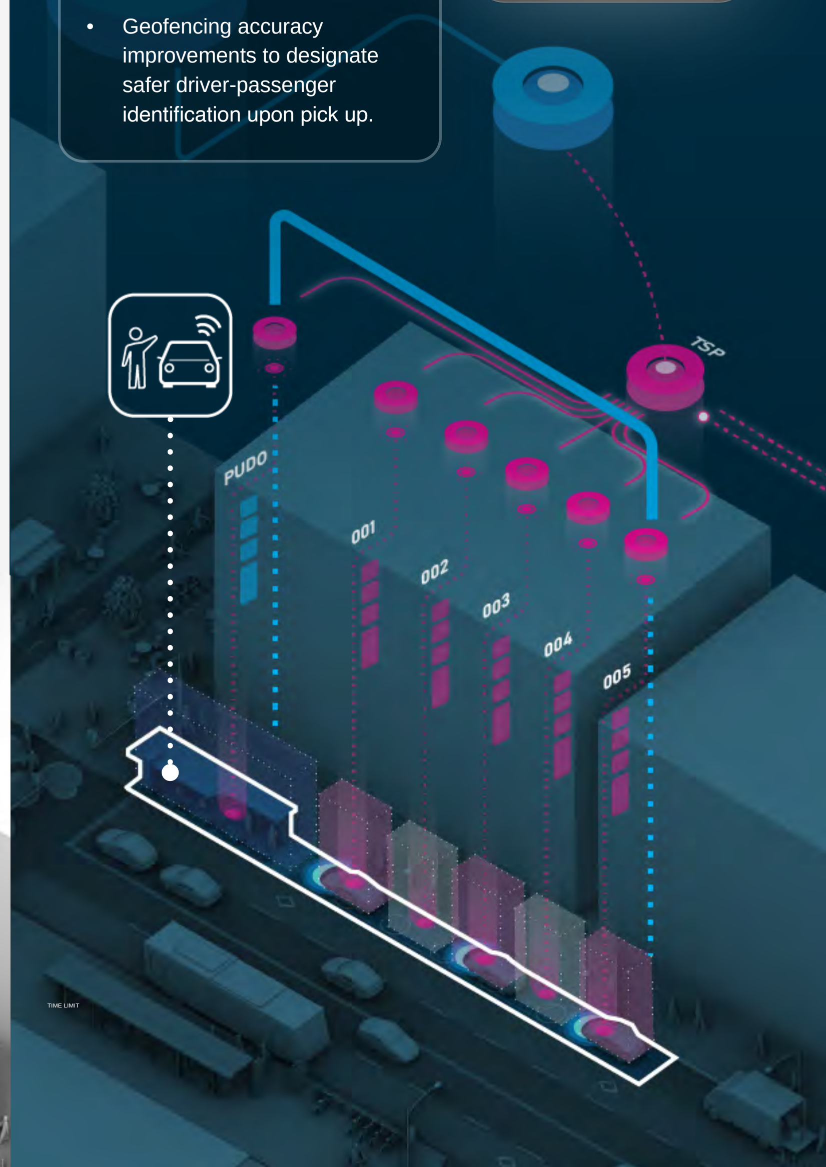

*DIDI Station* Shanghai, China
image: Imaginechina https://www.nytimes.com/2018/06/14/business/didi-women-late-night-safety.html





- PU-DO activities within designated geofenced corridor permitted in dedicated geofenced curb space zone only.
- MaaS allows integration between modes for a leg of journey. It allows for the integration of multiple TNC providers in different mobility bundles.
- PU-DO terminal usage analytics and data generated from digital kiosk help optimize operation and enforcement of terminal use.
- Geofencing accuracy improvements to designate safer driver-passenger identification upon pick up.



# PU-DO Terminal

0 Today · 1 1-2y · 2 5-10y · 3 25-35y **Vision**

## PHYSICAL

Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

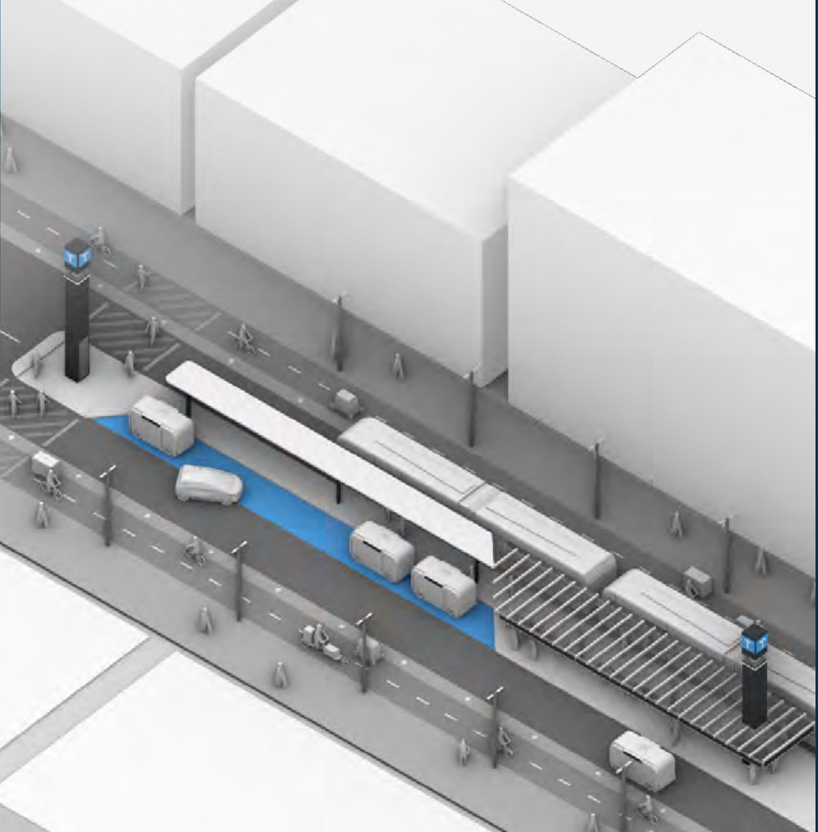
- The PU-DO terminal in the future may integrate a wide variety of autonomous passenger moving services, such as autonomous taxis, autonomous shuttles, car-pool, van-pool or other shared vehicular modes.
- The PU-DO terminal unites with the transit terminal in the median of the street.
- Terminal has real-time notice boards of commercialized scheduled arrival and departure of shared vehicle services. Private vehicles can also use this area for PU-DO.

*RoboTaxi / Kubik Design*

Image: https://www.designlaunches.com/transport/future_robot_taxis_at_your_service.php

*Olli AV Shuttle*

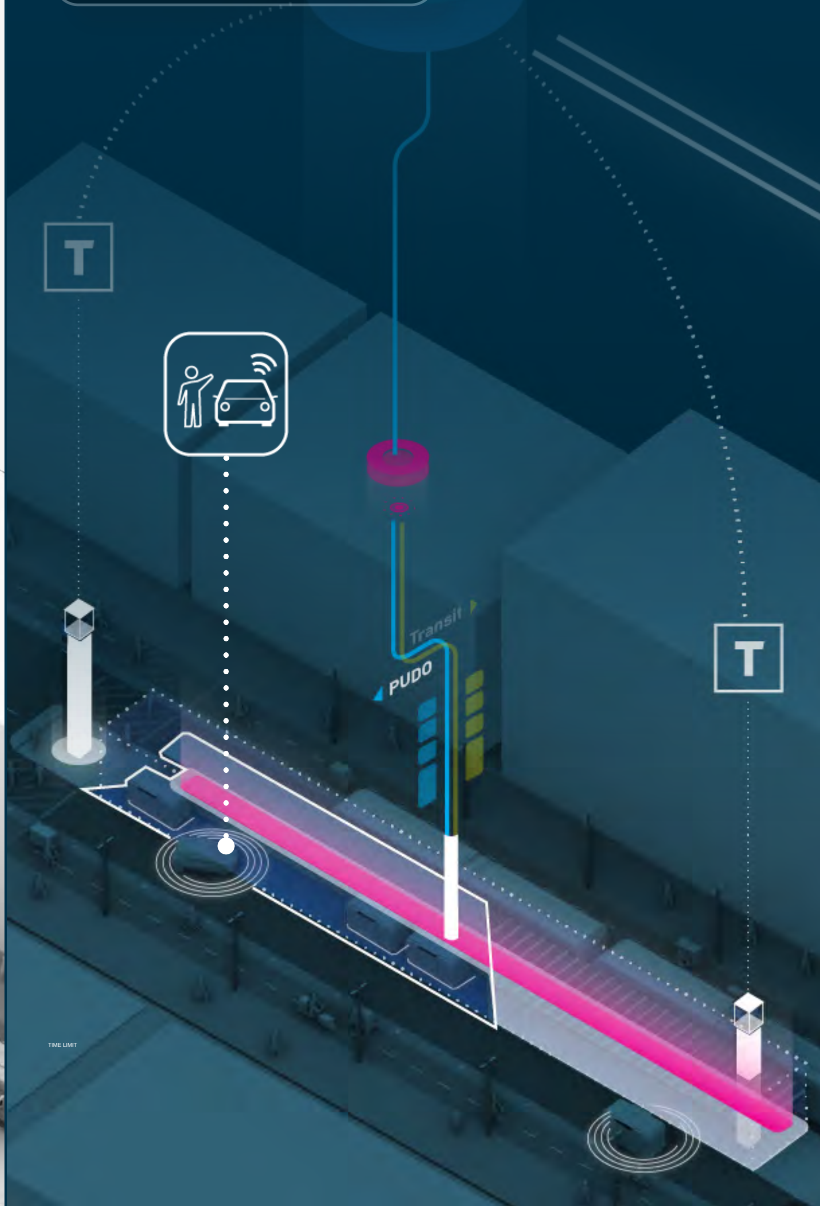
Image: https://www.itcilo.org/stories/future-wheels

## VIRTUAL

Silos · Network · Ecosystem

- Any autonomous vehicle is directed to PU-DO terminal within a designated geofenced zones or along a segment of a geofenced corridor.
- Analytics on passenger seat occupation in private shuttles can be shared across platforms within an ecosystem network.
- Real-time information on shuttles' arrival and departure data processed for optimized operation use of terminal, or for redirecting to other terminals.

## 4.4.5

# E-commerce Zone

E-commerce is responsible for an increase in the demand on temporary occupation of the curb space for loading and unloading. This is due to an increase in on-line shopping, as well as geo-based food delivery apps and other services related to movement of goods. In the investigation, an example of between 2-5 parking spaces is explored. This is composed from an adjustable 1-3 curb space for loading as well as 1-2 spaces for an unloading parklet. This parklet can be a simple curb level unloading platform in phase 1, later include delivery cycle or e-cargo bike facilities. The platform could potentially move on wheels in a later stage and can reallocate itself 1-2 parking spaces to each direction if deemed necessary. The platform could potentially include movable locker facilities for pick-up of express delivery goods. In the visionary phase, last-mile delivery solutions are largely autonomous and a fleet of small delivery bots can unload from the delivery van onto an adjacent low speed cycle infrastructure.

In terms of digital infrastructure in the initial phase a curb space reservation app can be used to utilize this space. In phase 2 any delivery vehicle may require to use an automated e-charging system in order to utilize this facility. In the visionary phase schedule and usage can be automated and coordinated remotely.

# E-commerce Zone

0 Today · 1 1-2y **Immediate** · 2 5-10y · 3 25-35y

## PHYSICAL

Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

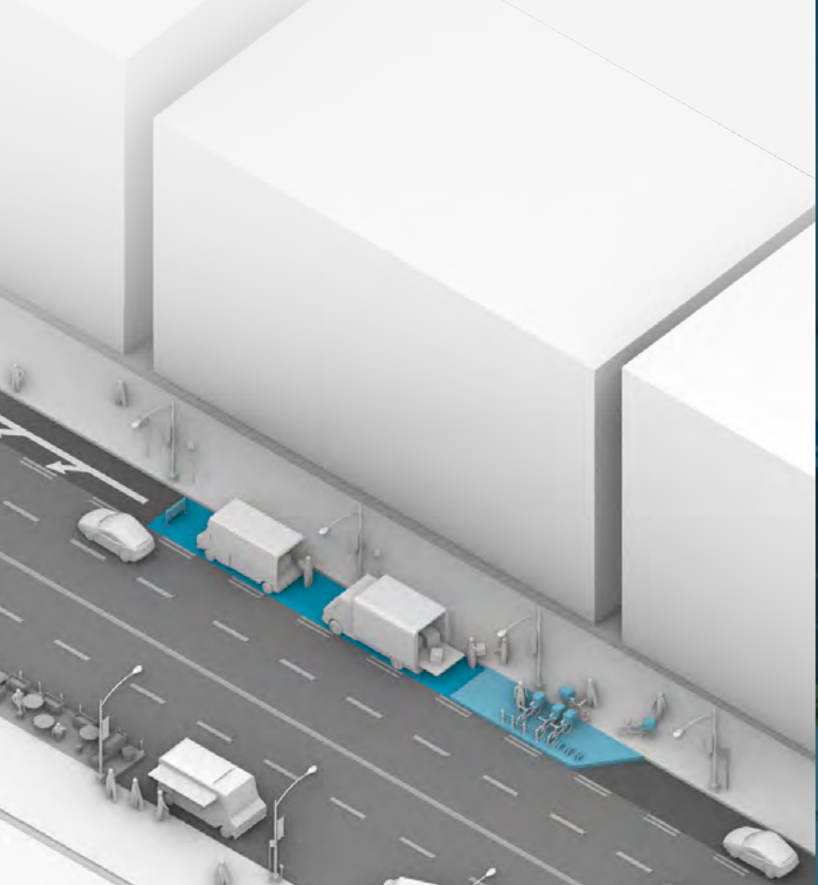
- An adjustable 1-3 curb space for loading / unloading activities, adjacent to a e-com parklet of 1-2 parking spaces.
- E-commerce delivery parklet to include unloading platform and delivery drivers waiting area.
- Piloting delivery curb zones
- Pilot infrastructure for delivery bikes, cargo e-bikes and downsizing of urban freight initiatives.
- Utilize parklet to pilot last-mile solutions with sensors or as a distribution base.

*Delivery zone (CurbflowApp)* Washington DC

Image: WTOP - https://wtop.com/dc/2019/08/double-parking-headaches-in-dc-new-app-hopes-to-curb-congestion/

*Delivery bike waiting* Shenzhen, China

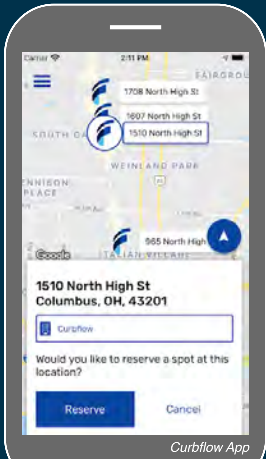
Image: SCMP - https://www.scmp.com/tech/apps-social/article/3100847/eleme-give-customers-option-wait-longer-food-deliveries-after



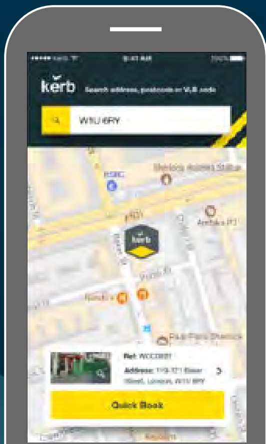
## VIRTUAL

Silos · Network · Ecosystem

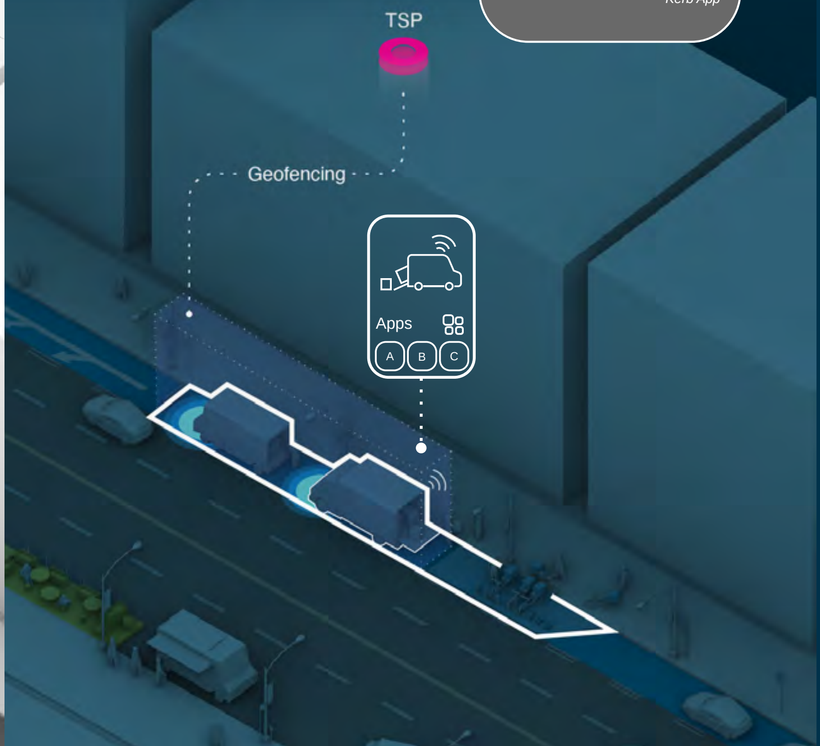
- Apps in silos (delivery of packages, food delivery, grocery delivery, etc)
- Curb space booking apps are piloted. Apps can allow for booking of a 15min time slot. The virtual enforcement of this can be piloted through geofencing integrated in the app, as well as the delivery van or device of delivery personnel.
- Analytics of data of space usage of each booking app can be used to optimize use of space, economically and operation wise.




*Curbflow App*




*Kerb App*



# E-commerce Zone

0 Today · 1 1-2y · 2 5-10y · 3 25-35y

**Concretization**

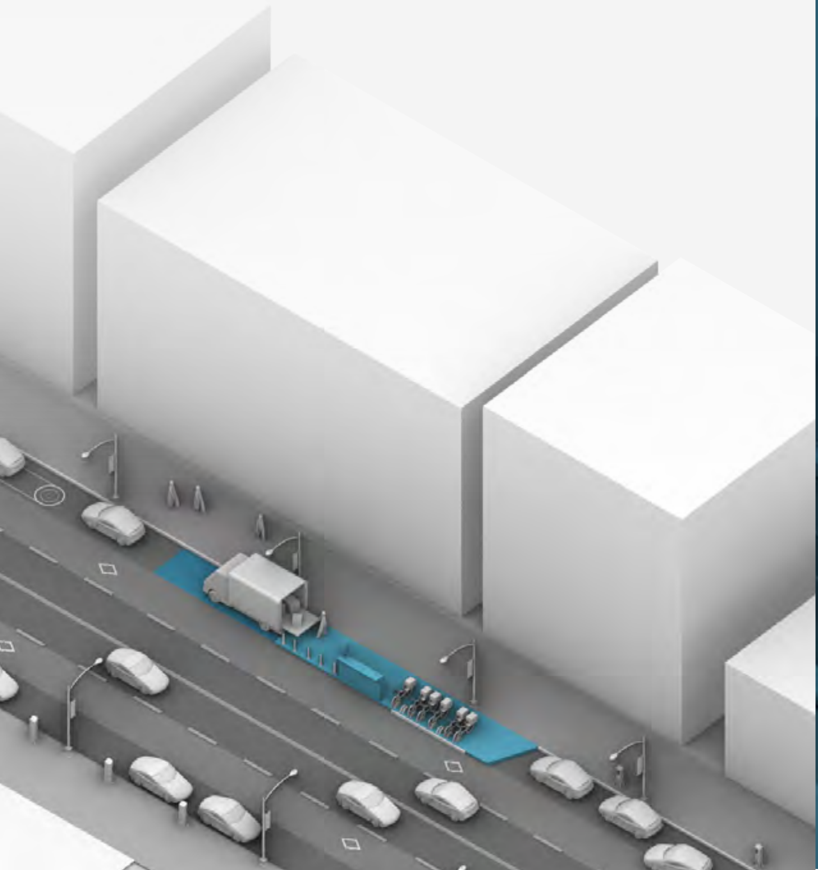
## PHYSICAL

Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

- Adaption of parklet from first phase to most adequately serve the current needs.
- The platform could potentially move on wheels and can reallocate itself 1-2 parking spaces to each direction if deemed necessary.
- Movable locker facilities as pick-up points for express delivery goods can be piloted.
- Testing of autonomous last-mile delivery of goods can be facilitated in this space.


Amazon Lockers Richmond VA, USA
Image: https://newsadvance.com/business/amazon-com-locker-installed-at-richmond-7-eleven/article_f4684792-74a1-11e3-badd-001a4bcf6878.html

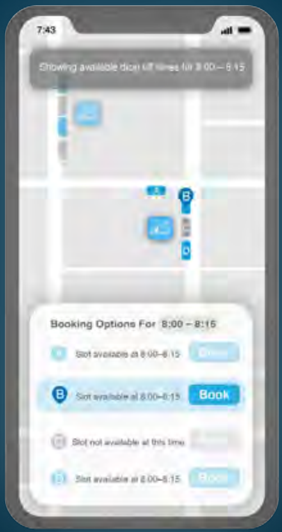
AV Delivery in lockers (Oxbotica) London, UK
Image: https://www.digitaltrends.com/cool-tech/ocado-cargopod-autonomous-delivery-vehicle-test/

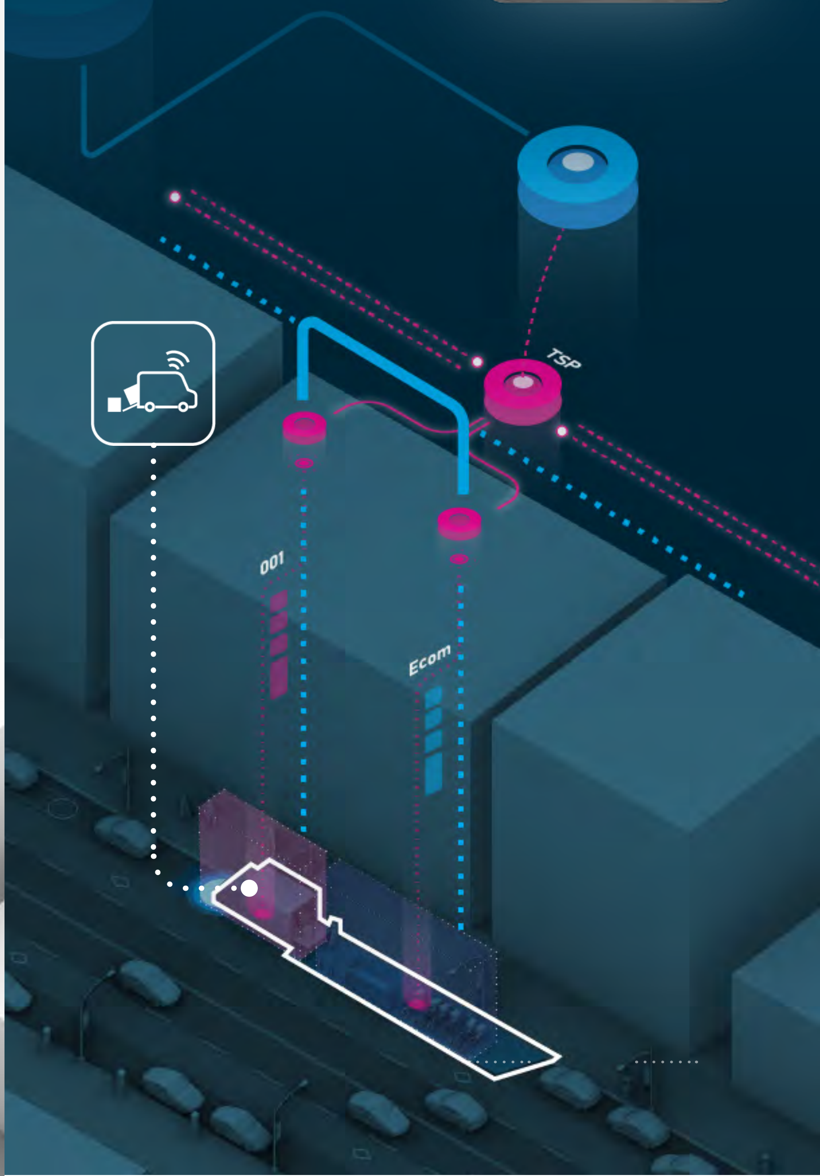


## VIRTUAL

Silos · Network · Ecosystem

- Booking and reservation of curb space slot for unloading is deployed.
- Booking system for temporary space use, for loading or unloading purposes, is integrated across platforms.
- Real-time analytics of use and demand
- Standardization of automated delivery fleets, coding of virtual sidewalk regulation.



# E-commerce Zone

0 Today · 1 1-2y · 2 5-10y · 3 25-35y **Vision**

## PHYSICAL

Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

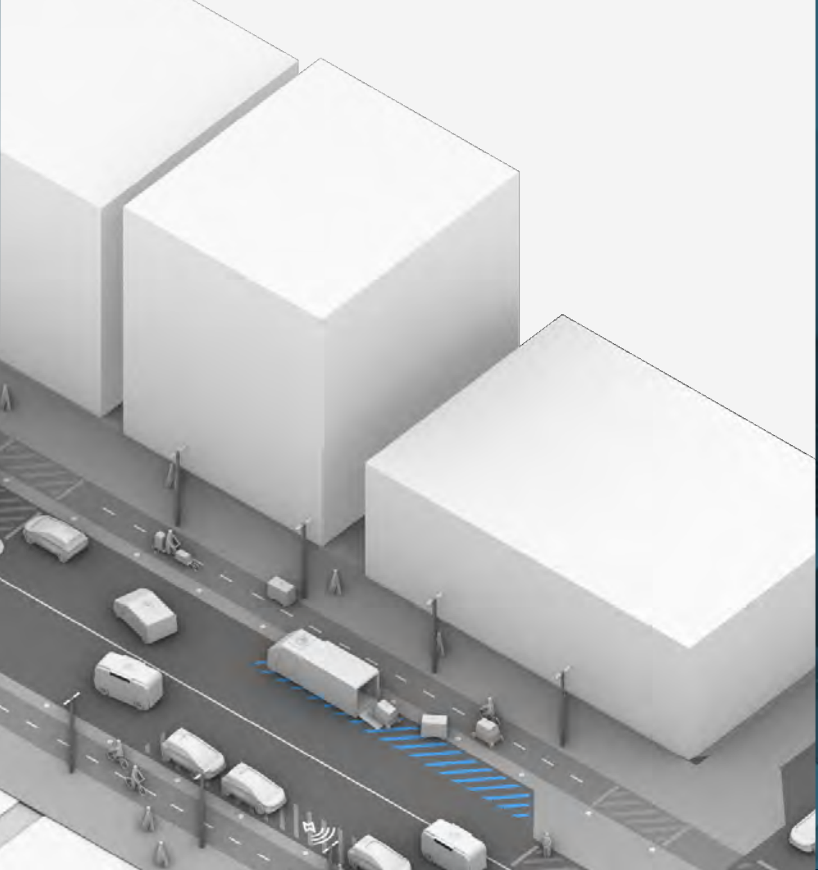
- Autonomous delivery is accommodated in this flexible zone which can be used for other uses in different times.
- Last-mile delivery bots can be dispatched from vans onto the curb space and towards the micromobility infrastructure, through a curbless design.
- Dispatch bay per locality, can be permanent or pop-up depending on demand of locality.
- Opportunity for mobile lockers at certain times.

*Mobile lockers*

Image: Chesky/Shutterstock - https://venturebeat.com/2018/12/02/autonomous-vehicles-will-completely-change-how-we-shop/

*Delivery Bots*

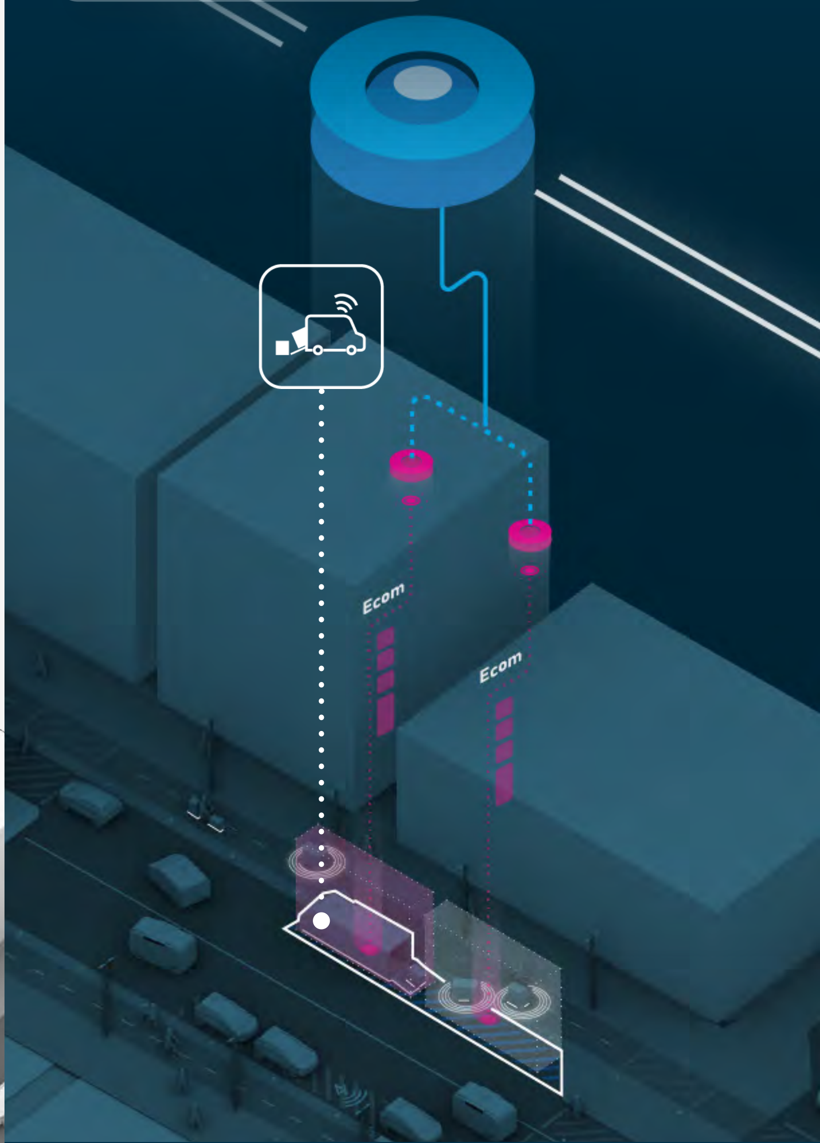
Image: https://www.innovatorsmag.com/delivery-robots-hit-american-streets/



## VIRTUAL

Silos · Network · Ecosystem

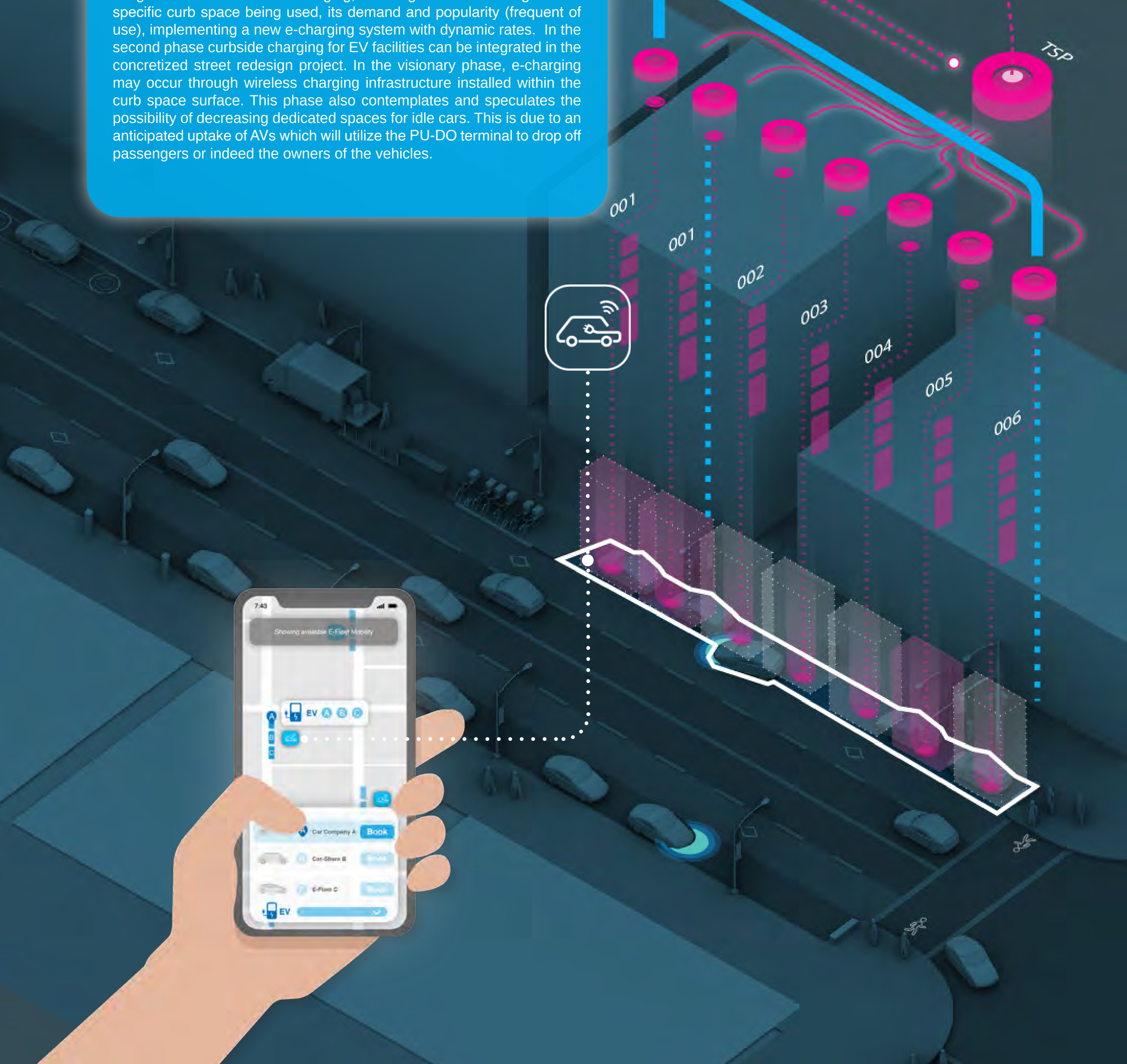
- Remote enforcement of geofenced space can be integrated with the curb space slot booking, reservation and payment systems. Fee can be dynamic and reward less emitting, lightweight vehicles or e-cargo.
- Logistic process automated from producer to last mile with geo-tracking of goods.
- Last mile automation facilitated through analytics of use of geofenced unloading area, as well as data generated from curbside IoT infrastructure.

## 4.4.6

# E-Fleet

The E-Fleet zone starts off as an area designated for car-share vehicles, the number of parking spaces can vary. In phase one there is a grouping of different car-share companies to a single zone. On the virtual front, car-share apps can be grouped by adhering to sharing data in an open system, data such as idle usage of each vehicle pertaining to each company. This can expand in phase to a network platform system integrated with data on managing, booking and scheduling of the specific curb space being used, its demand and popularity (frequent of use), implementing a new e-charging system with dynamic rates. In the second phase curbside charging for EV facilities can be integrated in the concretized street redesign project. In the visionary phase, e-charging may occur through wireless charging infrastructure installed within the curb space surface. This phase also contemplates and speculates the possibility of decreasing dedicated spaces for idle cars. This is due to an anticipated uptake of AVs which will utilize the PU-DO terminal to drop off passengers or indeed the owners of the vehicles.



# E-Fleet

0 Today · · · · · 1 1-2y **Immediate** · · · · · 2 5-10y · · · · · 3 25-35y

## PHYSICAL

Tactical - Pilot Project · · · · · · Project-Concretization · · · · · · Connected Autonomous Vision

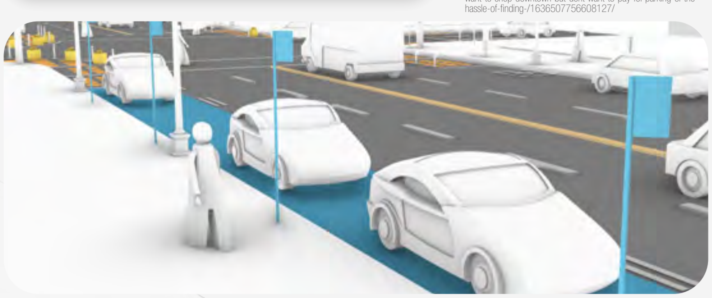
- Marked curb space can be used by any car-share or dedicated fleet included in pilot.
- Number of parking spaces can vary.
- Car-share designated spaces in parkades, and residential and commercial parking garages
- Testing of smart parking sensors on poles.

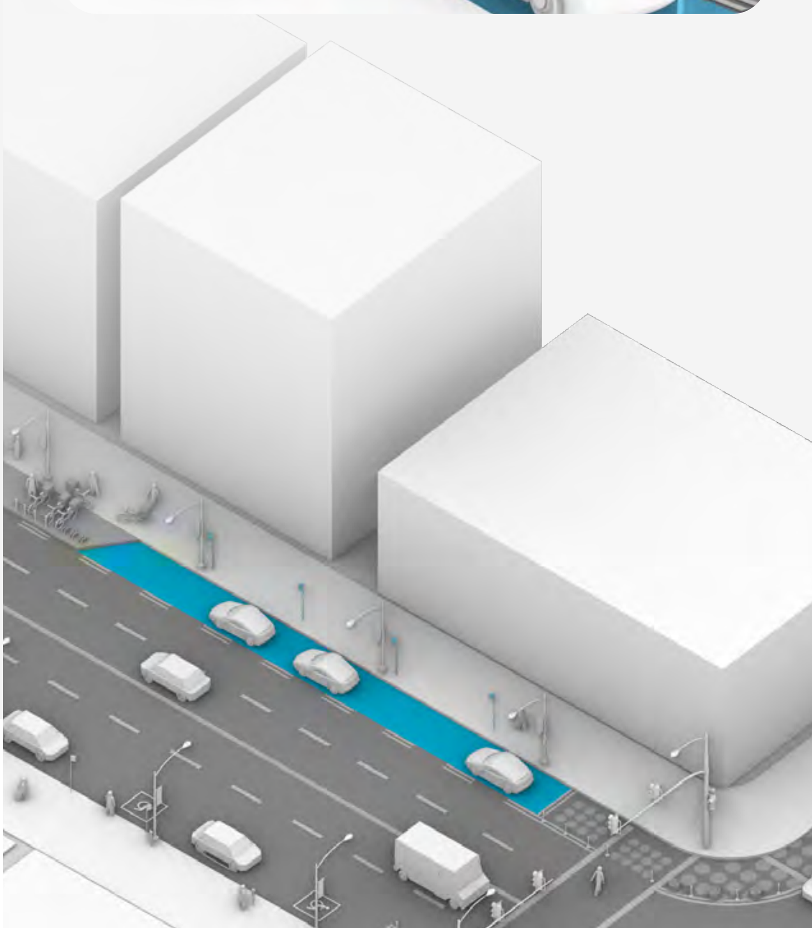
*Zone for any car-share company* UBC, Vancouver, BC

Image: Google Streetview


*Car-share in parkades* Vancouver, BC

Image: Evo Facebook - https://www.facebook.com/evocarshare/photos/want-to-shop-downtown-but-dont-want-to-pay-for-parking-or-the-hassle-of-finding-/1636507756608127/

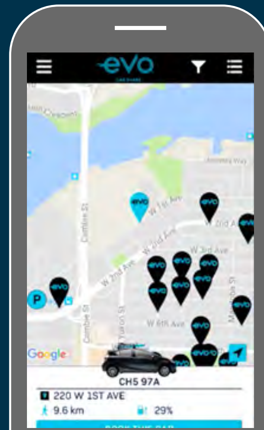




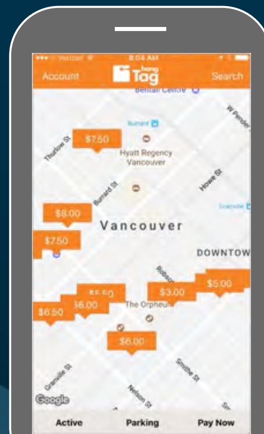
## VIRTUAL

Silos · · · · · · Network · · · · · · Ecosystem

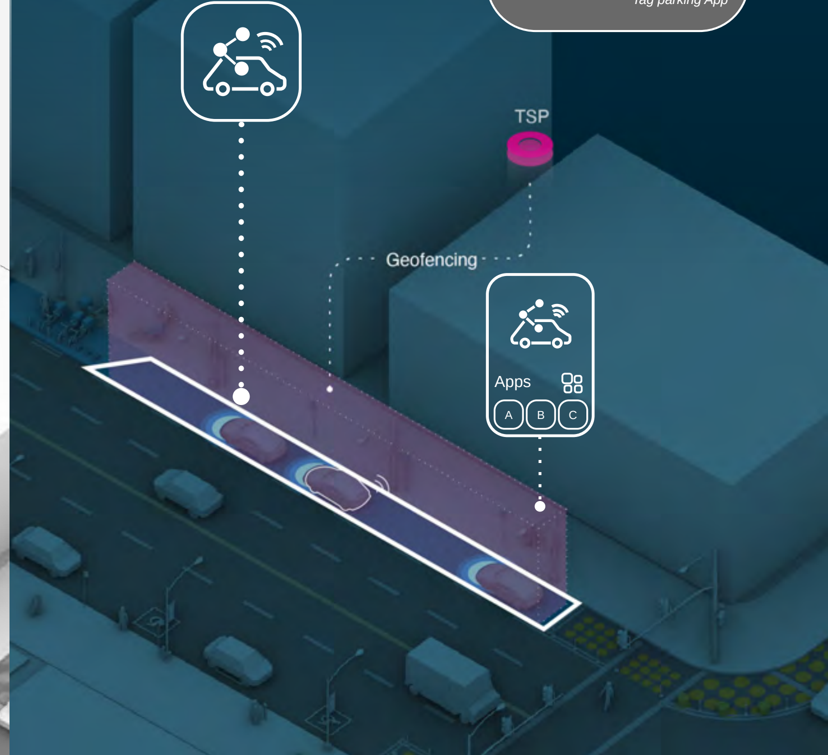
- Apps in silos (car-share, parking, EV charging)
- Piloting of regulation of curb space use through geofencing of designated zone. This will require integration in each siloed app of each service provider, in the first stages of piloting




*Evo App*




*Tag parking App*



# E-Fleet

0 Today · 1 1-2y · **2 5-10y Concretization** · 3 25-35y

## PHYSICAL

Tactical - Pilot Project · **Project-Concretization** · Connected Autonomous Vision

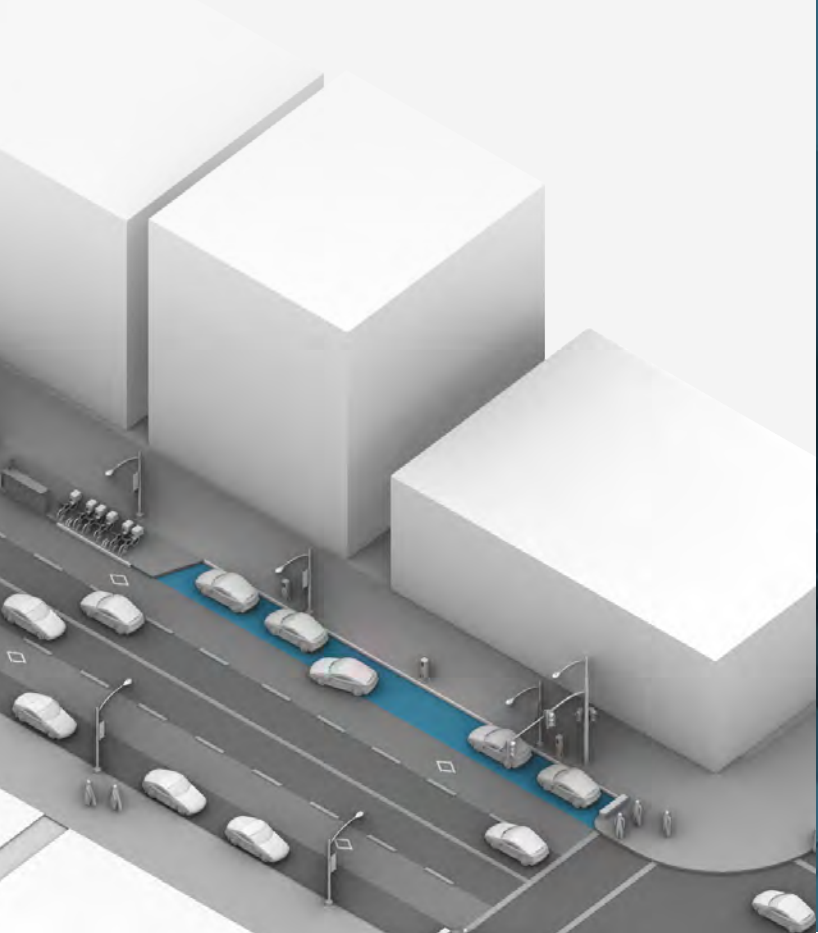
- Curbside EV charger at every parking space.
- Testing of smart parking sensors integrated in the new streetscape design.


*EV charger car-share fleet (BlueLA)* Los Angeles, CA

Image: Google Streetview

*EV charger car-share fleet (Car2go)* Berlin, Germany

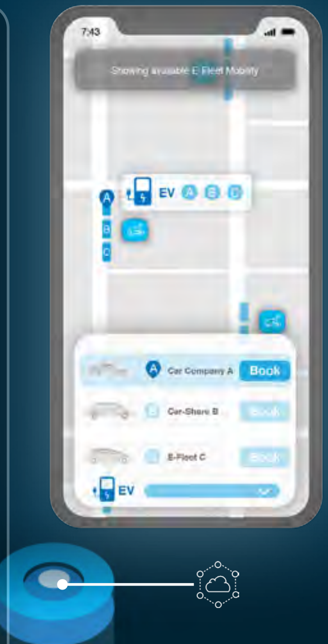
Image: Avda www.avda-foto.de - https://en.wikipedia.org/wiki/Plug-in_electric_vehicles_in_Germany#/media/File:Berlin_-_Potsdamer_Platz_-_E-Mobility-Charging.jpg

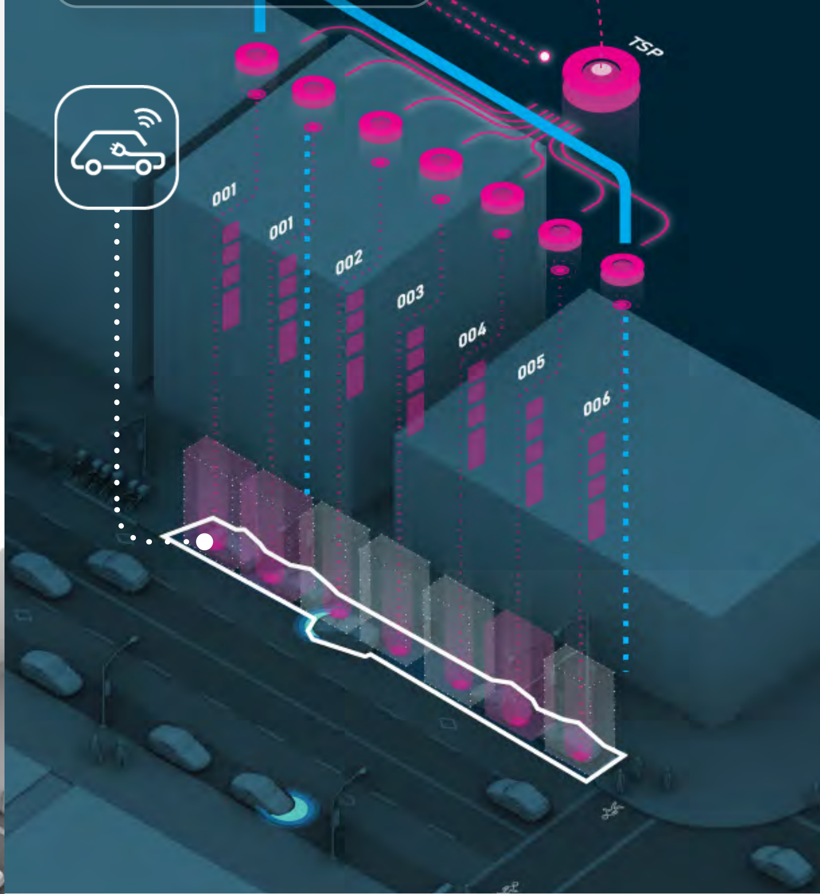


## VIRTUAL

Silos · **Network** · Ecosystem

- Coding of the curb space use regulations under a standard for every geofenced virtual curb space unit.
- A version of a MaaS system is functional, car-share and fleet operators are part of a network of mobility services.
- Integration of car-share, parking and EV-charging apps into a connected network.
- One-way and two-way car-share systems can experiment with business models around reservation of on and off-street designated curb spaces.
- Curb allocation, reservation and payment system. Analytics of stationary use of curb space used to optimize its use.
- Calculation of emission fee and energy consumption analytics, through EV charging data.



# E-Fleet

0 Today · 1 1-2y · 2 5-10y · 3 25-35y **Vision**

## PHYSICAL

Tactical - Pilot Project · Project-Concretization · Connected Autonomous Vision

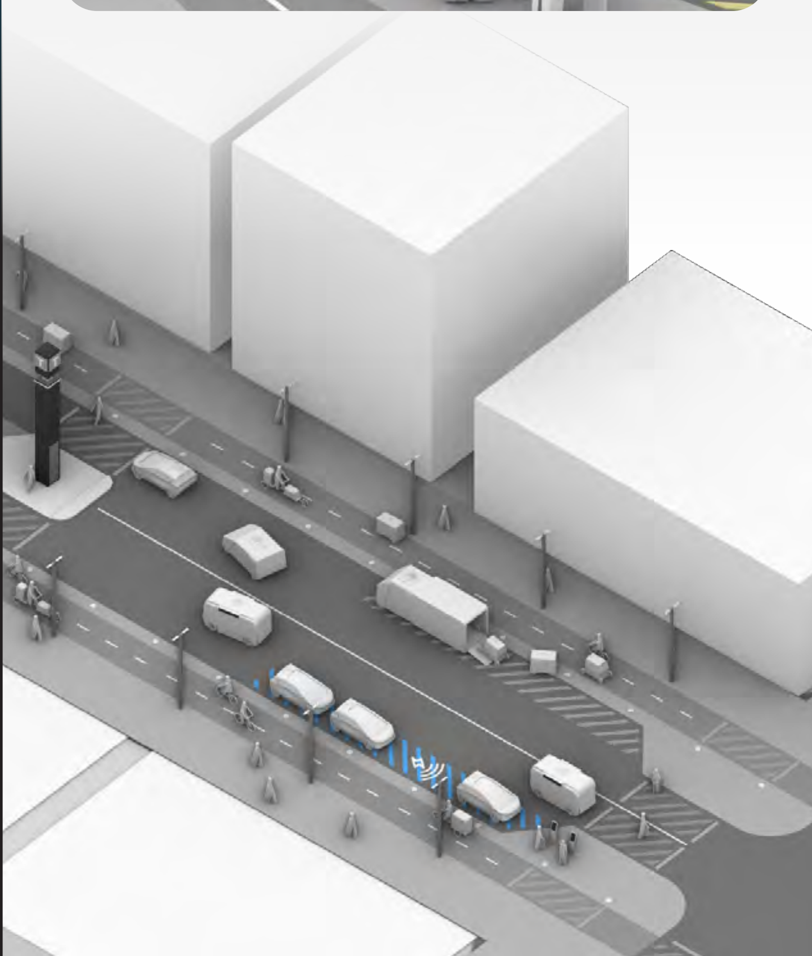
- Wireless EV charging embedded in curb space infrastructure.
- Opportunity for real-time parking management system, with the integration of commercialized (car-share and fleets) on & off-street parking spaces (for example in condos, strata or office buildings)

*Wireless EV charging*

Image: https://evchargeplus.com/ev-wireless-charging-on-witricity-technology/


*EV charging and parking integrated into a management and charging system*

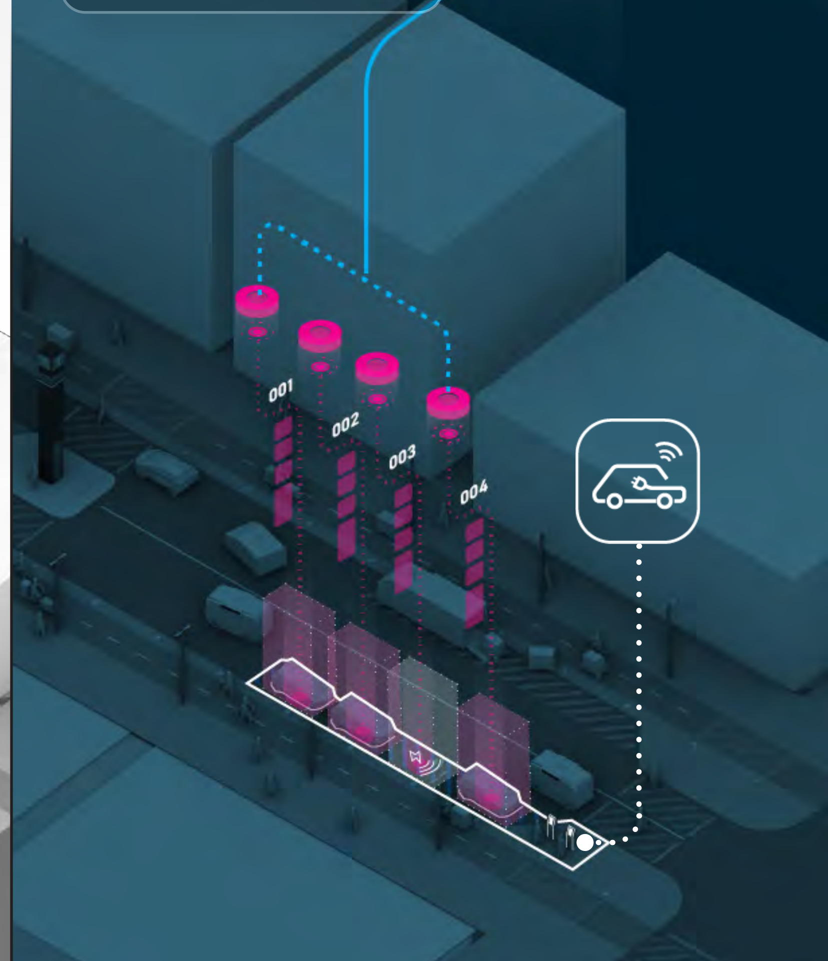
Image: https://www.emobilitysimplified.com/2020/03/how-to-charge-electric-vehicle-plug-in-battery-swap.html



## VIRTUAL

Silos · Network · Ecosystem

- Open-source shared data ecosystem of networks mobility operators.
- Remote management and optimization of commercialized autonomous fleets.
- Remote operation and enforcement of e-charging for stationary use of designated space.
- Integration of on-street + off-street parking of fleets in a shared network.
- Full integration within the energy 'internet' grid for billing the wireless vehicular charging fees.
- Ecosystem of AVs and IoT communication infrastructure.
- V2V & V2X technologies ubiquitous all fleet vehicles.

# 5

***Chapter 5*** *takes the speculative design solutions from Chapter 4 and proposes possible designs for different locations in municipalities across the Metro Vancouver area, served by TransLink. Here, different mobility hub typologies are applied to different locations with suitable characteristics, then a phased curb space re-design proposal is proposed. The selection process of the locations is explained, as well as interaction with the different municipalities where each case study is located in. Each location is explored through the lens of the transitional design methodology laid out in Chapter 3.*

# 5

# METRO VANCOUVER CASE STUDIES

# 5.1

# Investigation Process

Below is a description of the process flow taken in the selection of the locations and interaction with the relevant contributing parties. For the location selection there was an engagement process with TransLink which led to the organization of a workshop together with different municipalities across the Metro Vancouver area. The municipalities provided most of the site locations which were investigated as case studies. These locations were tested and consulted with each municipality. This process serves as a context which frames the following case studies in section 5.2.

Location Selection

## Case Studies

As part of the research, locations were selected in the Metro Vancouver area of the Lower Mainland area of British Columbia, Canada. These locations were selected to test out the hypothetical ideas laid out in Chapter 4 in real world scenarios, although as a theoretical exercise, within the scope of this research.

The case studies allowed interaction with local municipalities and the transit authority, needed in order to understand the applicability of the ideas explored in this research. At the same time, municipalities could learn about the ideas explored in this research and could exchange knowledge based on current issues and difficulties which they are facing.

Location Selection

## Engagement with Translink

The idea was to select different locations in different municipalities of the Metro Vancouver area served by TransLink. This would help to learn about the different issues each municipality is currently facing, relating to curb space occupation. It would help to encounter different approaches and gaps between the municipalities regarding deployment of new mobility related services. It would also allow TransLink to kick-start a collective conversation around future curb space design and management with the different municipalities under its area of service. While curb space is essentially an issue that every municipality has to deal with locally, at the time, it's a regional mobility issue, as much as a local parking issue.

It was decided that for the selection of the locations, an engagement process would take place, in the form of a workshop, together with the municipalities, invited by TransLink.

Location Selection

## Workshop Summary

The workshop had two main objectives, the first was to inform and form a discussion around future curb space design and management. The second was to select locations for the case studies of this research with the help of the local municipalities.

The workshop was aimed at participants from municipalities dealing with curb space allocation, transport and urban planning. The selection of most relevant participants was done by TransLink.

The workshop was divided into two parts:

***Day 1 Webinar*** - The first part of the workshop was in the format a webinar with the initial findings and process of this research, with contents roughly explored in chapters 1,2,3,4. The speculative design proposal was shown in a very initial conception. The workshop concluded with a call for participation for a focus group for 'Day 2'. Day 1 occurred on July 7th 2020, virtually, there were around 50 participants.

***Day 2 Virtual Charette*** – The second part of the workshop was in the format of a virtual charrette with interactive activities. The activities were documented on a collaborative virtual 'whiteboard' for shared consultation and documentation for case study elaboration. Here each municipality had time to discuss, share and present a location in their area of jurisdiction. This helped guide the continued study and engagement with the municipalities. Day 2 occurred on July 14th 2020, virtually, there were around 25 participants.

Testing Sites
## Design Research

The locations that were chosen in the workshop were analyzed and evaluated. The majority of the locations were chosen as areas of case studies, these are explored in the following section 5.2.

Design solutions proposed in Chapter 4 for a mobility hub were applied to the case studies. Each case study with its particular urban typology and corresponding mobility hub typology (section 4.2). The incremental phasing methodology 'Transitional Design Methodology' explored in Chapter 3 was also applied here, over a phasing strategy applied in both the physical and virtual realms in tandem.

Testing Sites
## Engagement with Municipalities

Municipalities were engaged a second time during the process, through individual consultations with each municipality. This happened during November-December 2020. The feedback from the municipalities provided the site selection and helped with the definition of some design aspects of the case studies. The case studies were presented and discussed. A snapshot was received on the current state of digital transformation and new mobility services available at each municipality. The consultations also helped to produce the recommendations explored in Chapter 6.

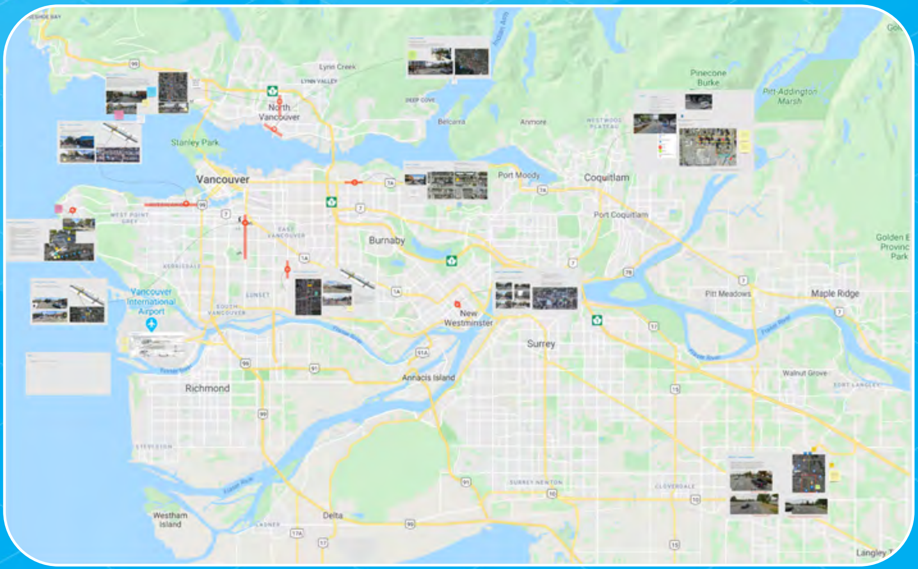
## Next Steps

As these case studies are only theoretical at this point, only through real-life pilots, is it possible to evaluate these proposals.

Municipalities have been conducting curb space piloting as part of Covid (Summer 2020), noticeably in three locations covered in the case studies (Vancouver, North Vancouver, New Westminster).

If municipalities or TransLink wish to conduct further curb space pilots, then additional uses may be considered, as well as the consideration of piloting digital technologies.

Chapter 6 for discusses the findings on the investigated case studies. It provides recommendations directed at municipalities and transit authorities, and discusses challenges ahead.



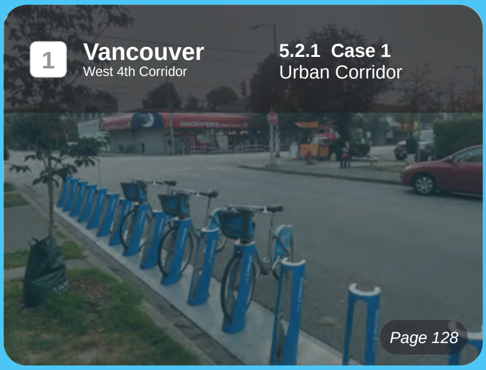

***Day 2 Virtual Charette*** - *Selected locations by participating municipalities*

# 5.2

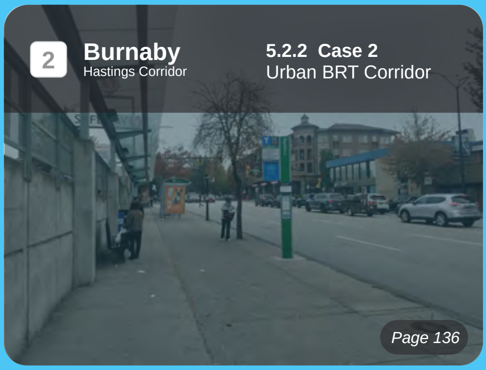
## Case Studies Overview

The locations selected for the case studies are all based in the Metro Vancouver area in the Lower Mainland region of British Columbia, Canada, in an area served by TransLink. It was done as a collaboration between the University of British Columbia's TIPSLAB (Transport Infrastructure and Public Space Lab) and TransLink Tomorrow's New Mobility Lab.

### Urban Corridors

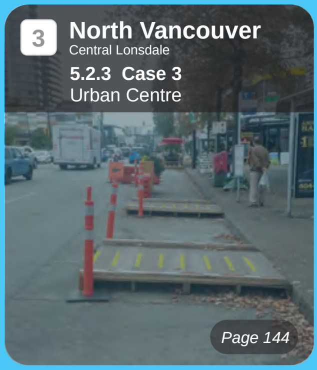


1 **Vancouver**
West 4th Corridor
**5.2.1 Case 1**
Urban Corridor
Page 128

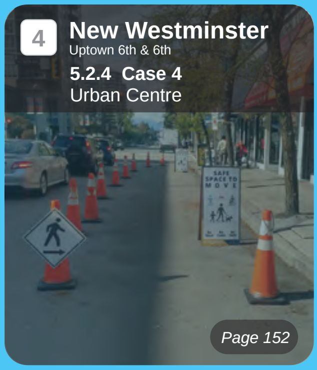


2 **Burnaby**
Hastings Corridor
**5.2.2 Case 2**
Urban BRT Corridor
Page 136

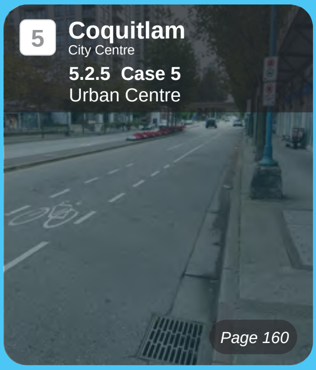
### Urban Centres



3 **North Vancouver**
Central Lonsdale
**5.2.3 Case 3**
Urban Centre
Page 144



4 **New Westminster**
Uptown 6th & 6th
**5.2.4 Case 4**
Urban Centre
Page 152

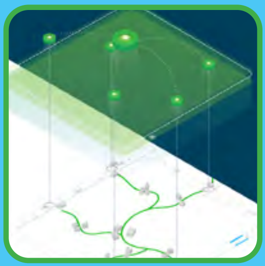


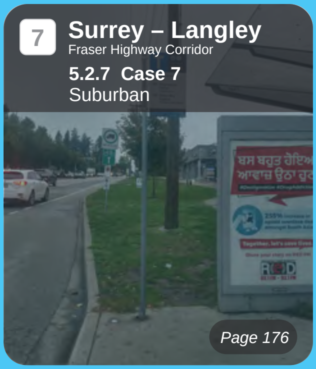
5 **Coquitlam**
City Centre
**5.2.5 Case 5**
Urban Centre
Page 160

### Campus MH

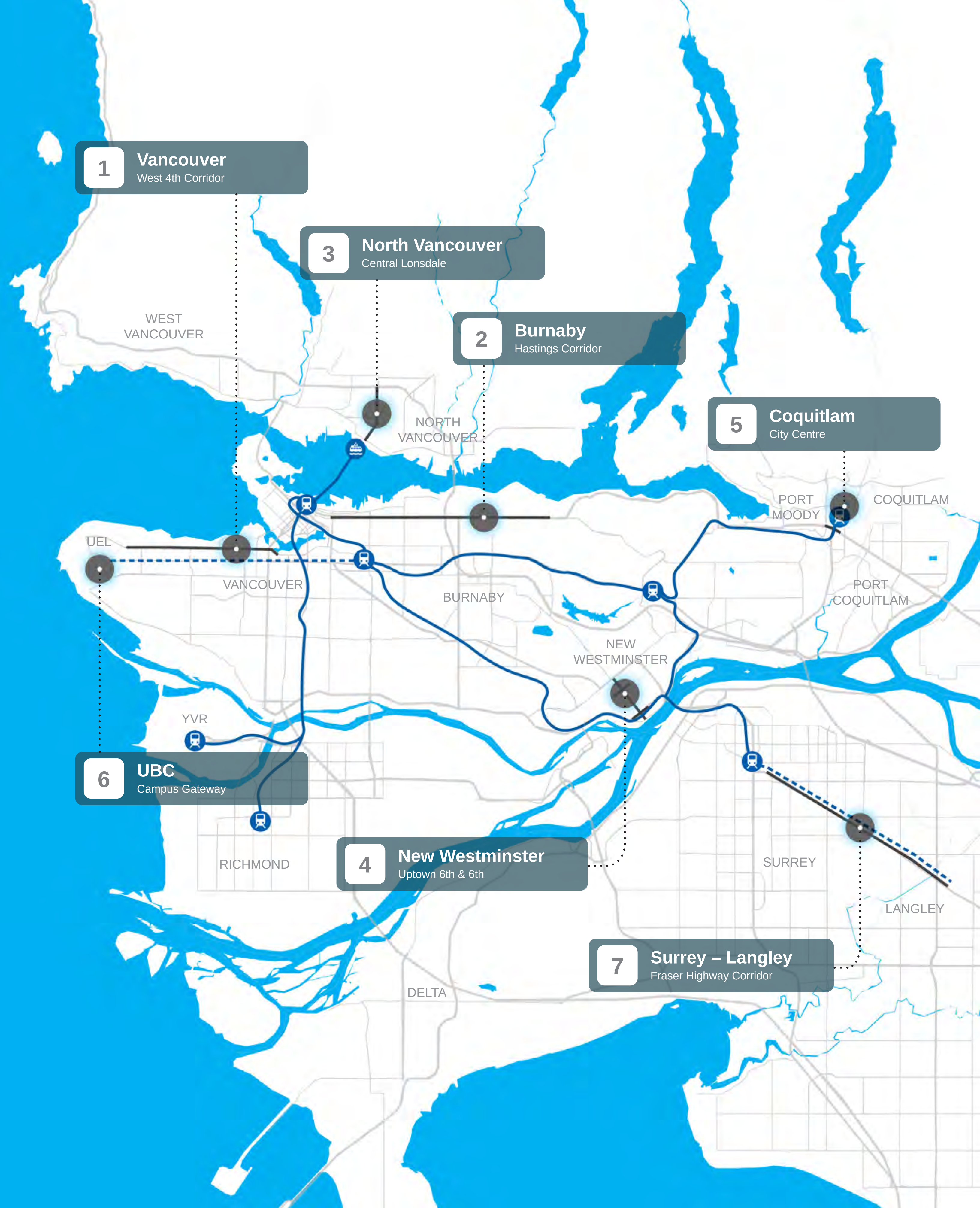
6 **UBC**
Campus Gateway
**5.2.6 Case 6**
Campus MH
Page 168

### Suburban





7 **Surrey – Langley**
Fraser Highway Corridor
**5.2.7 Case 7**
Suburban
Page 176


1 Vancouver
West 4th Corridor
3 North Vancouver
Central Lonsdale
2 Burnaby
Hastings Corridor
5 Coquitlam
City Centre
6 UBC
Campus Gateway
4 New Westminster
Uptown 6th & 6th
7 Surrey – Langley
Fraser Highway Corridor
WEST VANCOUVER
NORTH VANCOUVER
PORT MOODY
COQUITLAM
UEL
VANCOUVER
BURNABY
PORT COQUITLAM
NEW WESTMINSTER
YVR
RICHMOND
SURREY
LANGLEY
DELTA

## Metro Vancouver / The Lower Mainland Urban Context

Metro Vancouver is the largest urban conglomeration in Canada's West Coast, with around 2.5 million inhabitants. The region has some progressive municipalities with a desire to promote more sustainable modes of transportation, increase use of active transportation, the incentivization of increased usage of public transportation, as well as the reduction of GHG. While the region would like to be leading in this front, it also recognizes that it is largely composed of the North American low-density suburban typology which is incompatible with deployment of an effective transit system. That said, it has large districts which are more urban, walkable and well served by transit, mostly within the City of Vancouver, as well as in pockets of other municipalities.

The case studies deal with curb space redesign, expansion of new mobility options, and setting the ground for a MaaS-ready mobility hub network built around transit. Below is some of the context on new mobility and curb space transformations.

## New Mobility

In terms of new mobility adoption, there are a number of TNCs (Transport Network Companies) operating in the region.

Car-share - served by services such as: Evo, Modo, Zipcar, (and Car-2go until early 2020)

Ride-hail - ride hail services since early 2020 (the last urban region in North America).

Bike-share system by 'Mobi', however this serves the central region of downtown Vancouver and its surroundings.

E-scooters – (in 2020) there is no E-scooter or other electric micromobility service available in the region.

MaaS – (in 2020) no compatible Mobility as a Service provider operating.

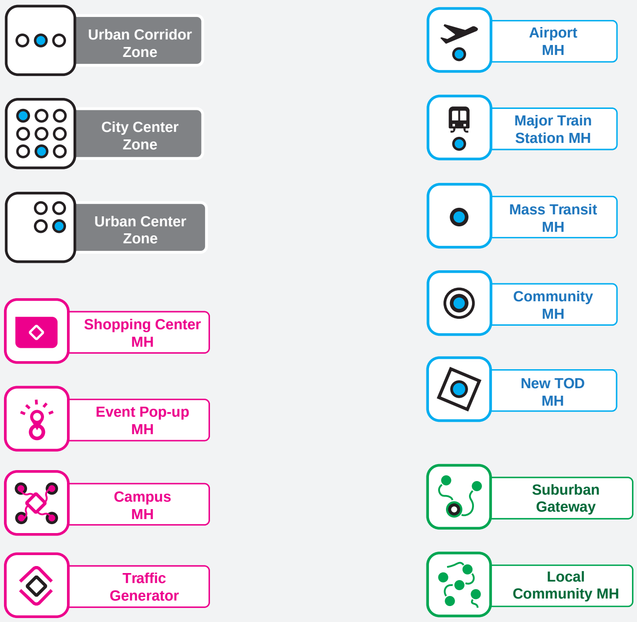
## Curb Space Re-allocation Piloting

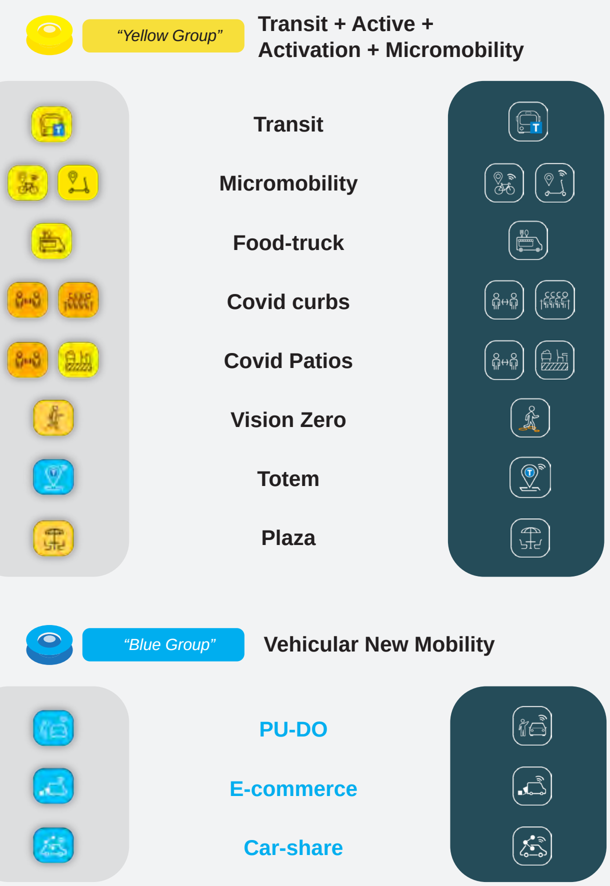
Curb space dedicated to car-share or bike-share docking stations exist throughout the city. Parklets and Pavement to Plaza initiatives have existed prior to 2020. However, in response to physical distancing measures, municipalities have been conducting curbspace piloting (Summer 2020) for patios, walking or queuing areas, noticeably in three areas covered in the case studies (Vancouver, North Vancouver, New Westminster). Experimentation with transit related curb-space re-use, Translink is conducting bus bulb extension tactical pilots in different locations, for example on Robson St (Summer 2020).

## Proof-of-Concept

The case studies in Metro Vancouver serve as a proof of concept to exemplify the speculative design presented in chapter 4. They follow the 'Transitional Design Methodology' laid out in chapter 3, with its phasing strategy. All locations analyzed in all phases are represented in two parallel realms, the virtual and physical, a concept explained in chapter 2. Finally, the design choices made in the case studies regarding curb space use, respond to questions that are laid out in chapter 1. These reflect the desire of municipalities to achieve a more sustainable modal split with an increased share of transit, cycling and walking. They also reflect the need to transition into new mobility and dedicating space for new uses within the public realm.

## Mobility Hub Typologies



# 5.2.1
## Case One

**1 Vancouver**
West 4th Corridor


**Mobility Hub Typology**

*See Chapter 4.2 for more information on Mobility Hub typologies*

As part of a city-wide network of interconnected Mobility Hubs, the West 4th corridor has the potential to be categorized as an Urban Corridor Zone (see 4.2) composed of sequential mobility hubs within the corridor zone, along a major urban axis. Some of these hubs are located around intersections with multiple transit routes, such as W4th / MacDonald and others may have the opportunity to create new plazas and civic space, forming a Community Mobility Hub (see 4.3), such as in the case of W4th / Vine St which will be explored in this section.

Similar typology in Metro Vancouver: *Main St, Commercial Drive, W Broadway (Larch St to Alma St), Lonsdale St, etc.*


*Vine St & 4th Ave*
*Image: Y Fogelson (Sep 2020)*

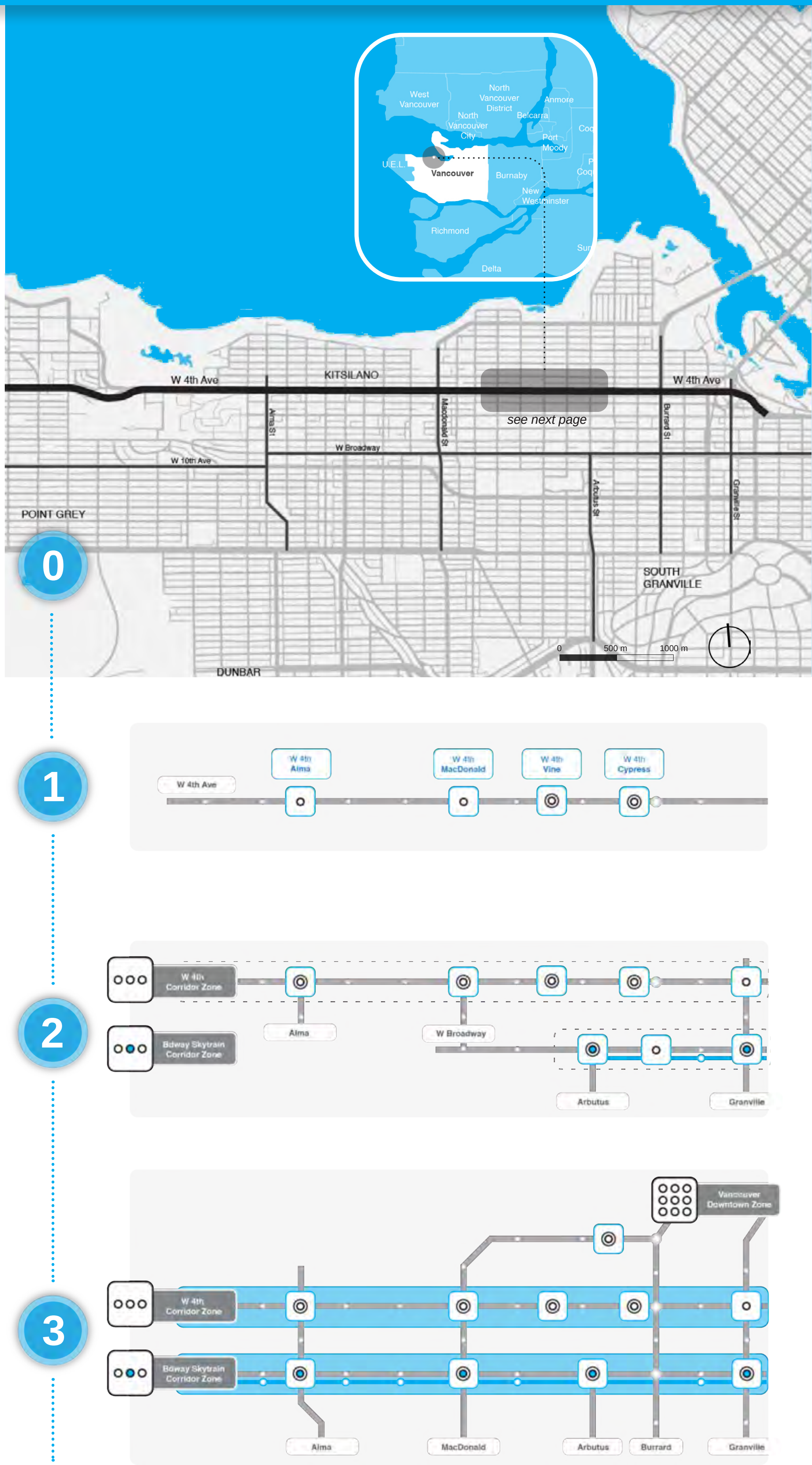
## Macro Vision

The vision of a city-wide network of interconnected Mobility Hubs can be achieved in an incremental gradual progression. Using the *Transitional Design Methodology* (from Chapter 3), we can imagine three phases in the timeline:

1. The first phase being the immediate action in the time frame of 1-2 years. Here we can imagine piloting of selected locations to test the *Community Mobility Hub* typology. In this phase the redesign proposed in the phase 2 can be tested with tactical urbanism methodology of light infrastructural changes. New mobility uses and services can be tested and expanded within this pilot. At this point each location is a separate test site and new geofencing and connectivity technologies can be trialed at the mobility hub level or along sections of the corridor.

2. The second phase represents the mid range (5-10 years) concretization of pilots done in the first phase. Here we can imagine the corridor multiplying its mobility hub locations along the corridor. Furthermore, a link can be established with the Arbutus subway station on the Broadway corridor, which by this point in the time-frame (of around 5-6 years) is scheduled to be complete. In this phase, new mobility services can be integrated within a MaaS enabled network.

3. In this visionary phase, the W4th corridor is an integral part of the city network of connected mobility hubs. The network functions like a rapid transit system, portrayed by a subway system style map as its user interface. In the time-frame of around 30 years, connections with other major streets and the parallel Broadway mass transit mobility corridor, with the intended continuation of the subway line further west towards UBC. years, connections with other major streets and the parallel Broadway mass transit mobility corridor, with the intended continuation of the subway line further west towards UBC.



## Current Situation

### West 4th Corridor Today

West 4th Avenue is a main corridor connecting UBC and Vancouver seaside westside neighborhoods. It has ample commercial activity, in particular between Burrard and Balsam and again around MacDonald and Alma intersections. The corridor is served by a number of different bus routes, including express services, mainly attending the UBC anchor and the residents connecting to the city's downtown.

West 4th corridor typology is similar to other corridors in the Metro Vancouver area which are also commercial corridors serviced by frequent transit lines. This typology is of a main artery with 3 lanes in both directions, of which the curb lane is not generally used for movement and has predominantly use of permanence, allowing for the allocation of a fixed overnight element like a parklet or bike-share docking station.

### West 4th & Vine St

This location was selected by the researcher as it represents a typical intersection, as imagined for the generic design proposal of the Community Mobility Hub in Chapter 4. This case study was used in the workshop as an example for selection of other sites. Additionally, the researcher has specific in-depth knowledge of its day-to-day functioning through daily observation over a period of a year, as a resident at the specific location.




West 4th looking west - potential for pick-up drop off and bus bulbs


Vine St looking north - potential for plaza with water views, integration with bike-share and Covid patios




Covid curbs for queuing areas at Shoppers Durg Mart (left) and Wholefoods (centre), Covid patios and Food Trucks, W4th (right)

# VANCOUVER

## Phase 0 | Current Situation | *August 2020*

0

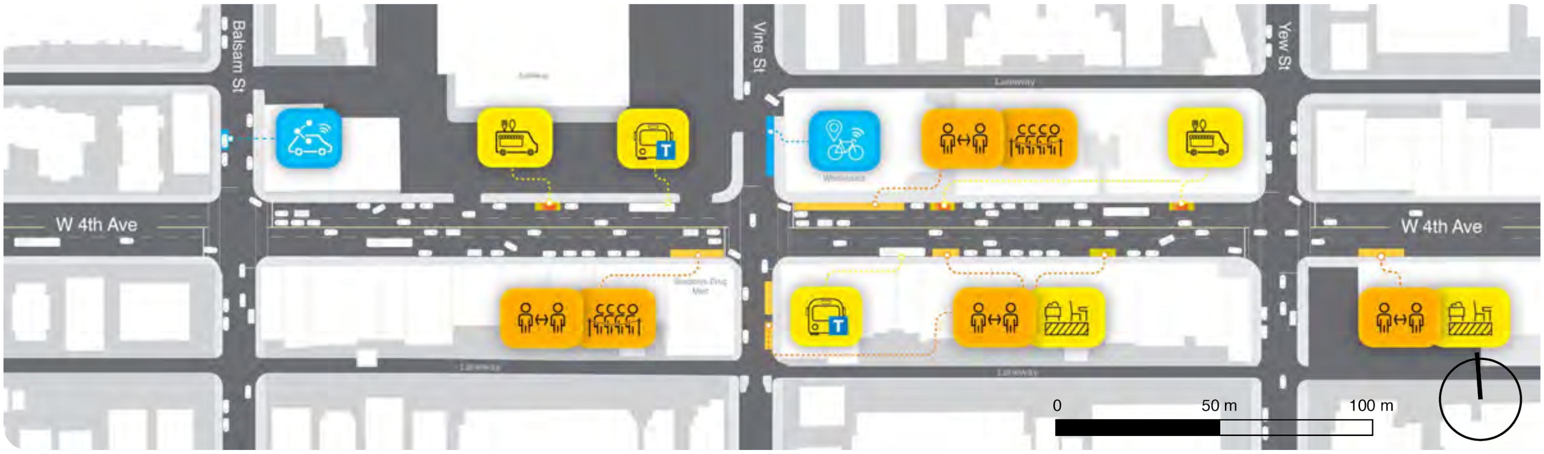
### VIRTUAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit**: real time bus times in various trip planner / navigation apps
- **Bike-share - App Silo**: Mobi – 1 connected docking station

"Blue Group" **Vehicular New Mobility**

- **PU-DO – Apps**: Uber, Lyft, taxi apps. No ride-hail pick-up drop off restrictions or geofencing within area
- **E-com / delivery**: e-commerce and delivery services in silos. Food delivery apps available.
- **Car-share – Apps**: Modo - 1 connected space, Evo available in area
- **Parking Apps**: Some integration between fleets and individual parking apps (PayByPhone Business for fleets).
- Parking apps and EV-charging apps in silos


### PHYSICAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit**: Express bus: 84, 44 (cancelled during Covid) / Bus: 4, 7, 14
- **Covid curbs**: Social distancing queuing areas: Wholefoods, Shoppers Drug Mart
- **Covid Patios**: around 6
- **Food-trucks**: 2-3 vehicles regularly
- **Bike-share**: 1 location

"Blue Group" **Vehicular New Mobility**

- **PU-DO**: currently no area allocated
- Delivery of goods direct to addressee or at Canada post location
- **Car-share**: Modo: 1 location. Evo: available in area, no designated space

# VANCOUVER

1

## Phase 1 | Piloting

*1–2 years*

### VIRTUAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

**Transit + Micromobility**: Pilot integration possibilities, for example through compass card or MaaS Pilots

**Micromobility**: Trial of e-bike and e-scooter integration through single booking and payment system.

**Civic space** to promote community engagement through business district and municipal website and social media, enabling booking location for community activities.

**Mobile street commerce**: Testing of e-permits for street vendors and food trucks for booking locations

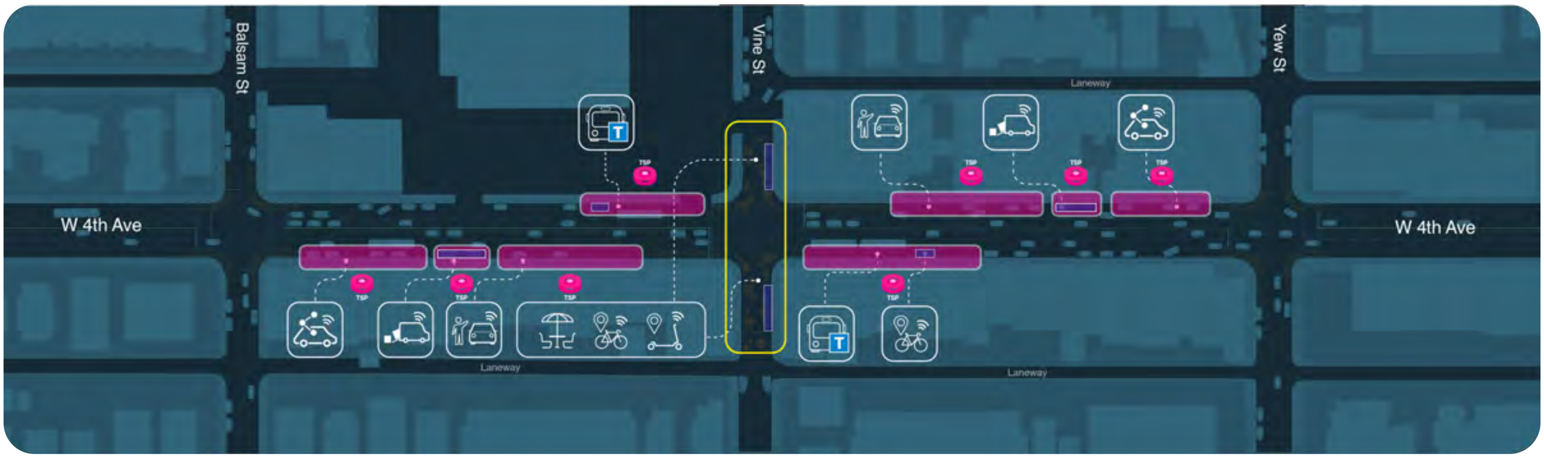
**Vision Zero** – analytics from sensors for studying vehicle-pedestrian conflicts in intersections

*"Blue Group"* **Vehicular New Mobility**

**PU-DO**: Trial of Geofencing for ride-hail TNCs pick-up drop off to redirect to parklet within apps, integration of booking system

**E-com** - trial of reservation of slots with booking apps, testing last-mile delivery technologies in e-com parklet

**E-Fleet** – testing of grouping of different car-share services to single booking system / trial of dynamic curb space rent or contract between the existing and new fleet companies / testing of integration of parking and EV-charging apps with fleets





### PHYSICAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

**Transit + Micromobility**: bus bulbs with new bus shelter on western bay combined with bike share

**Plaza + Micromobility**: Plaza at W4th/Vine with provision for bike share, e-scooters

**Vision zero**: safe intersections at W4th/Yew and W4th /Balsam

**Covid curbs** to become sidewalk extensions

*"Blue Group"* **Vehicular New Mobility**

**PU-DO**: parklet area for passenger waiting + designated 3min zone / 1 location westbound / 1 location eastbound

**E-commerce**: parklet with unloading zone + delivery bike parking + designated 15min zone / 1 location westbound / 1 location eastbound

**Car share**: designated zone / 1 location westbound / 1 location eastbound

# 2 Phase 2 | Concretization

*5–10 years*

## VIRTUAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

Mobility Hub integration in city wide network

**Transit**: MaaS ready transit integration with other connected modes

**Civic space**: E-permits and scheduling for local community activities

**Mobile street commerce**: E-permits for street vendors, food trucks and commercial public space use through booking of designated locations

**Vision Zero** - Geofencing at intersection integrated with V2I real-time data and analytics

**Vision Zero** - Geofencing along corridor coded with road regulations of speed limit and congestion charge.

Congestion charge, LEZ (Low Emissions Zone), ZEZ (Zero Emissions Zone) enforcement through geofencing as well as sensors

*"Blue Group"* **Vehicular New Mobility**

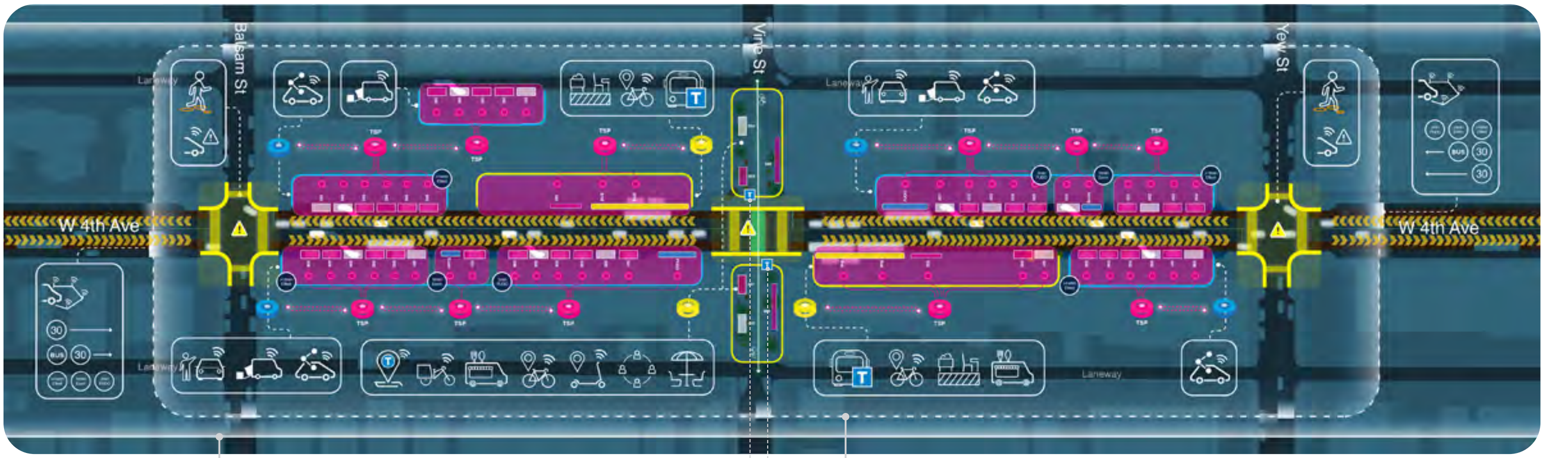
Network integration of the different siloed groups from previous phases into a MaaS enabled system

**PU-DO**: Redirect ride-hail activity within corridor geofence to terminal location, terminal integrated within Mobility Hub

**E-com**: redirect e-com to parklet to dispatch last mile delivery

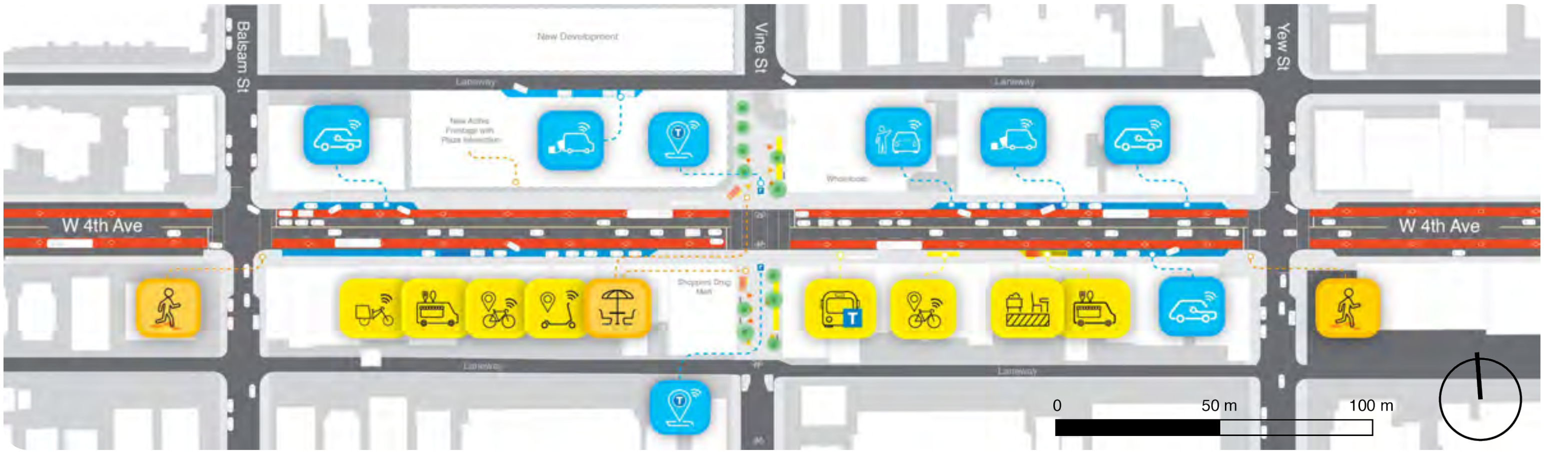
**E-Fleet**: redirect fleets to designated areas

Integrated EV charging and storage of vehicles mapped throughout the area




West 4th Corridor

West 4th & Vine




## PHYSICAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

**Transit**: Offset Transit Lane on W4th with concretized bus stations on previous bus bulb trial locations

Mobility Hub station totems at both sides of plaza, totems with booking/check-in stations, wayfinding integrated in streetscape

**Micromobility**: Formalize and expand bike share and e-scooters docking stations located in plaza and adjacent to transit stops, add e-cargo loading facilities

**Civic Space**: Redesign of pedestrian area to include concretization of plaza and connected transit stops with additional sidewalk extensions

Possible new development at Safeway site to interact with active frontage to plaza, eastern bus bay and sidewalk extension

**Vision Zero**: Implementation of safe intersections with sensors and V2I (Vehicle to Infrastructure) technology

*"Blue Group"* **Vehicular New Mobility**

**PU-DO**: several locations, each including terminal with service kiosk and shelter, Mobility Hub wayfinding + designated 3min zone of several curb spaces

**E-commerce**: several locations, each includes parklet with new uses (such as lockers or delivery bike facilities), 15min zone of designated curb space

**E-Fleet**: several locations, each with designated 15+mins stopping zone for registered fleets, wayfinding, curbside EV charging docks

## Overview

# PHYSICAL

*The maps below show how the curb space can be holistically reconfigured within a specific defined zone, with transit as an anchor. There is consideration for different uses of new mobility, public space activation and vision zero initiatives for pedestrian safety.*

**Current situation**
*(August 2020)*
*Today*

0


**Phase 1 - Piloting**
*1–2 years*

1


**Phase 2 - Concretization**
*5–10 years*

2


**Phase 3 - Autonomous** ?
*25–35 years*

3

For this stage with a time frame of around 30 years (2050 for 2020), a Vision Statement document will need to be created and updated yearly (see chapter 3.2) with the following points of attention:

Transit: priority given to collective mass transit anchoring the overall design of the Mobility Hub
Adaptable infrastructure for Autonomous transit, shuttles, vans and ride hail, to create equilibrium between PU-DO Terminal and Transit terminal. Explore options in median strip of avenue.
Introduction of low-speed e-cargo bike lanes and cycle infrastructure to serve as
Curbless zones for flexible and dynamic allocation of uses throughout the 24h period
Deployment of communication infrastructure (5G, 6G, etc to accommodate IoT

- Transit
- Micromobility
- Food-truck
- Covid curbs
- Covid Patios
- Vision Zero
- Totem
- Plaza
- PU-DO
- E-commerce
- Car-share

# VANCOUVER

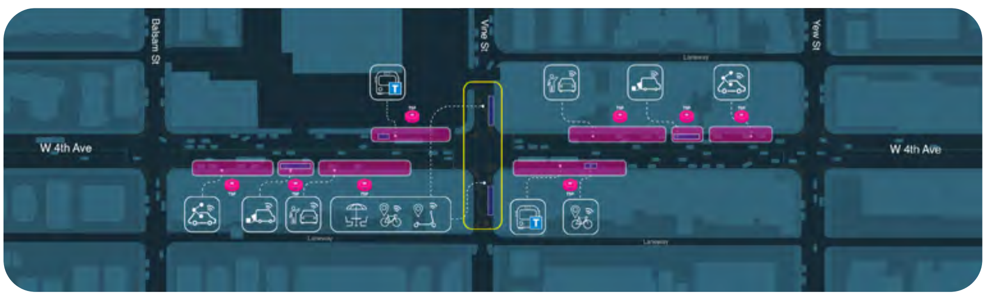
## Overview

*The maps below illustrate diagrammatically the virtual realm and connected new mobility elements as well as special virtual zoning and geofenced areas with special provisions. These measures are proposed to increase in time.*

## VIRTUAL

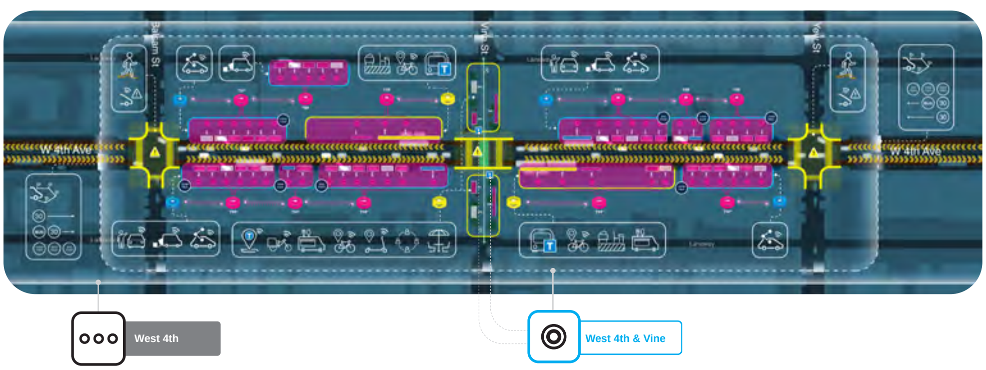

**0** — **Current situation** *(August 2020)*

*Today*




**1** — **Phase 1 - Silos**

*1–2 years*




**2** — **Phase 2 - Network**

*5–10 years*

For this stage with a time frame of around 30 years (2050 for 2020), a Vision Statement document will be created and updated yearly (see chapter 3.2) with the following points of attention:

MaaS integrated network within an eco-system platform of mobility management and ground traffic control
Geofencing and geo-zoning as a city-wide / region-wide strategy
EV charging integrated as part of energy internet to manage surcharge and electricity grid
Data exhaust and data management within a cohesive integrated policy framework under federal

**3** ? **Phase 3 - Ecosystem**

*25–35 years*

Transit
Micromobility
Food-trucks
Vision Zero
Totem
Plaza
PU-DO
E-commerce
Car-share

# 5.2.2
## Case Two

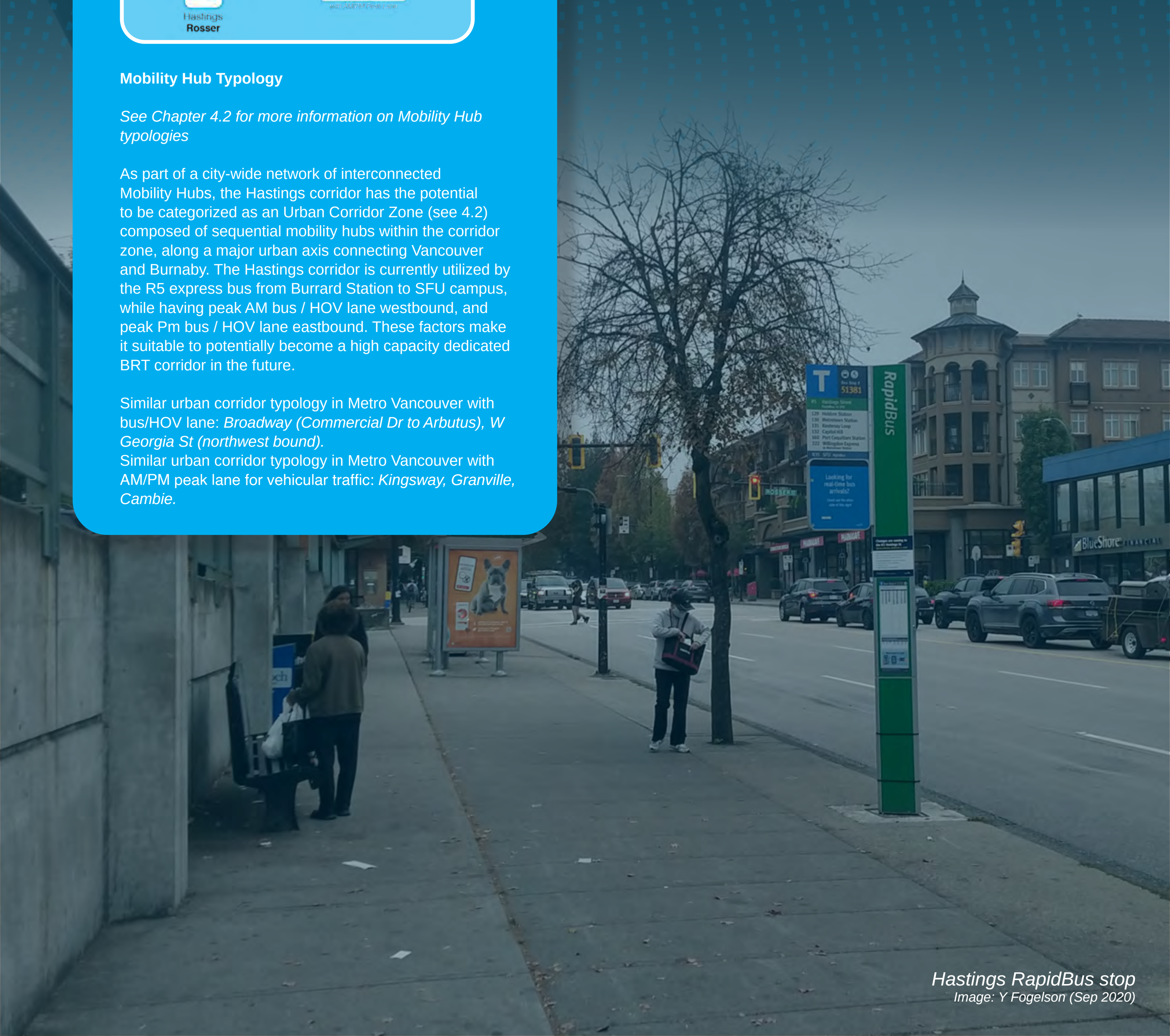
**2 Burnaby**
Hastings Corridor


**Mobility Hub Typology**

*See Chapter 4.2 for more information on Mobility Hub typologies*

As part of a city-wide network of interconnected Mobility Hubs, the Hastings corridor has the potential to be categorized as an Urban Corridor Zone (see 4.2) composed of sequential mobility hubs within the corridor zone, along a major urban axis connecting Vancouver and Burnaby. The Hastings corridor is currently utilized by the R5 express bus from Burrard Station to SFU campus, while having peak AM bus / HOV lane westbound, and peak Pm bus / HOV lane eastbound. These factors make it suitable to potentially become a high capacity dedicated BRT corridor in the future.

Similar urban corridor typology in Metro Vancouver with bus/HOV lane: *Broadway (Commercial Dr to Arbutus), W Georgia St (northwest bound).*
Similar urban corridor typology in Metro Vancouver with AM/PM peak lane for vehicular traffic: *Kingsway, Granville, Cambie.*




*Hastings RapidBus stop*
*Image: Y Fogelson (Sep 2020)*

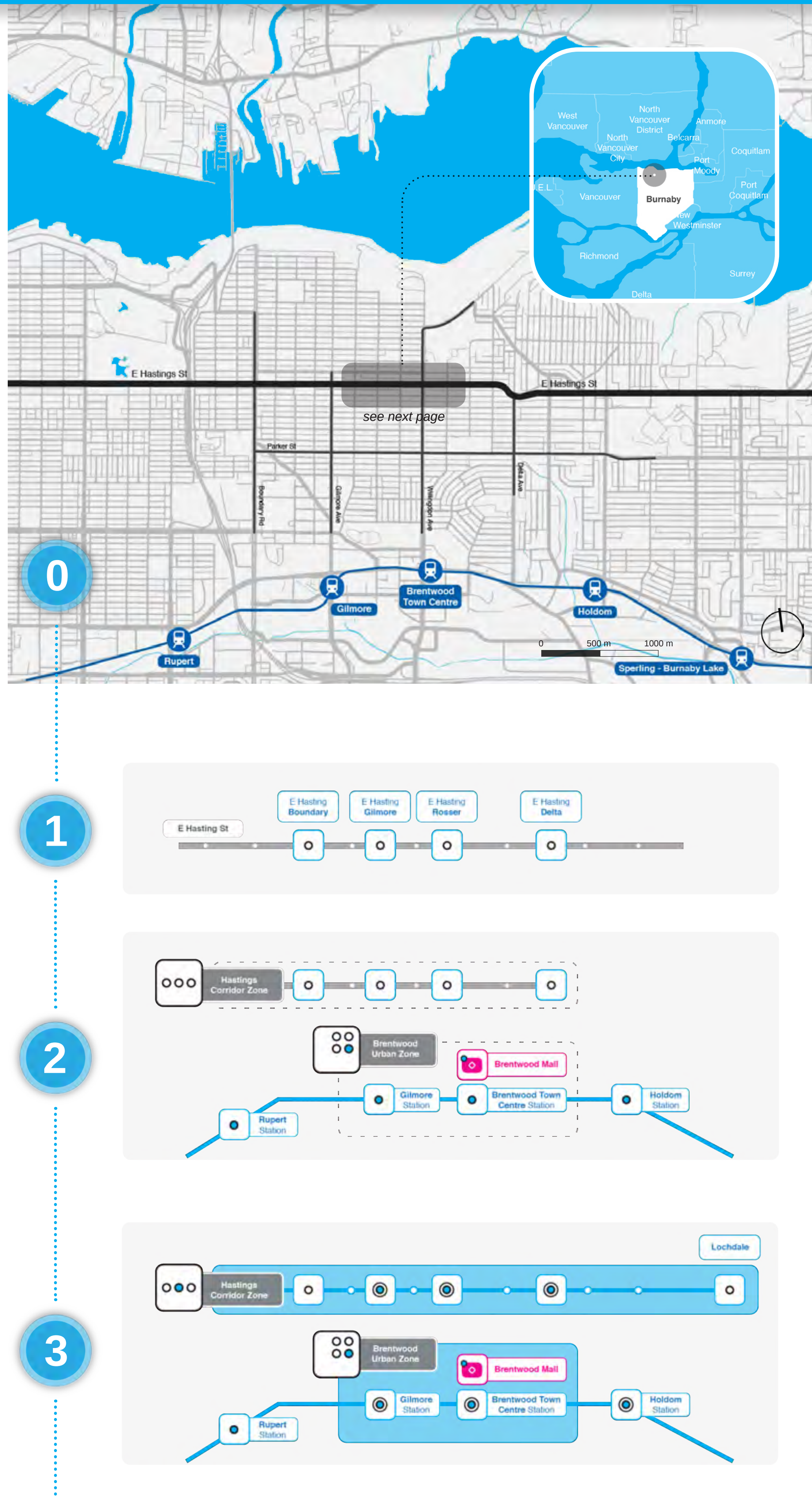
## Macro Vision

The vision of a city-wide network of interconnected Mobility Hubs can be achieved in an incremental gradual progression. Using the Transitional Design Methodology (from Chapter 3), we can imagine three phases in the timeline:

① The first phase being the immediate action in the time frame of 1-2 years. Here we can imagine piloting of selected locations to test the Community Mobility Hub typology. In this phase the redesign proposed in the phase 2 can be tested with tactical urbanism methodology of light infrastructural changes. New mobility uses and services can be tested and expanded within this pilot. At this point each location is a separate test site and new geofencing and connectivity technologies can be trialed at the mobility hub level or along sections of the corridor.

② The second phase represents the mid range (5-10 years) concretization of pilots done in the first phase. Here we can imagine the corridor multiplying its mobility hub locations along the corridor. In this phase a BRT system can be implemented with regular automated service in a dedicated right-of-way, this can upgrade the corridor to a mass transit corridor. Furthermore, a link can be established with Brentwood and Gilmore stations along the Millennium SkyTrain route. In this phase, new mobility services can be integrated within a MaaS enabled network.

③ In this visionary phase, in the time-frame of around 30 years, Hastings corridor is an integral part of the city network of connected mobility hubs. The network functions like a rapid transit system, portrayed by a subway system style map as its user interface. In this visionary phase there are multiple connections between different major connected rapid transit corridors.



## Current Situation

### Hastings Corridor today

Currently, the Hastings Corridor serves as an important city-wide connection to the SFU Campus, Port Moody and Coquitlam. As such, there arises a conflict between the need to connect metropolitan areas and attend its traffic flows, contradicting with the enhancement of a main commercial street with local urban fabric. The section of Hastings corridor in Burnaby known as 'The Heights', resembles to some extent its urban typology of East Hastings corridor west of Boundary Rd within the City of Vancouver.

Hastings corridor has three lanes in each direction including the curb lane, the latter has AM peak priority bus / HOV lane westbound and PM peak lane eastbound. As such, permanent transformation of the curb space are not possible during the respective peak hours to accommodate 24-hour use of potential pick-up drop off zones, parklets, loading zone, etc. Therefore, solutions explored in the corridor in Case 1 cannot be implemented here and the side streets can be utilized for this end to guarantee the trial of new mobility uses such as ride hail, car-share and e-commerce loading zones.

As a major transit route, the case study investigates an opportunity to implement a BRT system giving a clear priority to transit for this route, this does however come at the expense of a major vehicular traffic reduction, which may be controversial. However, the combination of a BRT system and reduction of traffic lanes, falls in line with the downscaling of the avenue to enhance the local character of a commercial main street.


Hastings / Rosser bus stop eastbound

Hastings / Rosser bus stop westbound


Rosser Ave (Hastings and Pender) facing south (top), facing north (bottom)

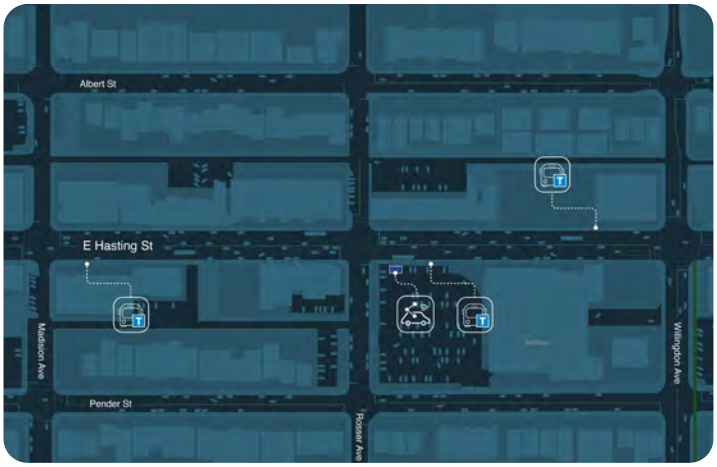
Rosser Ave (Albert and Hastings) facing south

Car-share parking adjacent to bus stop

# BURNABY

0

## Phase 0 | Current Situation | *September 2020*


### PHYSICAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit**: Express bus R5, buses: 129, 130, 131, 132, 160, 222, N35, dedicated peak direction bus lanes in both directions AM westbound, PM eastbound
- **Vision Zero**: None
- **Covid curbs / patios**: None
- **Food-trucks**: ?
- **Bike-share**: None

"Blue Group" **Vehicular New Mobility**

- **PU-DO**: currently no area allocated
  Delivery of goods direct to addressee or at Canada post location
- **Car-share**: Modo: 1 location. Evo: NOT available in the area

### VIRTUAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit**: real time bus times in various trip planner / navigation apps
- **Bike-share**: None

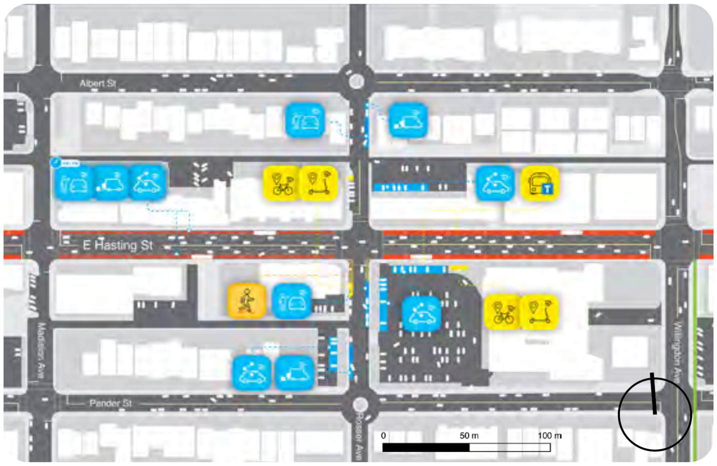
"Blue Group" **Vehicular New Mobility**

- **PU-DO** – Apps: Uber, Lyft, taxi apps. No ride-hail pick-up drop off restrictions or geofencing within area
- **E-com / delivery**: e-commerce and delivery services in silos. Food delivery apps available.
- **Car-share – Apps**: Modo - 1 connected location, Evo – not available in the area
  **Parking Apps**: Some integration between fleets and individual parking apps (PayByPhone Business for fleets).
  Parking apps and EV-charging apps in silos

1

## Phase 1 | Piloting

*1–2 years*





## PHYSICAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

**Transit**: dedicated peak direction bus lane

**Micromobility**: provision for bike share, e-scooters near bus stop

*"Blue Group"* **Vehicular New Mobility**

Roundabouts at Rosser Ave & Albert St as well as Pender St, to facilitate traffic from Hastings destined for PU-DO and E-com on Rosser Ave

**PU-DO**: parklet area for passenger waiting + designated 3min zone / 2 locations on Rosser Ave / 2 off-peak hour locations on Hastings

**E-commerce**: parklet with unloading zone + delivery bike parking + designated 15min zone / 2 locations on Rosser Ave / 2 off-peak hour locations on Hastings

**Car share**: designated zone on Rosser Ave / designated spaces in Safeway parking

## VIRTUAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

**Transit + Micromobility**: Pilot integration possibilities, for example through compass card or MaaS Pilots

**Micromobility**: Trial of e-bike and e-scooter integration through single booking and payment system.

**Civic space** to promote community engagement through business district and municipal website and social media, enabling booking location for community activities.

**Mobile street commerce**: Testing of e-permits for street vendors and food trucks for booking locations

**Vision Zero** – analytics from sensors for studying vehicle-pedestrian conflicts in intersections

*"Blue Group"* **Vehicular New Mobility**

**PU-DO**: Trial of Geofencing for ride-hail TNCs pick-up drop off to redirect to parklet within apps, integration of booking system

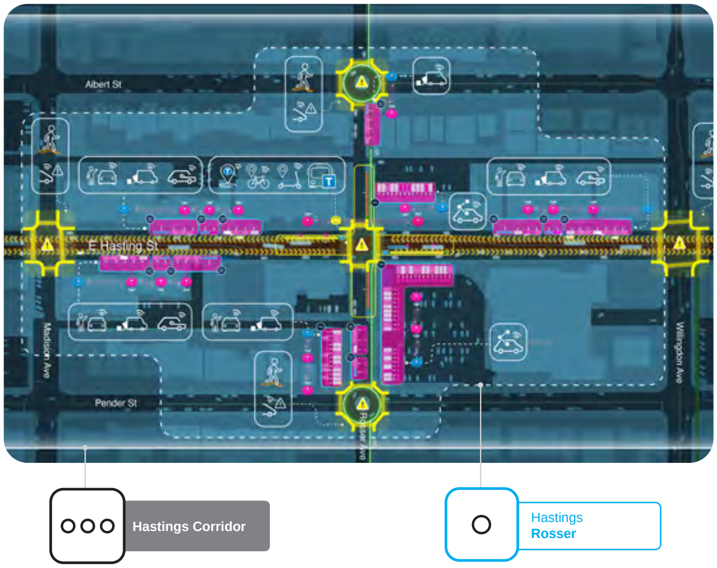
**E-com** - trial of reservation of slots with booking apps, testing last-mile delivery technologies in e-com parklet

**E-Fleet** – testing of grouping of different car-share services to single booking system / trial of dynamic curb space rent or contract between the existing and new fleet companies / testing of integration of parking and EV-charging apps with fleets

# 2

## Phase 2 | Concretization

*5–10 years*


## PHYSICAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit**: BRT system with stations in median of Hastings coincides with reduction of capacity for automobiles in Hastings corridor
- Mobility Hub station totems at BRT station with booking/check-in stations, wayfinding integrated in streetscape
- **Micromobility**: Cycle infrastructure added on Rosser to connect to BRT station. Formalize and expand bike share and e-scooters docking stations, add e-cargo bike facilities
- **Vision Zero**: Implementation of safe intersections with sensors and V2I (Vehicle to Infrastructure) technology

"Blue Group" **Vehicular New Mobility**

- **PU-DO**: several locations, each including terminal with service kiosk and shelter, Mobility Hub wayfinding + designated 3min zone of several curb spaces
- **E-commerce**: several locations, each includes parklet with new uses (such as lockers or delivery bike facilities), 15min zone of designated curb space
- **E-Fleet**: several locations, each with designated 15+mins stopping zone for registered fleets, wayfinding, curbside EV charging docks

## VIRTUAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

Mobility Hub integration in city wide network

- **Transit**: MaaS ready transit integration with other connected modes
- **Civic space**: E-permits and scheduling for local community activities
- **Mobile street commerce**: E-permits for street vendors, food trucks and commercial public space use through booking of designated locations
- **Vision Zero** - Geofencing at intersection integrated with V2I real-time data and analytics
- **Vision Zero** - Geofencing along corridor coded with road regulations of speed limit and congestion charge.

  Congestion charge, LEZ (Low Emissions Zone), ZEZ (Zero Emissions Zone) enforcement through geofencing as well as sensors

"Blue Group" **Vehicular New Mobility**

Network integration of the different siloed groups from previous phases into a MaaS enabled system

- **PU-DO**: Redirect ride-hail activity within corridor geofence to terminal location, terminal integrated within Mobility Hub
- **E-com**: redirect e-com to parklet to dispatch last mile delivery
- **E-Fleet**: redirect fleets to designated areas
- Integrated EV charging and storage of vehicles mapped throughout the area

# BURNABY

## Overview

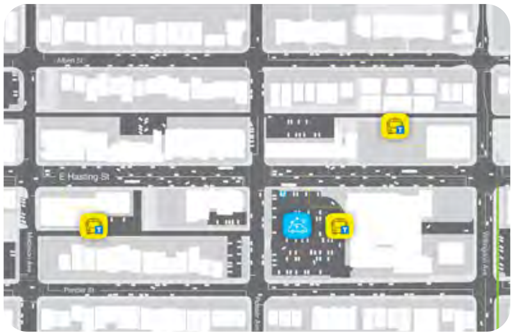
## PHYSICAL

The maps below show how the curb space can be holistically reconfigured within a specific defined zone, with transit as an anchor. There is consideration for different uses of new mobility, public space activation and vision zero initiatives for pedestrian safety.

**0** — **Current situation** *(September 2020)* — *Today*

**1** — **Phase 1 - Piloting** — *1–2 years*

**2** — **Phase 2 - Concretization** — *5–10 years*



**3** — **?**

**Phase 3 - Autonomous** — *25–35 years*

For this stage with a time frame of around 30 years (2050 for 2020), a Vision Statement document will be created and updated yearly (see chapter 3.2) with the following points of attention:

Adaptable infrastructure for Autonomous transit, shuttles, vans and ride hail, to create equilibrium between PU-DO Terminal and Transit terminal. Explore options in median strip of avenue.
Introduction of low-speed e-cargo bike lanes and cycle infrastructure
Curbless zones for flexible and dynamic allocation of uses throughout the 24h period
Deployment of communication infrastructure (5G, 6G, etc to accommodate IoT

Transit
Micromobility
Food-truck
Covid curbs
Covid Patios
Vision Zero
Totem
Plaza
PU-DO
E-commerce
Car-share

# Overview

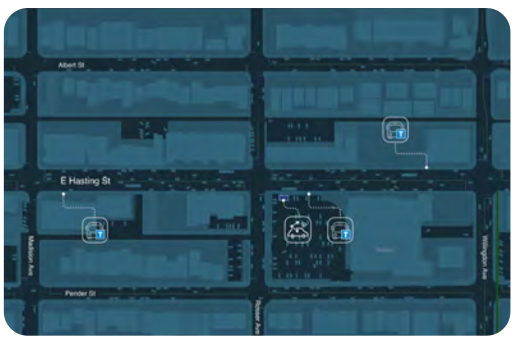
The maps below illustrate diagrammatically the virtual realm and connected new mobility elements as well as special virtual zoning and geofenced areas with special provisions. These measures are proposed to increase in time.

## VIRTUAL

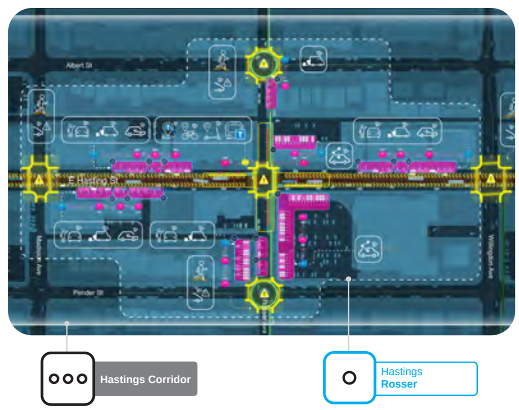
**0** — **Current situation** *(September 2020)* — *Today*

**1** — **Phase 1 - Silos** — *1–2 years*

**2** — **Phase 2 - Network** — *5–10 years*








For this stage with a time frame of around 30 years (2050 for 2020), a Vision Statement document will be created and updated yearly (see chapter 3.2) with the following points of attention:

MaaS integrated network within an eco-sytem platform of mobility management and ground traffic control
Geofencing and geo-zoning as a city-wide / region-wide strategy
EV charging integrated as part of energy internet to manage surcharge and electricity grid
Data exhaust and data management within a cohesive integrated policy framework under federal and municipal oversight

**?** **3** — **Phase 3 - Ecosystem** — *25–35 years*

Transit
Micromobility
Food-trucks
Vision Zero
Totem
Plaza
PU-DO
E-commerce
Car-share

# 5.2.3
## Case Three

**3 North Vancouver**
Central Lonsdale


### Mobility Hub Typology

*See Chapter 4.2 for more information on Mobility Hub typologies*

As part of a city-wide network of interconnected Mobility Hubs, North Vancouver ‘Central Lonsdale’ has the potential to be categorized as an *Urban Centre Zone* (see 4.2) with a natural connection to the adjacent Urban Centre Zone ‘Lower Lonsdale’ with SeaBus connections to Vancouver city centre. Although this centre zone is built upon the backbone of Lonsdale Ave, it is not categorized as a corridor, but rather as a central urban locality, hence the *Urban Centre Zone*.

*Lonsdale Ave - tactical bus stop*
*Image: Y Fogelson (Sep 2020)*

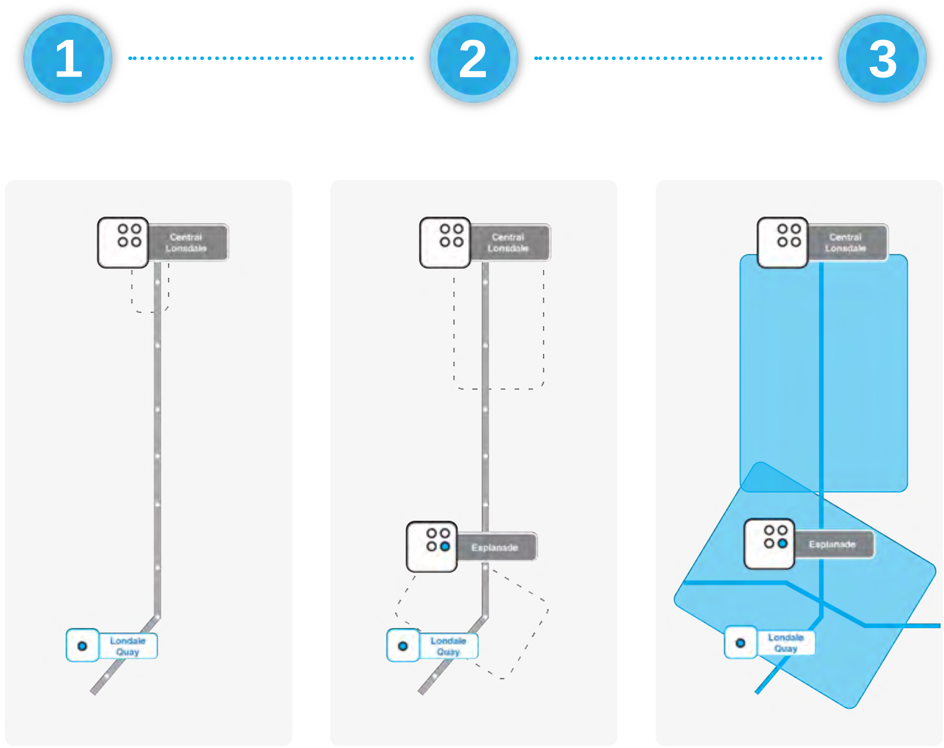
## Macro Vision

The vision of a city-wide network of interconnected Mobility Hubs can be achieved in an incremental gradual progression. Using the Transitional Design Methodology (from Chapter 3), we can imagine three phases in the timeline:

1. The first phase being the immediate action in the time frame of 1-2 years. Here we can imagine piloting of a limited area in the immediate vicinity of a central section along Lonsdale Ave, as well as the immediate vicinity of Lonsdale Quay. In this phase the redesign proposed in the phase 2 can be tested with tactical urbanism methodology of light infrastructural changes. New mobility uses and services can be tested and expanded within this pilot. At this point each location is a separate test site and new geofencing and connectivity technologies can be trialed at a local level.

2. The second phase represents the mid range (5-10 years) concretization of pilots done in the first phase. Here we can imagine the expansion of both test areas (Lonsdale Central and Lower Lonsdale) each expanding to become a functional Urban Centre Zone. In this phase rapid transit solutions can be incorporated in order to upgrade the transit system and reduce the vehicular component of mobility in the most central area of the north shore. New mobility services can be integrated within a MaaS enabled network.

3. In this visionary phase, in the time-frame of around 30 years, Lonsdale Central and Lower Lonsdale Urban Centre Zones may eventually integrate to a larger zone and become an integral part of the city network of connected mobility hubs. The network functions like a rapid transit system, portrayed by a subway system style map as its user interface.

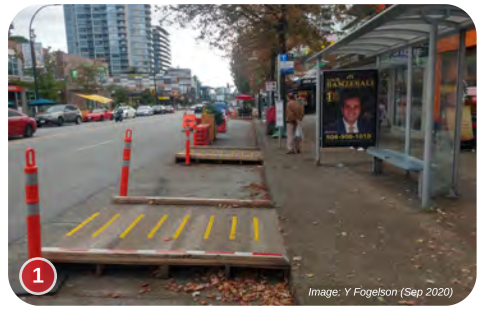
# Current Situation

## Central Lonsdale today

Lonsdale Central is one of the major precincts of North Vancouver and is centred around Lonsdale Ave as its backbone, connecting Highway 1 in the north to Lonsdale Quay waterfront district in the south, with SeaBus connection to central Vancouver. It also serves as central location connecting the district east-west through 13th St and 15th St. The intersection at 15th St serves as a transit interchange between main routes. Lonsdale Ave in the section between 17th St and 13th St has ample commercial activity, as well as civic spaces around 14th St with a plaza connecting to North Vancouver City Hall as well as the city library. Lonsdale Ave has 3 lanes in each direction, including curb lanes used for parking, as well as sidewalk bulb outs at crossings.

Regarding re-allocation of road space, the Covid 19 pandemic has served as a impetus to test new configurations of space to add public space activation and patios on behalf of the existing curb lane, while reinstating the 'lost' parking lane on the second vehicular lane, leaving a single lane in each direction for traffic. Tactical bus bulbs have also been experimented with, leaving the municipality at an advantage point to implement, consolidate and concretize further transformation of Lonsdale Ave in the vision to become a great commercial high street.

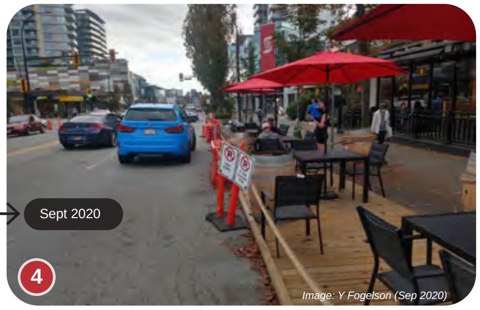
In this context, the study has investigated a more radical transformation in phase 2, compared to other case studies, as many of the phase 1 related piloting is being tested early on in phase 0 (current situation). In this transformation, vehicular road space has been reduced to a minimum, transit and cycle infrastructure to a maximum, while connected new mobility services are being accommodated exclusively in the central section of Lonsdale Ave in the long term.

Covid-curbs - Tactical bus-bulb, facing south (between 15th and 14th)

Covid-curbs - public seating areas and parking lane, facing south (16th and 15th)

Pre-covid condition, 2 lanes and a parking lane, facing south (15th and 14th)



Covid-curbs - patio and taxi-zone, loading zone, facing south (15th and 14th)


Covid-curbs - public seating areas and parking lane, facing south (17th and 16th)

Pre-covid condition, 2 lanes and dedicated car-share spaces, facing north (13th and 14th)

Dedicated car-share spaces, facing south (14th and 13th)

# NORTH VANCOUVER

## Phase 0 | Current Situation | *September 2020*

0



## PHYSICAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit**: Express bus 240, buses: 241, 229, 230, 232, 255, N24. Tactical bus bulbs at 15 St and 17 St stations on Lonsdale
- **Covid curbs / patios**: Continuous patio and activation areas on curb lane from 17St to 14 St – tactical parking lane in lane adjacent to Covid curb lane, reduction to a single continuous traffic lane
- **Food-trucks**: ?
- **Bike-share**: None
- **Car-share**: 2 locations – Evo and Modo
- **Ride-hail**: 1 dedicated space

"Blue Group" **Vehicular New Mobility**

- **PU-DO**: 1 location 3min zone
  Delivery of goods direct to addressee or at Canada post location
- **Car-share**: Modo: 1 location. Evo: 1 location

## VIRTUAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit**: real time bus times in various trip planner / navigation apps
- **Bike-share**: None

"Blue Group" **Vehicular New Mobility**

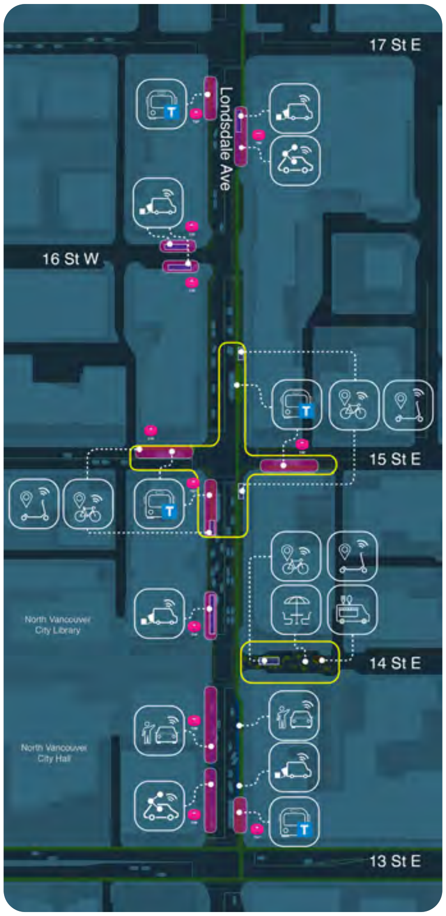
- **PU-DO** – Apps: Uber, Lyft, taxi apps. No ride-hail pick-up drop off restrictions or geofencing within area
- **E-com / delivery**: e-commerce and delivery services in silos. Food delivery apps available.
- **Car-share – Apps**: Modo - 1 connected location, Evo – 1 connected location
- **Parking Apps**: Some integration between fleets and individual parking apps (PayByPhone Business for fleets).
  Parking apps and EV-charging apps in silos

# NORTH VANCOUVER

1

## Phase 1 | Piloting

*1–2 years*


## PHYSICAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

- **Transit**: Exchange station on 15st & Lonsdale through expansion of bus bulbs on 15 St and consolidation of bus bulbs on Lonsdale
- Sidewalk extension or public space activation and expansion of Covid curbs
- Plaza activation at 14 St E with Food Truck and micromobility
- **Cycle infrastructure**: piloting a bi-directional cycle way on west-side of Lonsdale Ave, bike share and e-scooters near bus stop

*"Blue Group"* **Vehicular New Mobility**

- **PU-DO**: parklet area for passenger waiting + designated 3min zone / 3 locations along Lonsdale Ave
- **E-commerce**: parklet with unloading zone + delivery bike parking + designated 15min zone / 3 locations along Lonsdale Ave / 1 Location at 16 St
- **Car share**: designated zone / 4 locations along Lonsdale Ave

## VIRTUAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

- **Transit + Micromobility**: Pilot integration possibilities, for example through compass card or MaaS Pilots
- **Micromobility**: Trial of e-bike and e-scooter integration through single booking and payment system.
- **Civic space** to promote community engagement through business district and municipal website and social media, enabling booking location for community activities.
- **Mobile street commerce**: Testing of e-permits for street vendors and food trucks for booking locations
- **Vision Zero** – analytics from sensors for studying vehicle-pedestrian conflicts in intersections

*"Blue Group"* **Vehicular New Mobility**

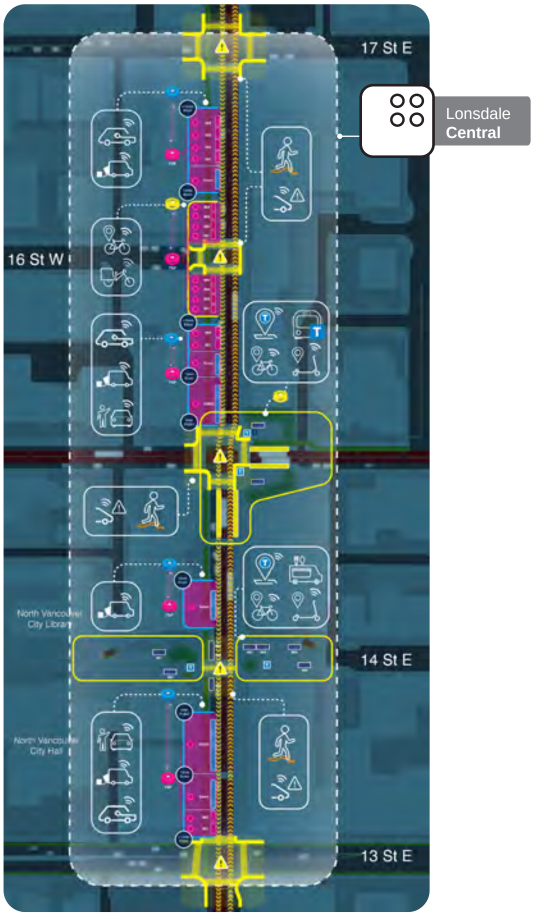
- **PU-DO**: Trial of Geofencing for ride-hail TNCs pick-up drop off to redirect to parklet within apps, integration of booking system
- **E-com** - trial of reservation of slots with booking apps, testing last-mile delivery technologies in e-com parklet
- **E-Fleet** – testing of grouping of different car-share services to single booking system / trial of dynamic curb space rent or contract between the existing and new fleet companies / testing of integration of parking and EV-charging apps with fleets

# NORTH VANCOUVER

2

## Phase 2 | Concretization

*5–10 years*


### PHYSICAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

**Transit**: BRT exchange station at 15 St & Lonsdale Ave, anchoring location for potential civic space. Lonsdale Ave redesign to include directional transit only lanes southbound and northbound

Mobility Hub station totems at BRT exchange station square at 15 St and plaza on 14 St with booking / totems with check-in stations, wayfinding integrated in streetscape

**Cycle infrastructure**: A major bi-directional cycle way on east-side of Lonsdale Ave, multiple locations of bike share and e-scooters facilities, provision for e-cargo bike loading stations

**Vision Zero**: safe curbless intersections along Lonsdale. Implementation of safe intersections with sensors and V2I (Vehicle to Infrastructure) technology

*"Blue Group"* **Vehicular New Mobility**

Lonsdale Ave redesign to include one-way vehicular access road southbound with curb space bulbs for new mobility uses (see below)

**PU-DO**: several locations, each including terminal with service kiosk and shelter, Mobility Hub wayfinding + designated 3min zone of several curb spaces

**E-commerce**: several locations, each includes parklet with new uses (such as lockers or delivery bike facilities in correlation with adjacent cycle infrastructure), 15min zone of designated curb space

**E-Fleet**: several locations, each with designated 15+mins stopping zone for registered fleets, wayfinding, curbside EV charging docks

### VIRTUAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

Mobility Hub integration in city wide network

**Transit**: MaaS ready transit integration with other connected modes

**Civic space**: E-permits and scheduling for local community activities

**Mobile street commerce**: E-permits for street vendors, food trucks and commercial public space use through booking of designated locations

**Vision Zero** - Geofencing at intersection integrated with V2I real-time data and analytics

**Vision Zero** - Geofencing along corridor coded with road regulations of speed limit and congestion charge.

Congestion charge, LEZ (Low Emissions Zone), ZEZ (Zero Emissions Zone) enforcement through geofencing as well as sensors

*"Blue Group"* **Vehicular New Mobility**

Network integration of the different siloed groups from previous phases into a MaaS enabled system

**PU-DO**: Redirect ride-hail activity within corridor geofence to terminal location, terminal integrated within Mobility Hub

**E-com**: redirect e-com to parklet to dispatch last mile delivery

**E-Fleet**: redirect fleets to designated areas

Integrated EV charging and storage of vehicles mapped throughout the area

# NORTH VANCOUVER

## Overview

## PHYSICAL

The maps below show how the curb space can be holistically reconfigured within a specific defined zone, with transit as an anchor. There is consideration for different uses of new mobility, public space activation and vision zero initiatives for pedestrian safety.

**0**

**Current situation**
*(September 2020)*

*Today*


**1**

**Phase 1 - Piloting**

*1–2 years*


**2**

**Phase 2 - Concretization**

*5–10 years*


**3** ?

**Phase 3 - Autonomous**

*25–35 years*

For this stage with a time frame of around 30 years (2050 for 2020), a Vision Statement document will be created and updated yearly (see chapter 3.2) with the following points of attention:

Adaptable infrastructure for Autonomous transit, shuttles, vans and ride hail, to create equilibrium between PU-DO Terminal and Transit terminal. Explore options in median strip of avenue.
Introduction of low-speed e-cargo bike lanes and cycle infrastructure
Curbless zones for flexible and dynamic allocation of uses throughout the 24h period
Deployment of communication infrastructure (5G, 6G, etc to accommodate IoT

Transit
Micromobility
Food-truck
Covid curbs
Covid Patios
Vision Zero
Totem
Plaza
PU-DO
E-commerce
Car-share

## Overview

# VIRTUAL

The maps below illustrate diagrammatically the virtual realm and connected new mobility elements as well as special virtual zoning and geofenced areas with special provisions. These measures are proposed to increase in time.

**0**

**Current situation**
*(September 2020)*

*Today*

**1**

**Phase 1 - Silos**

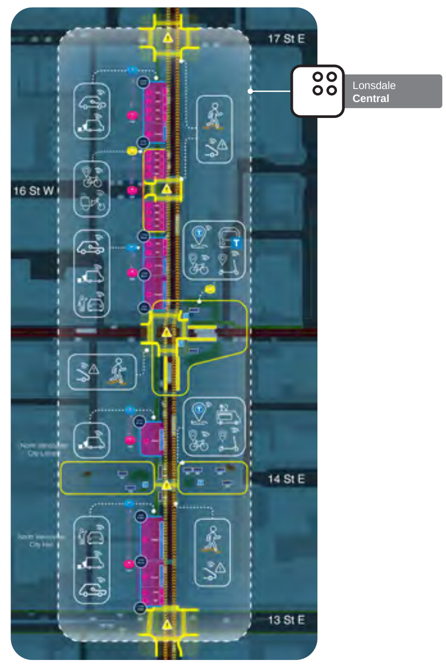
*1–2 years*

**2**

**Phase 2 - Network**

*5–10 years*






For this stage with a time frame of around 30 years (2050 for 2020), a Vision Statement document will be created and updated yearly (see chapter 3.2) with the following points of attention:

MaaS integrated network within an eco-sytem platform of mobility management and ground traffic control
Geofencing and geo-zoning as a city-wide / region-wide strategy
EV charging integrated as part of energy internet to manage surcharge and electricity grid
Data exhaust and data management within a cohesive integrated policy framework under federal and municipal oversight

?

**3**

**Phase 3 - Ecosystem**

*25–35 years*

**Transit**
**Micromobility**
**Food-trucks**

**Vision Zero**

**Totem**
**Plaza**

**PU-DO**
**E-commerce**
**Car-share**

# 5.2.4
## Case Four

**4 New Westminster**
Uptown 6th & 6th


**Mobility Hub Typology**

*See Chapter 4.2 for more information on Mobility Hub typologies*

As part of a city-wide network of interconnected Mobility Hubs, New Westminster 'Uptown' has the potential to be categorized as an Urban Centre Zone (see 4.2) with a natural connection to the adjacent Urban Centre Zone 'Downtown' with Skytrain connections to Vancouver, Burnaby and Surrey.


*6th St - tactical Covid sidewalk extension*
*Image: Y Fogelson (Sep 2020)*

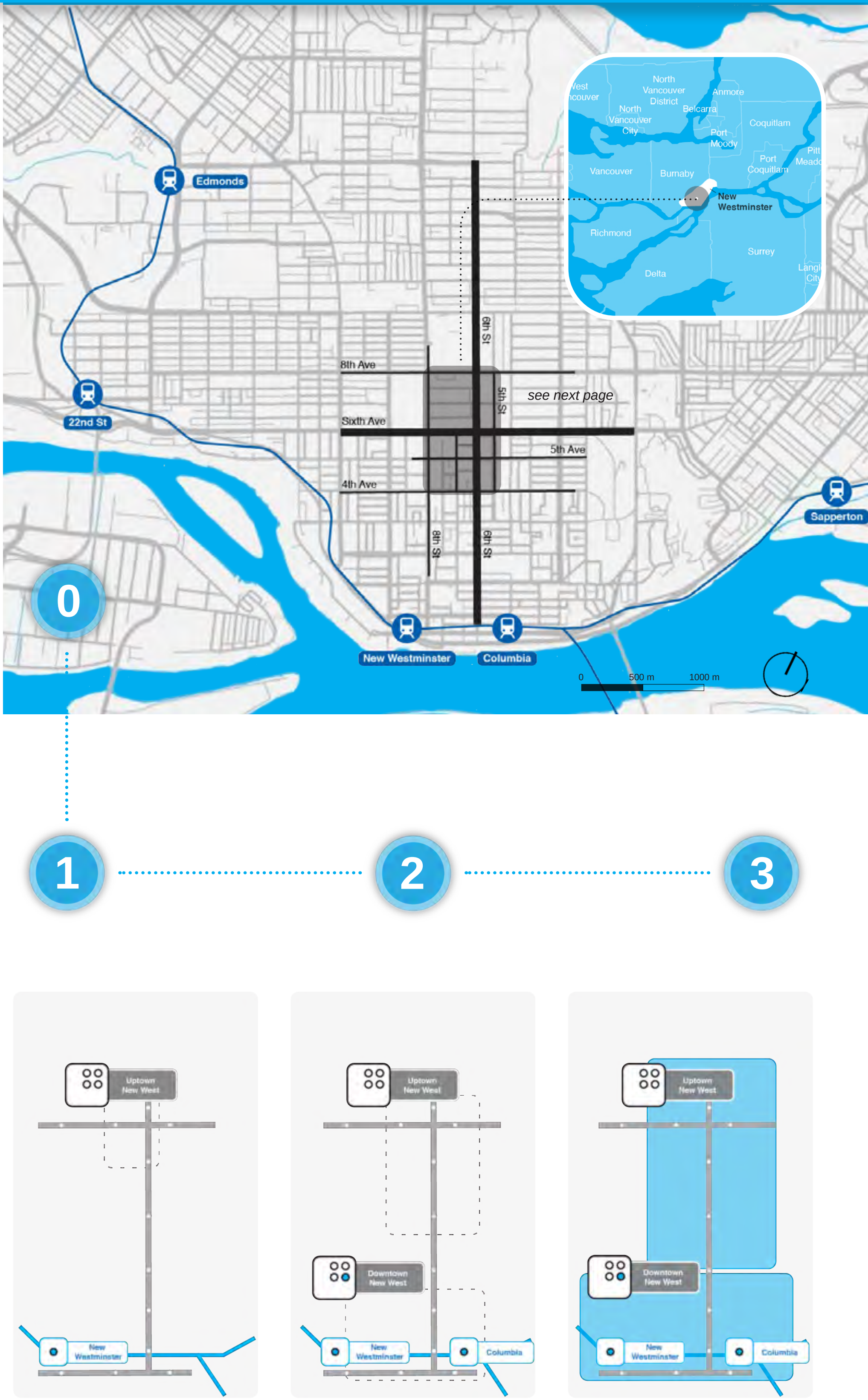
## Macro Vision

The vision of a city-wide network of interconnected Mobility Hubs can be achieved in an incremental gradual progression. Using the *Transitional Design Methodology* (from Chapter 3), we can imagine three phases in the timeline:

1. The first phase being the immediate action in the time frame of 1-2 years. Here we can imagine piloting of a limited area in the immediate vicinity of Uptown around 6th & 6th, as well as the immediate vicinity of New Westminster SkyTrain station. In this phase the redesign proposed in the '*Uptown Streetscape Vision (June 8, 2020)*' document can be simulated and tested with tactical urbanism methodology of light infrastructural changes. New mobility uses and services can be tested and expanded within this pilot. At this point each location is a separate test site and new geofencing and connectivity technologies can be trialed at a local level.

2. The second phase represents the mid range (5-10 years) concretization of pilots done in the first phase. Here we can imagine the expansion of both test areas (Uptown and Downtown) each expanding to become a functional *Urban Centre Zone*. In this phase, the '*Uptown Streetscape Vision (June 8, 2020)*' can be implemented after readjustment and recalibration thanks to phase 1 piloting. In this phase, new mobility services can be integrated within a MaaS enabled network.

3. In this visionary phase, in the time-frame of around 30 years, New Westminster Uptown and Downtown Urban Centre Zones may eventually integrate to a larger zone and become an integral part of the city network of connected mobility hubs. The network functions like a rapid transit system, portrayed by a subway system style map as its user interface.



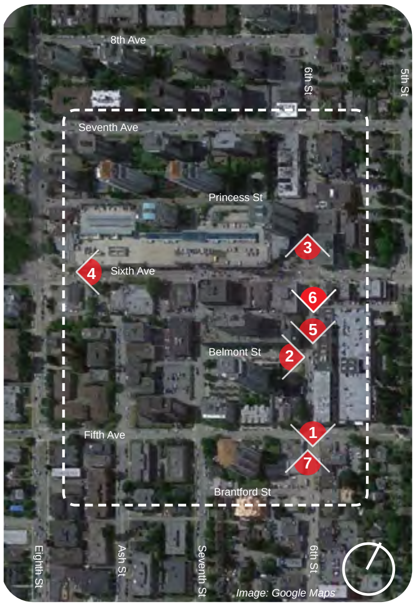
## Current Situation

### Uptown Today

Uptown serves as a secondary central district in New Westminster in its geographical centre point. The immediate vicinity around the intersection of 6th Ave and 6th Street is the focal point of this case study. 6th Street acts as a connector between Downtown New Westminster and the boundary with Burnaby, while 6th Ave connects Marine Way and Queensborough Bridge on the west with McBride Blvd on the east. The Royal City Centre shopping centre is located at this intersection, creating small urban plazas at 6th Ave & 6th St, as well as 6th Ave & 8th St.

The area is currently designated for a redesign as indicated in the '*Uptown Streetscape Vision (June 8, 2020)*' document. Here 6th St will be transformed to create a new visual identity, pedestrian areas are to be enhanced and expanded through re-allocation of road space, mostly in the curb lanes. The challenges that face the municipalities include trade-off's between transit and pedestrian priority, as well as dealing with the competing interest for curb space by different modes.

Regarding re-allocation of road space, since 2017 a small pop-up plaza has been piloted in Belmont street. In 2020, the Covid pandemic has been the impetus for a wide scale ephemeral re-allocation of curb space to sidewalk extensions and patio space along 6th St, as well as along 6th Ave alongside the Royal City Centre. To leverage these reconfigurations of street distribution, this study investigates the possibility of an interim phase (phase 1) to further consolidate and test configuration of space as well as allocation of new mobility uses, prior to advancing to phase 2, which would be the concretization of the '*Uptown Streetscape Vision*'.





6th St / 5th Ave intersection - facing northwest (pre-cvoid situation)


6th St / Belmont St - plaza - facing southwest (pre-cvoid situation)


6th St / 6th Ave intersection - facing southeast (pre-cvoid situation)


Covid-curbs - sidewalk extension
6th Ave facing northeast


Covid-curbs - seating area
6th St facing northwest


Covid-curbs - sidewalk extension
6th St facing northwest


Covid-curbs - patio
6th St facing southeast

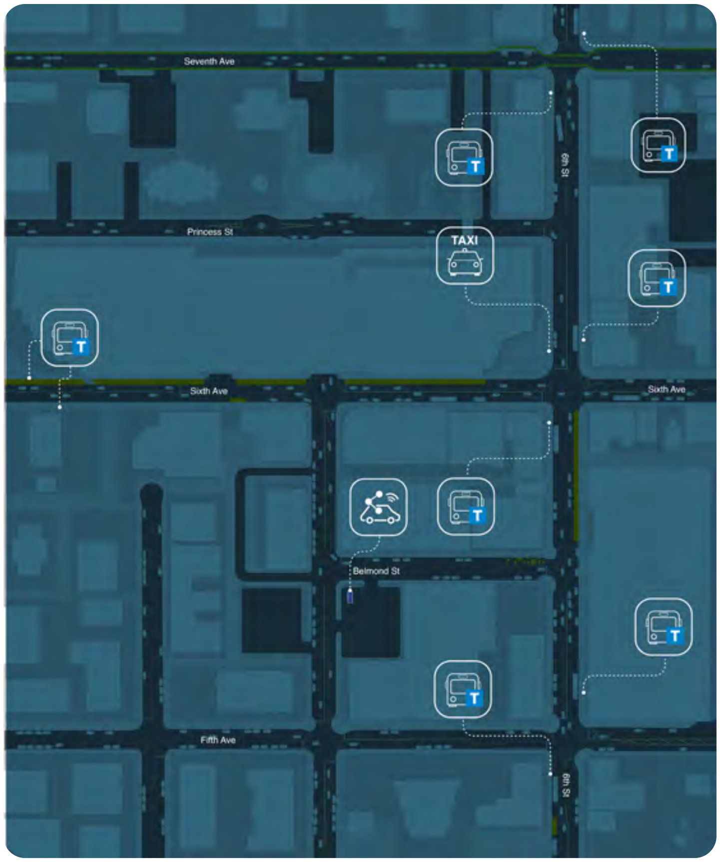

Proposal for 6th St between Belmont and 6th Ave
*Uptown Streetscape Vision - November 16, 2020*


Proposal for Belmont St with expanded plaza
*Uptown Streetscape Vision - November 16, 2020*

# NEW WESTMINSTER

0

## Phase 0 | Current Situation | *September 2020*


### PHYSICAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit**: Buses: 101, 105, 106, 155, N19.
- **Covid curbs**: Sidewalk extension along Royal City Centre on 6th Ave and small stretch on 6th St
- **Covid Patios**: 1 centralized on 6th St, 2 commercial patios
- **Plaza**: existing tactical pop-up plaza at Belmont St
  Food-trucks: ?
- **Bike-share**: None
- **Car-share**: 2 locations – Modo, Evo available in area
- Designated Taxi zone

"Blue Group" **Vehicular New Mobility**

- **PU-DO**: currently no area allocated
  Delivery of goods direct to addressee or at Canada post location
- **Car-share**: Modo: 1 location. Evo: available in the area

### VIRTUAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit**: real time bus times in various trip planner / navigation apps
- **Bike-share**: None

"Blue Group" **Vehicular New Mobility**

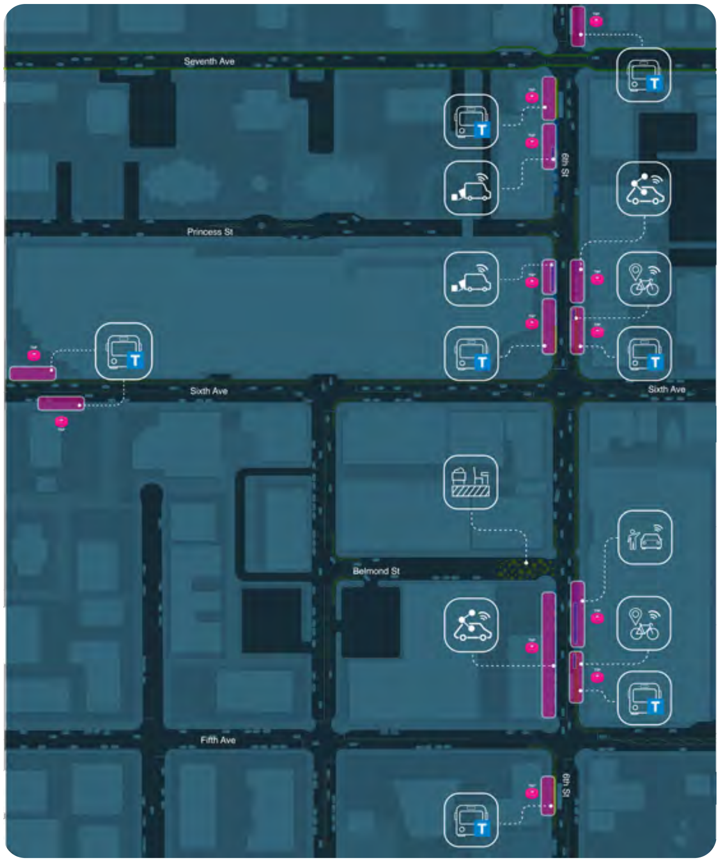
- **PU-DO** – Apps: Uber, Lyft, taxi apps. No ride-hail pick-up drop off restrictions or geofencing within area
- **E-com / delivery**: e-commerce and delivery services in silos. Food delivery apps available.
- **Car-share – Apps**: Modo - 1 connected location, Evo – available in the area
- **Parking Apps**: Some integration between fleets and individual parking apps (PayByPhone Business for fleets).
  Parking apps and EV-charging apps in silos

# NEW WESTMINSTER

1

## Phase 1 | Piloting

*1–2 years*


### PHYSICAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

- **Transit**: Bus bulbs on 6th St
- Sidewalk extension or public space activation and expansion of Covid curbs
- **Plaza**: consolidation of plaza with sidewalk extensions
- **Vision Zero**: safe intersections, simulation of phase 2 project in 'Uptown Streetscape Vision' document
- **Micromobility**: Bike-share and e-scooter stations adjacent to bus stops

*"Blue Group"* **Vehicular New Mobility**

- **PU-DO**: parklet area for passenger waiting + designated 3min zone / 1 location on 6th St / 1 location on 6th Ave
- **E-commerce**: parklet with unloading zone + delivery bike parking + designated 15min zone / 3 locations on 6th St / 1 location on 6th Ave
- **Car share**: designated zone / 2 locations on 6th St / 1 location on Belmont St

### VIRTUAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

- **Transit + Micromobility**: Pilot integration possibilities, for example through compass card or MaaS Pilots
- **Micromobility**: Trial of e-bike and e-scooter integration through single booking and payment system.
- **Civic space** to promote community engagement through business district and municipal website and social media, enabling booking location for community activities.
- **Mobile street commerce**: Testing of e-permits for street vendors and food trucks for booking locations
- **Vision Zero** – analytics from sensors for studying vehicle-pedestrian conflicts in intersections

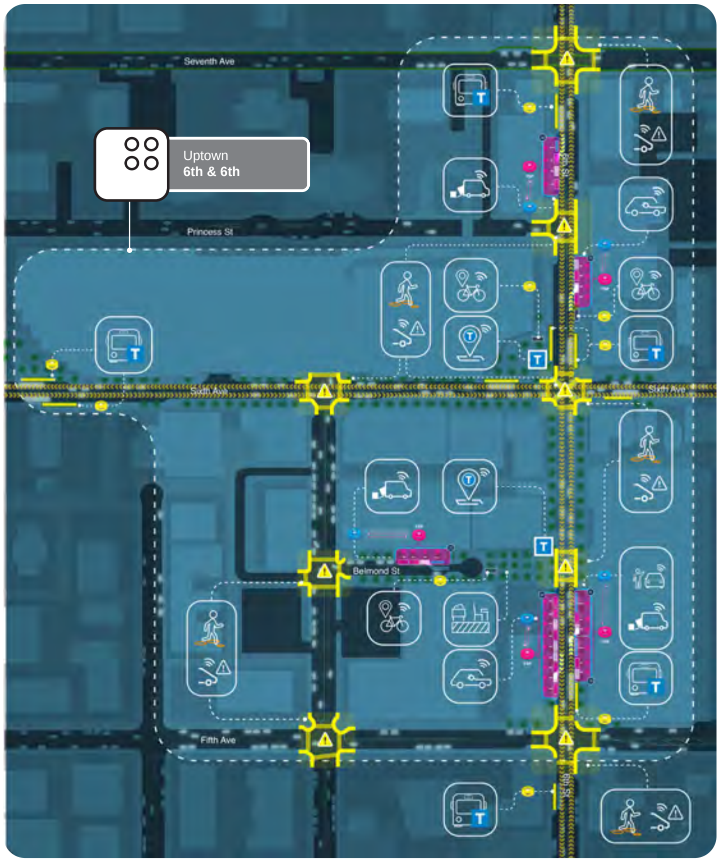
*"Blue Group"* **Vehicular New Mobility**

- **PU-DO**: Trial of Geofencing for ride-hail TNCs pick-up drop off to redirect to parklet within apps, integration of booking system
- **E-com** - trial of reservation of slots with booking apps, testing last-mile delivery technologies in e-com parklet
- **E-Fleet** – testing of grouping of different car-share services to single booking system / trial of dynamic curb space rent or contract between the existing and new fleet companies / testing of integration of parking and EV-charging apps with fleets

2

## Phase 2 | Concretization

*5–10 years*


## PHYSICAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit**: Concretization of bus bulbs in streetscape design
  Follow streetscape redesign as indicated in '*Uptown Streetscape Vision*' document
- Mobility Hub station totems at 6th & 6th plaza and Belmont plaza / totems with check-in stations, wayfinding integrated in streetscape
- **Vision Zero**: safe curbless intersections on 6th St. Implementation of safe intersections with sensors and V2I (Vehicle to Infrastructure) technology
- **Micromobility**: Expansion of bike-share and e-scooter stations adjacent to bus stops

"Blue Group" **Vehicular New Mobility**

- **PU-DO**: several locations, each including terminal with service kiosk and shelter, Mobility Hub wayfinding + designated 3min zone of several curb spaces
- **E-commerce**: several locations, each includes parklet with new uses (such as lockers or delivery bike facilities), 15min zone of designated curb space
- **E-Fleet**: several locations, each with designated 15+mins stopping zone for registered fleets, wayfinding, curbside EV charging docks

## VIRTUAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

Mobility Hub integration in city wide network

- **Transit**: MaaS ready transit integration with other connected modes
- **Civic space**: E-permits and scheduling for local community activities
- **Mobile street commerce**: E-permits for street vendors, food trucks and commercial public space use through booking of designated locations
- **Vision Zero** - Geofencing at intersection integrated with V2I real-time data and analytics
- **Vision Zero** - Geofencing along corridor coded with road regulations of speed limit and congestion charge.
  Congestion charge, LEZ (Low Emissions Zone), ZEZ (Zero Emissions Zone) enforcement through geofencing as well as sensors

"Blue Group" **Vehicular New Mobility**

Network integration of the different siloed groups from previous phases into a MaaS enabled system

- **PU-DO**: Redirect ride-hail activity within corridor geofence to terminal location, terminal integrated within Mobility Hub
- **E-com**: redirect e-com to parklet to dispatch last mile delivery
- **E-Fleet**: redirect fleets to designated areas
  Integrated EV charging and storage of vehicles mapped throughout the area

# NEW WESTMINSTER

## Overview

## PHYSICAL

The maps below show how the curb space can be holistically reconfigured within a specific defined zone, with transit as an anchor. There is consideration for different uses of new mobility, public space activation and vision zero initiatives for pedestrian safety.

**0** Current situation (September 2020)
*Today*

**1** Phase 1 - Piloting
*1–2 years*

**2** Phase 2 - Concretization
*5–10 years*

**3** Phase 3 - Autonomous
*25–35 years*

?

For this stage with a time frame of around 30 years (2050 for 2020), a Vision Statement document will be created and updated yearly (see chapter 3.2) with the following points of attention:

Adaptable infrastructure for Autonomous transit, shuttles, vans and ride hail, to create equilibrium between PU-DO Terminal and Transit terminal. Explore options in median strip of avenue.
Introduction of low-speed e-cargo bike lanes and cycle infrastructure
Curbless zones for flexible and dynamic allocation of uses throughout the 24h period
Deployment of communication infrastructure (5G, 6G, etc to accommodate IoT

Transit
Micromobility
Food-truck
Covid curbs
Covid Patios
Vision Zero
Totem
Plaza
PU-DO
E-commerce
Car-share

# NEW WESTMINSTER

## Overview

The maps below illustrate diagrammatically the virtual realm and connected new mobility elements as well as special virtual zoning and geofenced areas with special provisions. These measures are proposed to increase in time.

## VIRTUAL

**0**

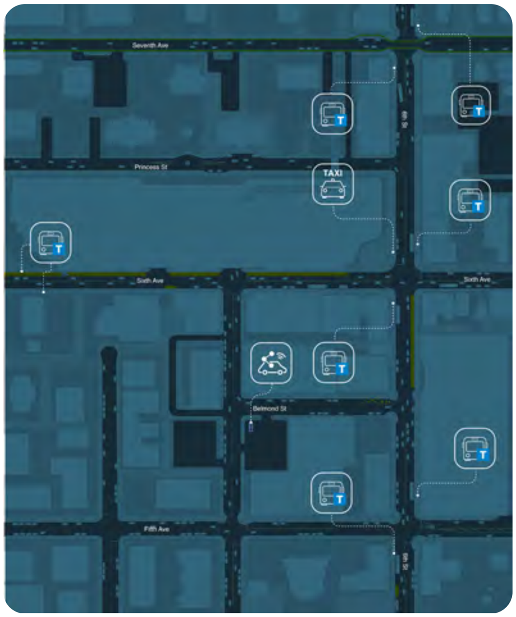
**Current situation**
***(September 2020)***
*Today*

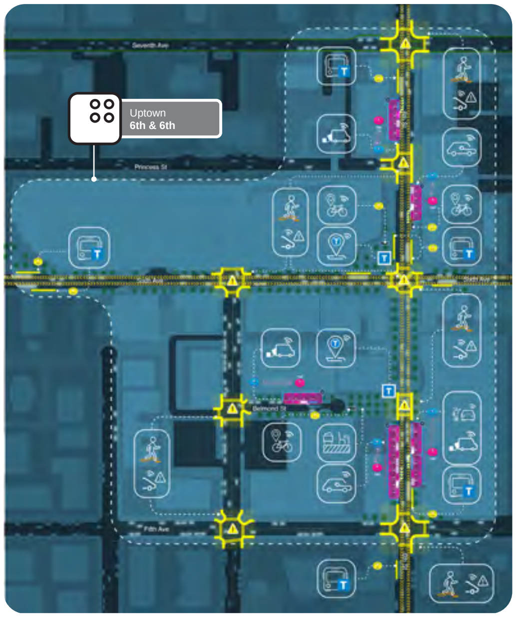
**1**

**Phase 1 - Silos**
*1–2 years*

**2**

**Phase 2 - Network**
*5–10 years*






For this stage with a time frame of around 30 years (2050 for 2020), a Vision Statement document will be created and updated yearly (see chapter 3.2) with the following points of attention:

MaaS integrated network within an eco-sytem platform of mobility management and ground traffic control
Geofencing and geo-zoning as a city-wide / region-wide strategy
EV charging integrated as part of energy internet to manage surcharge and electricity grid
Data exhaust and data management within a cohesive integrated policy framework under federal and municipal oversight

**?**

**3**

**Phase 3 - Ecosystem**
*25–35 years*

- Transit
- Micromobility
- Food-trucks
- Vision Zero
- Totem
- Plaza
- PU-DO
- E-commerce
- Car-share

# 5.2.5
## Case Five

**5 Coquitlam**
City Centre


### Mobility Hub Typology

*See Chapter 4.2 for more information on Mobility Hub typologies*

As part of a city-wide network of interconnected Mobility Hubs, ‘Coquitlam City Centre’ has the potential to be categorized as an *Urban Centre Zone* (see 4.2) with transit through a direct Skytrain connections to Vancouver, Burnaby and elsewhere in the transit network. Eventually this zone can include 3 Skytrain stations (Coquitlam Central, Lincoln, Lafarge Lake-Douglas), each with a *Mass Transit Mobility Hub*, as well as a *Shopping Centre Mobility Hub* at Coquitlam Centre.

*Glen Drive*
*Image: Y Fogelson (Aug 2020)*

Macro Vision

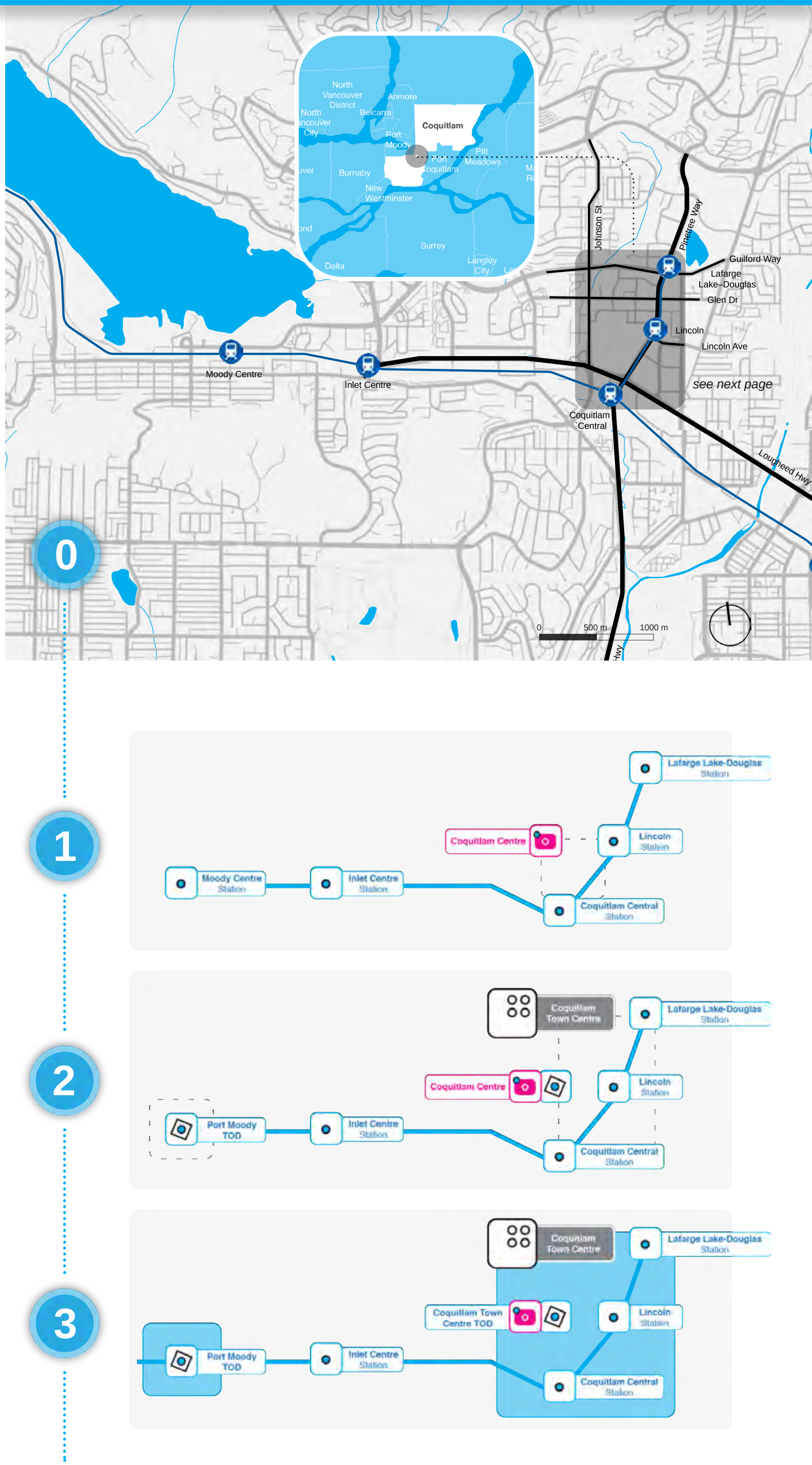
## Macro Vision

The vision of a city-wide network of interconnected Mobility Hubs can be achieved in an incremental gradual progression. Using the *Transitional Design Methodology* (from Chapter 3), we can imagine three phases in the timeline:

1. The first phase being the immediate action in the time frame of 1-2 years. Here, two typologies can be tested, namely the *Mass Transit Mobility Hub* (see 4.2) at Lincoln station and a *Shopping Centre Mobility Hub* (see 4.2) at Coquitlam Centre. Other *Mass Transit Mobility Hubs* along the SkyTrain line (Inlet Centre, Moody Centre, etc.) are trialed. At this point each location is a separate test site and new geofencing and connectivity technologies can be trialed at a local level. New mobility uses and services can be tested and expanded within this pilot.

2. The second phase represents the mid range (5-10 years) concretization of pilots done in the first phase. Here we can imagine the expansion of the test area to become a functioning Urban Centre Zone that included 3 Skytrain stations (Coquitlam Central, Lincoln, Lafarge Lake-Douglas), each with a *Mass Transit Mobility Hub*, as well as a *Shopping Centre Mobility Hub* at Coquitlam Centre. In this phase, the redevelopment plans of Coquitlam City Centre indicated in the '*Draft City Centre Plan (Sept 14, 2020)*' are taken into account. The new street network, replacing parts of Coquitlam Centre and its parking lot areas, can be constructed with new mobility solutions incorporated in the streetscape design. In this phase, new mobility services can be integrated within a MaaS enabled network.

3. In this visionary phase, in the time-frame of around 30 years, Coquitlam City Centre can be consolidated and expanded as an Urban Centre Zone. It can become an integral part of the city network of connected mobility hubs, adjacent to Port Moody *Transport Oriented Development Mobility Hub* (See 4.2). The network functions like a rapid transit system, portrayed by a subway system style map as its user interface.



# COQUITLAM

## Current Situation

### Coquitlam Today

Over the past two decades, Coquitlam City Centre has transformed from a suburban North American typology of a regional mall, into a transit-oriented development with an urban typology of built form and streetscape. Currently, this is most evident around Glen Drive and the area north of Northern Way. However, over the next decade, according to the '*Draft City Centre Plan (Sept 14, 2020)*' document, the Coquitlam Centre will be eventually transformed into an urban typology, built in phases occupying the parking lots around the shopping centre, as well as reconfiguration of large parts of the shopping centre. This area is unique, as it is served by three SkyTrain stations and has the potential to justify the use of shared mobility, currently largely absent. Furthermore, the use of Covid curbs is also absent, compared to some of the other case studies.

In this study, there is an investigation into how small scale local new mobility initiatives in curb spaces and parking lot area can serve as a testing ground for future implementation of a new street network which already incorporates some of the ideas of new mobility provisions towards a connected, shared and more sustainable modes. The advantage here lies in the fact that a complete new infrastructure can be designed from the ground up, welcoming future residents and businesses of the proposed new city centre.



Glen Dr (at Pacific St, curb space parking, cycle path, facing east


The High St, curbless curb space, paid parking, facing north


Proposal of new streetscape, Character streets and street frontage types. *Draft City Centre Area Plan - Sept 14, 2020*



Northern Ave, curb space (top), Lincoln Station approach (bottom) facing east

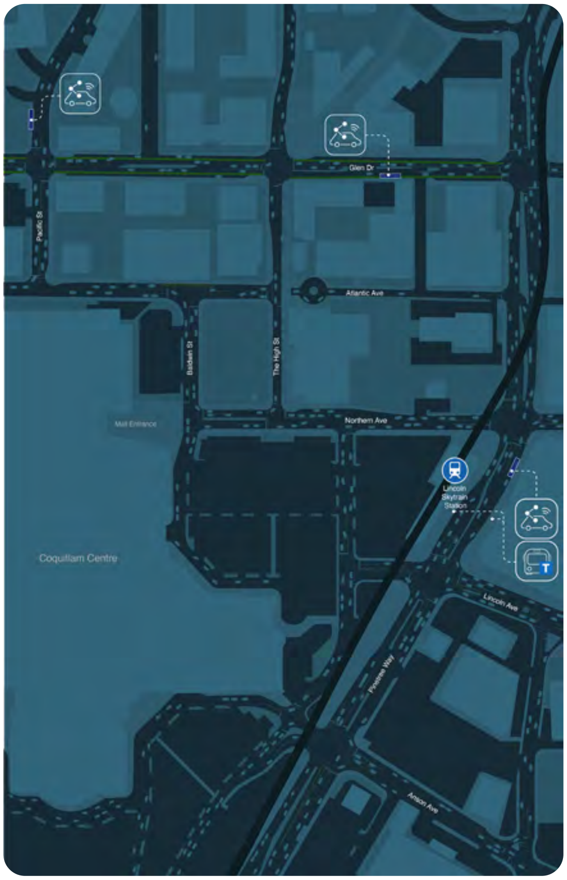

Proposal of new streetscape


Proposal of new streetscape

# COQUITLAM

0

## Phase 0 | Current Situation | *September 2020*


## PHYSICAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit**: Lincoln SkyTrain station, Buses: 160, 183, 186, 188, 191, N9
- **Vision Zero**: Safe intersection (Atlantic Ave / Baldwin St)
- **Covid curbs / patios**: none
- **Food-trucks**: ?
- **Bike-share**: None

"Blue Group" **Vehicular New Mobility**

- **PU-DO**: currently no area allocated
  Delivery of goods direct to addressee or at Canada post location
- **Car-share**: 3 location – Modo, Evo not available in area

## VIRTUAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit**: real time Skytrain and bus times in various trip planner / navigation apps
- **Bike-share**: None

"Blue Group" **Vehicular New Mobility**

- **PU-DO** – Apps: Uber, Lyft, taxi apps. No ride-hail pick-up drop off restrictions or geofencing within area
- **E-com / delivery**: e-commerce and delivery services in silos. Food delivery apps available.
- **Car-share – Apps**: Modo - 3 connected locations, Evo – not available in the area
- **Parking Apps**: Some integration between fleets and individual parking apps (PayByPhone Business for fleets).
  Parking apps and EV-charging apps in silos

# 1 Phase 1 | Piloting

*1–2 years*

## PHYSICAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit + micromobility**: Bike-share and e-scooter facilities in Lincoln station
- **Plaza**: Pop-up plaza connecting Skytrain station and entrance to Coquitlam Centre with food trucks and micromobility facilities
- **Vision Zero**: Safe intersection (Atlantic Ave / Baldwin St)

"Blue Group" **Vehicular New Mobility**

- **PU-DO**: parklet area for passenger waiting + designated 3min zone / 1 location on Northern Ave
- **E-commerce**: parklet with unloading zone + delivery bike parking + designated 15min zone / 2 locations
- **Car share**: designated zone / 4 locations

## VIRTUAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

- **Transit + Micromobility**: Pilot integration possibilities, for example through compass card or MaaS Pilots
- **Micromobility**: Trial of e-bike and e-scooter integration through single booking and payment system.
- **Civic space** to promote community engagement through business district and municipal website and social media, enabling booking location for community activities.
- **Mobile street commerce**: Testing of e-permits for street vendors and food trucks for booking locations
- **Vision Zero** – analytics from sensors for studying vehicle-pedestrian conflicts in intersections

"Blue Group" **Vehicular New Mobility**

- **PU-DO**: Trial of Geofencing for ride-hail TNCs pick-up drop off to redirect to parklet within apps, integration of booking system
- **E-com** - trial of reservation of slots with booking apps, testing last-mile delivery technologies in e-com parklet
- **E-Fleet** – testing of grouping of different car-share services to single booking system / trial of dynamic curb space rent or contract between the existing and new fleet companies / testing of integration of parking and EV-charging apps with fleets

2

## Phase 2 | Concretization

*5–10 years*


## PHYSICAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

- Redevelopment of Coquitlam Centre area with new configuration of street network following 'Draft City Area Plan – Sept 14 2020' document
- Mobility Hub station totems at Lincoln Station and mall entrance plaza / totems with check-in stations, wayfinding integrated in streetscape
- **Vision Zero**: safe curbless intersections along The High St. Implementation of safe intersections with sensors and V2I (Vehicle to Infrastructure) technology
- **Micromobility**: Cycle infrastructure network connecting Lincoln station. Expansion of bike-share and e-scooter stations

*"Blue Group"* **Vehicular New Mobility**

- Lonsdale Ave redesign to include one-way vehicular access road southbound with curb space bulbs for new mobility uses (see below)
- **PU-DO**: several locations, each including terminal with service kiosk and shelter, Mobility Hub wayfinding + designated 3min zone of several curb spaces
- **E-commerce**: several locations, each includes parklet with new uses (such as lockers or delivery bike facilities in correlation with adjacent cycle infrastructure), 15min zone of designated curb space
- **E-Fleet**: several locations, each with designated 15+mins stopping zone for registered fleets, wayfinding, curbside EV charging docks

## VIRTUAL

*"Yellow Group"* **Transit + Active + Activation + Micromobility**

- Mobility Hub integration in city wide network
- **Transit**: MaaS ready transit integration with other connected modes
- **Civic space**: E-permits and scheduling for local community activities
- **Mobile street commerce**: E-permits for street vendors, food trucks and commercial public space use through booking of designated locations
- **Vision Zero** - Geofencing at intersection integrated with V2I real-time data and analytics
- **Vision Zero** - Geofencing along corridor coded with road regulations of speed limit and congestion charge.
  Congestion charge, LEZ (Low Emissions Zone), ZEZ (Zero Emissions Zone) enforcement through geofencing as well as sensors

*"Blue Group"* **Vehicular New Mobility**

- Network integration of the different siloed groups from previous phases into a MaaS enabled system
- **PU-DO**: Redirect ride-hail activity within corridor geofence to terminal location, terminal integrated within Mobility Hub
- **E-com**: redirect e-com to parklet to dispatch last mile delivery
- **E-Fleet**: redirect fleets to designated areas
- Integrated EV charging and storage of vehicles mapped throughout the area

## Overview

# PHYSICAL

The maps below show how the curb space can be holistically reconfigured within a specific defined zone, with transit as an anchor. There is consideration for different uses of new mobility, public space activation and vision zero initiatives for pedestrian safety.

**0**

**Current situation**
*(September 2020)*

*Today*

**1**

**Phase 1 - Piloting**

*1–2 years*

**2**

**Phase 2 - Concretization**

*5–10 years*

**3**

?

**Phase 3 - Autonomous**

*25–35 years*

For this stage with a time frame of around 30 years (2050 for 2020), a Vision Statement document will be created and updated yearly (see chapter 3.2) with the following points of attention:

Adaptable infrastructure for Autonomous transit, shuttles, vans and ride hail, to create equilibrium between PU-DO Terminal and Transit terminal. Explore options in median strip of avenue.
Introduction of low-speed e-cargo bike lanes and cycle infrastructure
Curbless zones for flexible and dynamic allocation of uses throughout the 24h period
Deployment of communication infrastructure (5G, 6G, etc to accommodate IoT

Transit
Micromobility
Food-truck
Covid curbs
Covid Patios
Vision Zero
Totem
Plaza
PU-DO
E-commerce
Car-share

## Overview

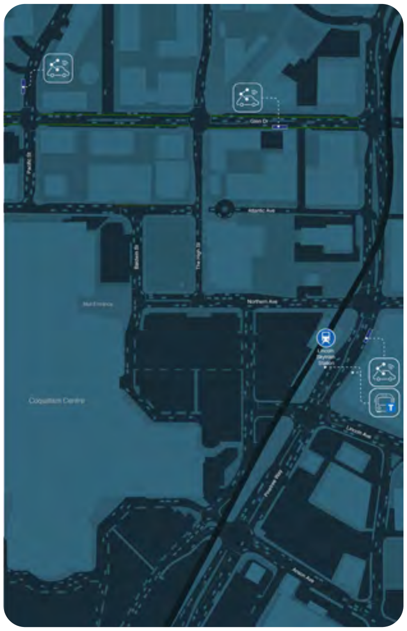
The maps below illustrate diagrammatically the virtual realm and connected new mobility elements as well as special virtual zoning and geofenced areas with special provisions. These measures are proposed to increase in time.

# VIRTUAL

**0**

**Current situation**
*(September 2020)*

*Today*



**1**

**Phase 1 - Silos**

*1–2 years*

**2**

**Phase 2 - Network**

*5–10 years*


For this stage with a time frame of around 30 years (2050 for 2020), a Vision Statement document will be created and updated yearly (see chapter 3.2) with the following points of attention:

MaaS integrated network within an eco-sytem platform of mobility management and ground traffic control
Geofencing and geo-zoning as a city-wide / region-wide strategy
EV charging integrated as part of energy internet to manage surcharge and electricity grid
Data exhaust and data management within a cohesive integrated policy framework under federal and municipal oversight

**?**

**3**

**Phase 3 - Ecosystem**

*25–35 years*

Transit
Micromobility
Food-trucks
Vision Zero
Totem
Plaza
PU-DO
E-commerce
Car-share

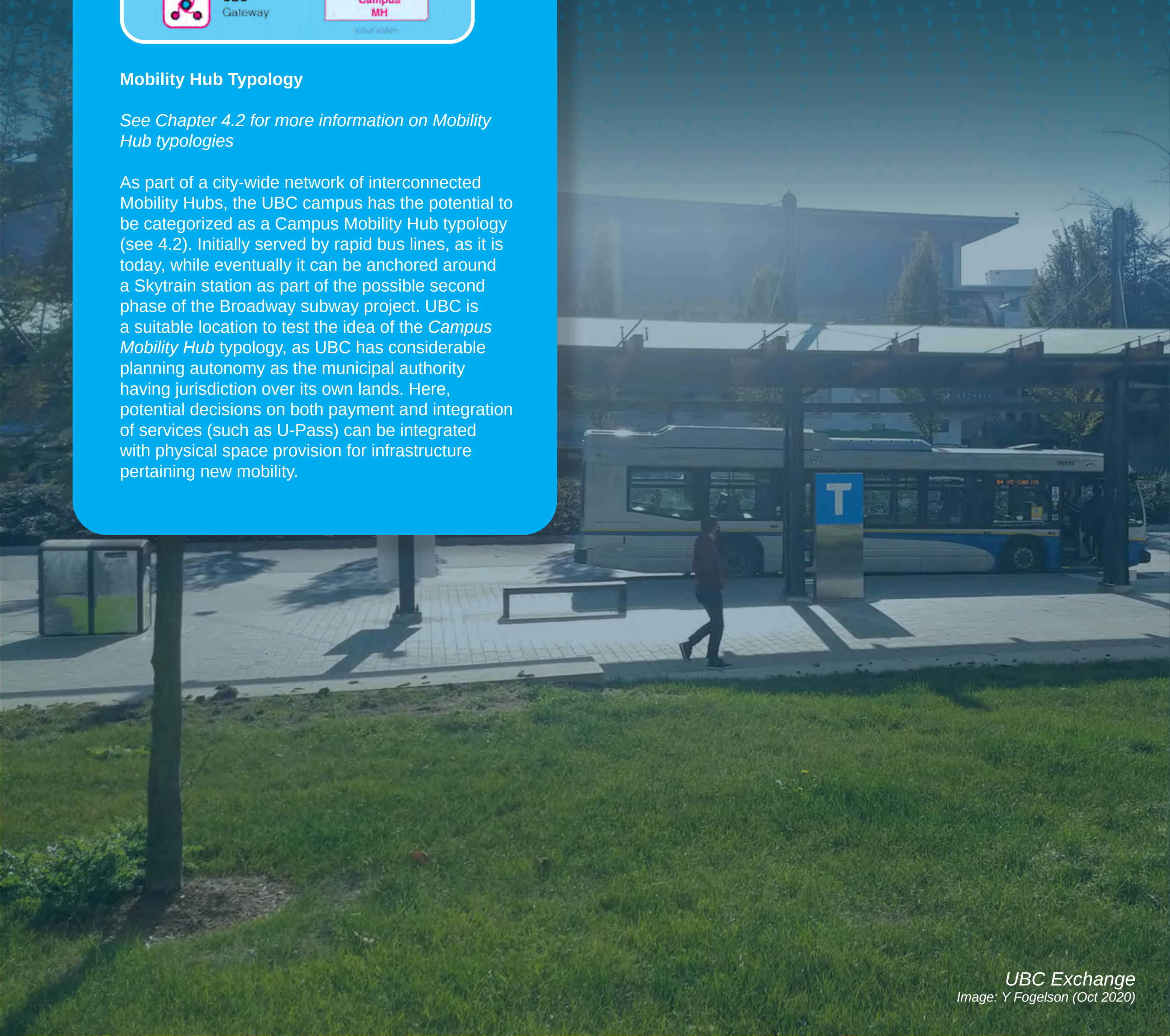
# 5.2.6
## Case Six

**6 UBC**
Campus Gateway


### Mobility Hub Typology

*See Chapter 4.2 for more information on Mobility Hub typologies*

As part of a city-wide network of interconnected Mobility Hubs, the UBC campus has the potential to be categorized as a Campus Mobility Hub typology (see 4.2). Initially served by rapid bus lines, as it is today, while eventually it can be anchored around a Skytrain station as part of the possible second phase of the Broadway subway project. UBC is a suitable location to test the idea of the *Campus Mobility Hub* typology, as UBC has considerable planning autonomy as the municipal authority having jurisdiction over its own lands. Here, potential decisions on both payment and integration of services (such as U-Pass) can be integrated with physical space provision for infrastructure pertaining new mobility.



*UBC Exchange*
*Image: Y Fogelson (Oct 2020)*

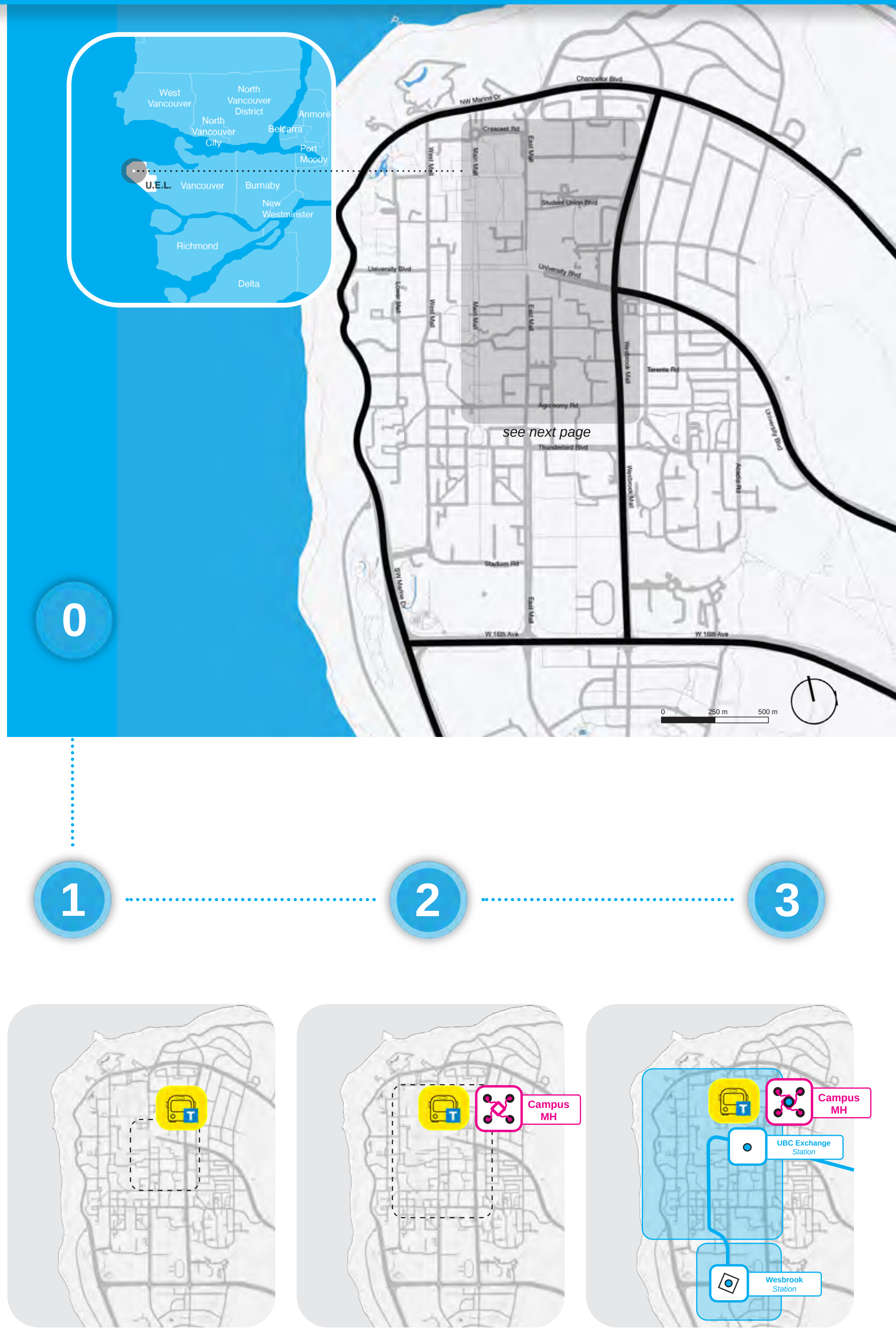
## Macro Vision

The vision of a city-wide network of interconnected Mobility Hubs can be achieved in an incremental gradual progression. Using the Transitional Design Methodology (from Chapter 3), we can imagine three phases in the timeline:

1. The first phase being the immediate action in the time frame of 1-2 years. Here, the Campus Mobility Hub (see 4.2) can be tested. At this point the UBC area is a separate test site and not yet connected to other test sites in the city. New geofencing and connectivity technologies can be trialed at a local level. New mobility uses and services can be tested and expanded within this pilot, with a focus on last-mile micromobility options and AV shuttles.

2. The second phase represents the mid range (5-10 years) concretization of pilots done in the first phase. Here we can imagine the expansion of the test area to become a functioning Campus Mobility Hub built around the existing UBC Exchange Bus terminal. We can imagine the expansion of the AV shuttle network. In this phase, new mobility services can be integrated within a MaaS enabled network.

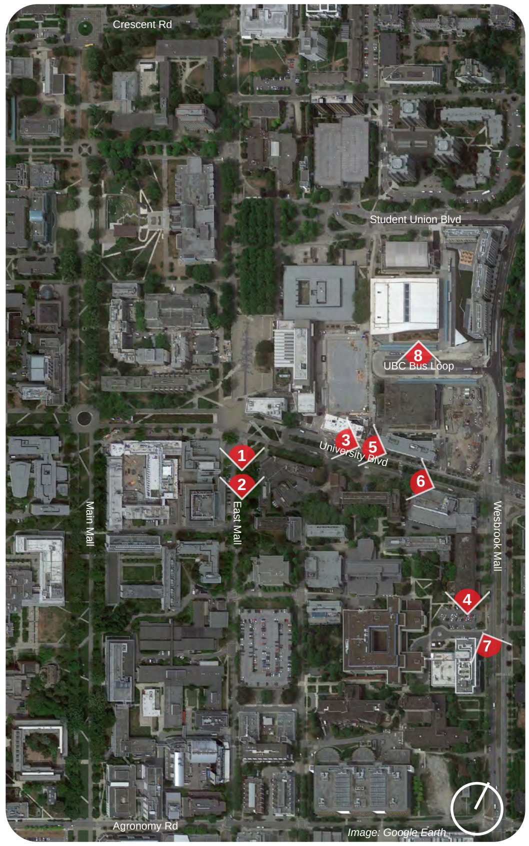
3. In this visionary phase, in the time-frame of around 30 years, the Campus Mobility Hub can be expanded to include the main campus area. Here it is anticipated that the Broadway subway will continue until UBC with a station at UBC Exchange and a potential station at Wesbrook Village, which can function as a New TOD Mobility Hub. The UBC area can become an integral part of the city network of connected mobility hubs. The network functions like a rapid transit system, portrayed by a subway system style map as its user interface.



# Current Situation

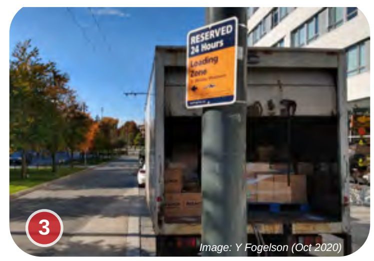
## UBC Today

Currently UBC is a university related hub for employment, education, as well as a growing residential area. It is located at a distance of approximately 10km from Vancouver's city centre and can be characterized as an isolated end-of-the-line hub, within the metropolitan area, due to its geographic enclosure between the Straight of Georgia and Pacific Spirit Park. The campus is well served by express buses to the rest of the city, transit terminates around the UBC Exchange which is located in a centrally accessible area within the campus. Although in the past decade the internal area has become increasingly more pedestrian oriented, large parts of the campus lie beyond a 5-10min walkable distance from the transit services (beyond 500m radius). Micromobility options such as the dockless HOPR bike-share system is not integrated with provisions such as the U-Pass or Compass card. Currently, separated dedicated cycle paths throughout campus are limited, especially internally in the heart of campus west of Wesbrook Mall.



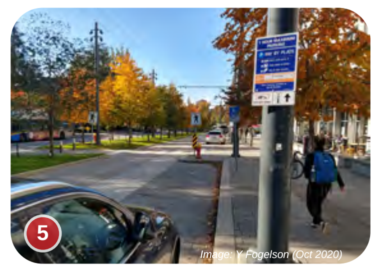

Car-share designated spaces - East Mall

PU-DO zone, East Mall



Loading zone, University Blvd

HOPR bike-share designated dockless parking area



On-street parking, University Blvd

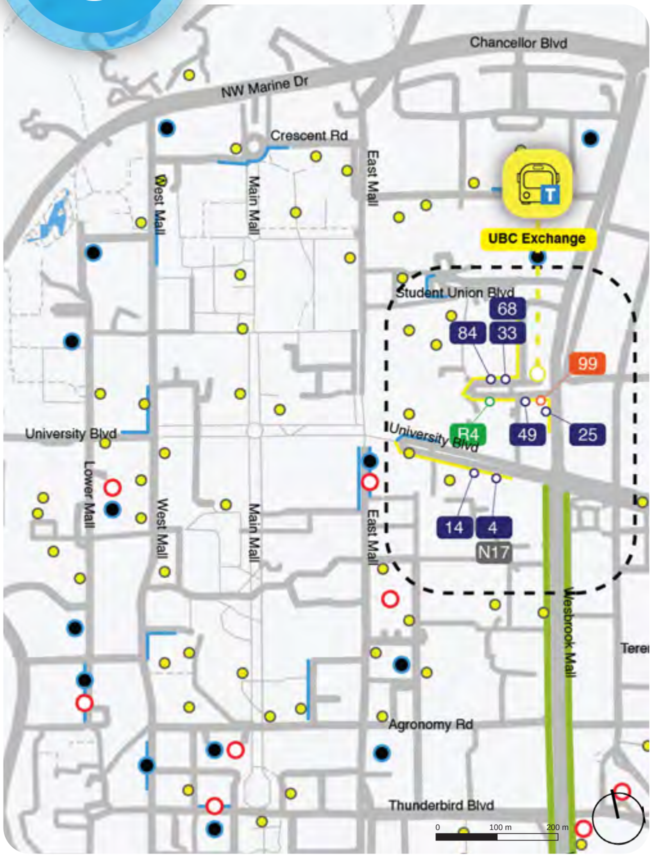
Curb lane on University Blvd - bus end/start journey

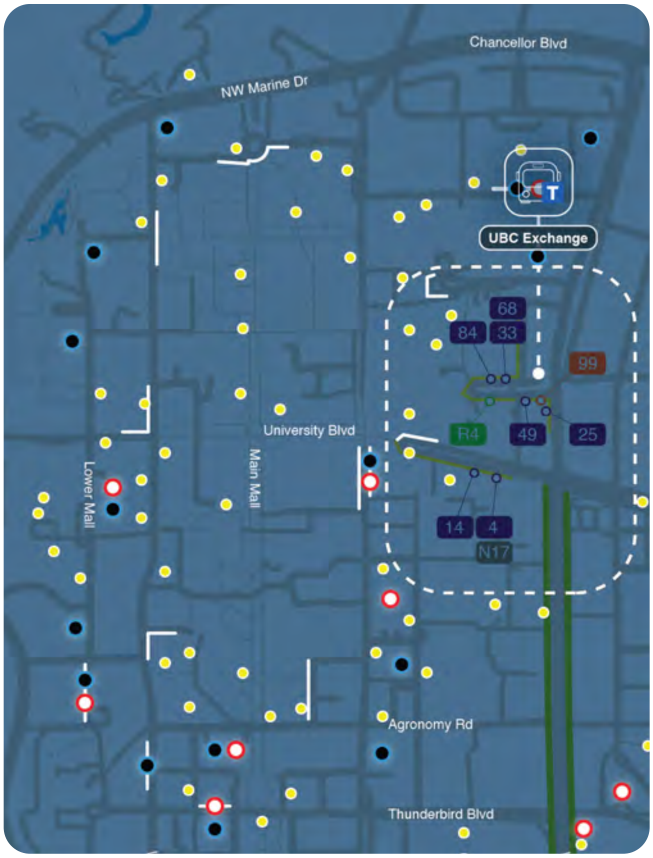
Loading zone, bike lane, bus lane, Wesbrook Mall

UBC Exchange Bus loop

0

## Phase 0 | Current Situation | *October 2020*




## PHYSICAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

**Transit**: UBC Exchange: 99, R4, 49, 84, 44, 33, 68, 25 / University Blvd: 4, 14 N17

Bus curb

**Bike-share**: About 200 HOPR bikes through-out the campus with 80+ designated dockless parking location

"Blue Group" **Vehicular New Mobility**

**PU-DO**: 3min drop-off zones throughout campus

15min loading zones, delivery of goods direct to addressee

**Car-share**: Modo and Evo, several locations throughout campus

## VIRTUAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

**Transit**: real time bus times in various trip planner / navigation apps

**Bike-share**: HOPR isolated app

"Blue Group" **Vehicular New Mobility**

**PU-DO** – Apps: Uber, Lyft, taxi apps. Ride-hail restrictions on drop off locations being tested through geofencing within the area,

**E-com** / delivery: e-commerce and delivery services in silos. Food delivery apps available.

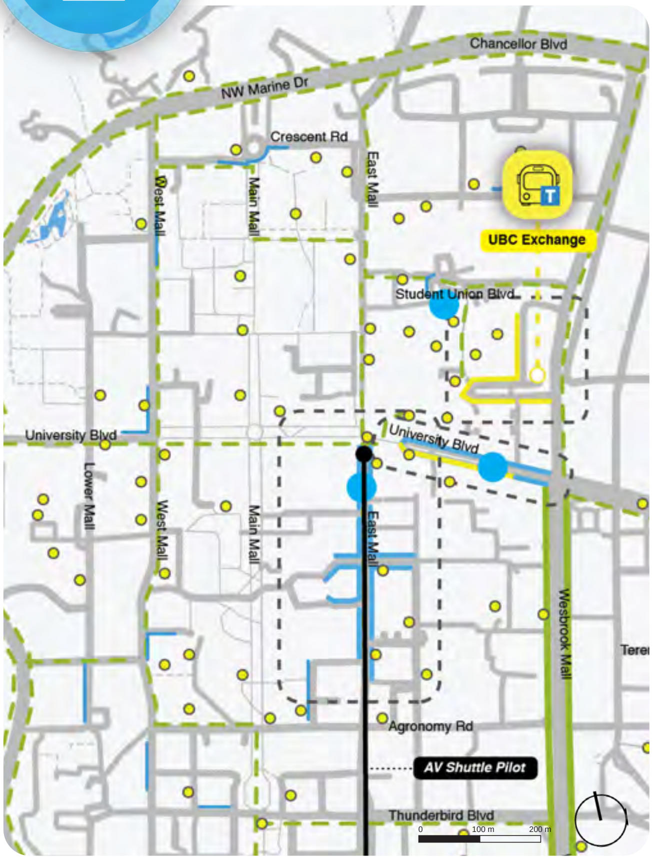
**Car-share** – Apps: Modo & Evo - several connected locations, available in the area

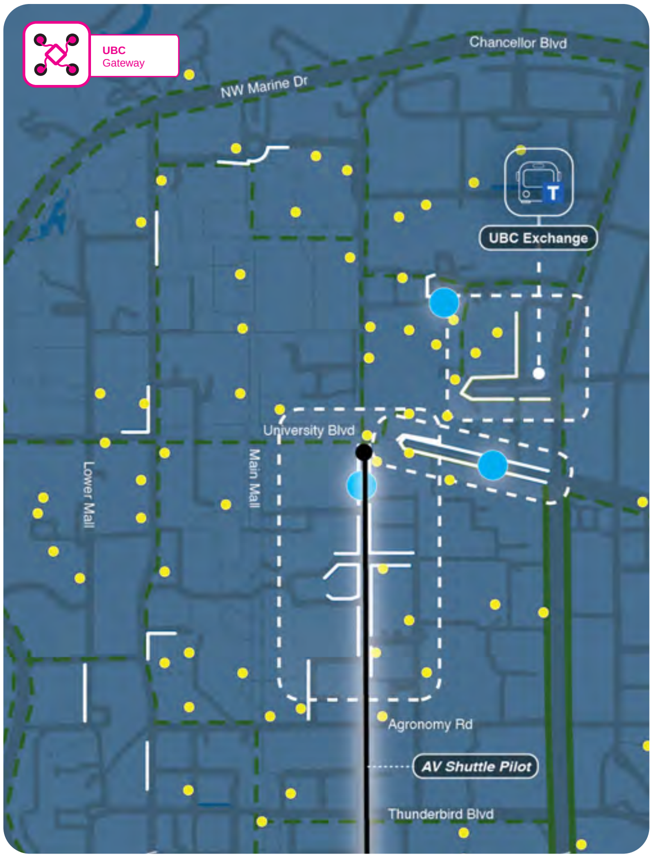
Parking Apps: Parking apps and EV-charging apps in silos

1

## Phase 1 | Piloting

*1–2 years*




### PHYSICAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

Isolated pilot locations: UBC Exchange, University Blvd, East Mall

Wayfinding and visual identity to be expanded in this phase to unify visual identity of UBC Exchange with other new mobility services through campus

UBC Exchange with real-time transit info screens, testing transit totems prototyping

**Transit+ Micromobility**: UBC Exchange, University Blvd, more direct physical integration of micromobility docking stations, bike-share adjacent to bus loop

**Micromobility infrastructure**: piloting tactical physical segregation in pedestrian areas for pedestrian and cyclist safety, piloting of additional micromobility services.

**AV Shuttle:** Testing of AV shuttle services in pilot area on East Mall

**Vision Zero**: implementation of road safety/monitoring technologies on East Mall as test site.

"Blue Group" **Vehicular New Mobility**

**PU-DO** (within pilot zone): parklet area for passenger waiting + designated 3min zone / 1 location on University Blvd (westbound) / several locations on East Mall

parklet area for passenger waiting + designated 3min zone / 1 location on University Blvd (westbound) / several locations on East Mall

**E-commerce** (within pilot zone): unloading zone + delivery bike parking + designated 15min zone / 1 location on University Blvd (westbound) / several locations on East Mall

**Car- share** (within pilot zone): designated zones / several locations along East Mall. Additional locations in parkades and building parking garages (not indicated in map)

### VIRTUAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

**Transit + Micromobility**: Pilot integration possibilities, for example through compass card or MaaS Pilots

**Micromobility**: Trial of HOPR bike integration in current programs such as U-Pass or Compass card. Trail of new e-bike and e-scooter integration through single booking and payment system.

**Civic space** to promote community/student engagement on campus through campus website/social media, enabling booking location for communal or non-profit activities.

**Mobile street commerce**: Testing of e-permits for street vendors and food trucks for booking locations

**Vision Zero**: analytics from sensors for studying vehicle-pedestrian conflicts and counts in intersections and designated test zones

"Blue Group" **Vehicular New Mobility**

**PU-DO**: Trial of Geofencing for ride-hail TNCs pick-up drop off to redirect to parklet within apps, integration of booking system

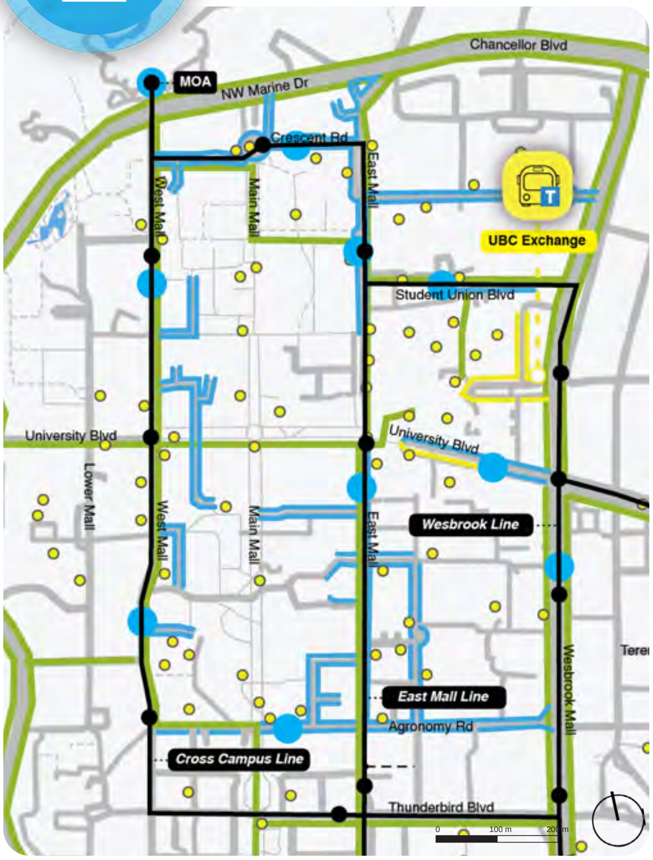
**E-com** - trial of reservation of slots with booking apps, testing last-mile delivery technologies in e-com parklet

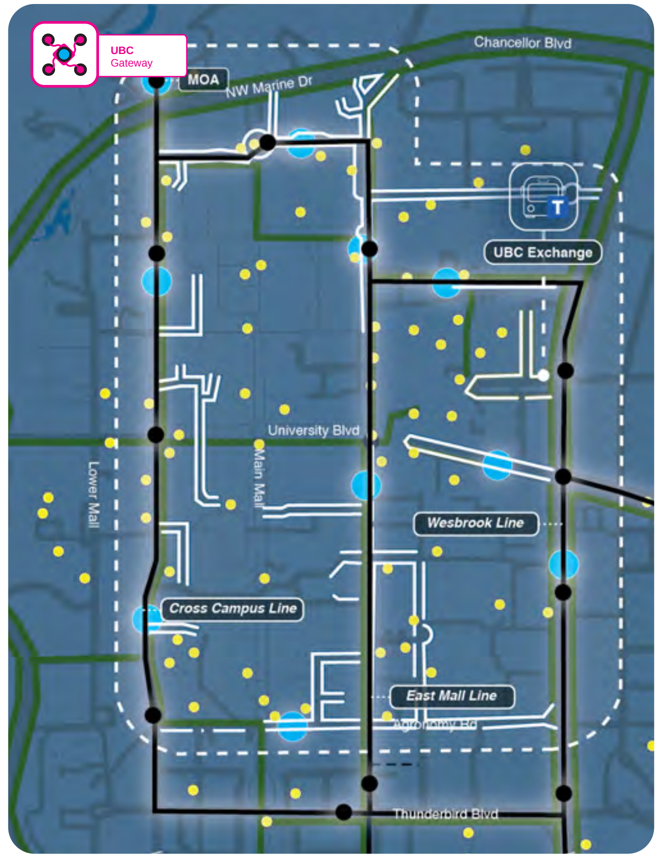
**E-Fleet** – testing of grouping of different car-share services to single booking system / trial of dynamic curb space rent or contract between the existing and new fleet companies / testing of integration of parking and EV-charging apps with fleets

2

## Phase 2 | Concretization

*5–10 years*




## PHYSICAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

Connected *Campus Mobility Hub* pilot area: Between Wesbrook Mall (NE), Agronomy Rd (SE), West Mall (SW), Crescent Rd (NW).

Mobility Hub station totems at UBC Exchange, University Blvd & East Mall / totems with check-in stations, wayfinding integrated in streetscape

**Transit**: consolidation of transit and integration options with other modes

**Vision Zero**: safe, low-speed streets and intersections within MH area. Implementation of safe intersections with sensors and V2I (Vehicle to Infrastructure) technology

**Micromobility**: Concretization of separated cycle paths in campus tested in phase 1. Incorporation of city-wide/regional programs (with focus on e-bike share)

**AV Shuttle:** Concretization of shuttle services and testing of AV shuttle services: ***East Mall Line, Wesbrook Line, Cross Campus Line***

"Blue Group" **Vehicular New Mobility**

**PU-DO**: several locations, each including terminal with service kiosk and shelter, Mobility Hub wayfinding + designated 3min zone of several curb spaces

**E-commerce**: several locations, each includes parklet with new uses (such as lockers or delivery bike facilities), 15min zone of designated curb space

**E-Fleet**: several locations, each with designated 15+mins stopping zone for registered fleets, wayfinding, curbside EV charging docks. Additional locations in parkades and building parking garages (not indicated in the map)

## VIRTUAL

"Yellow Group" **Transit + Active + Activation + Micromobility**

Mobility Hub integration in city wide network

**Transit**: MaaS ready transit integration with other connected modes

**Civic space**: E-permits and scheduling and allocating local community activities on campus

**Mobile street commerce**: E-permits for street vendors, food trucks and commercial public space use through booking of designated locations

**Vision Zero** - Geofencing at intersection integrated with V2I real-time data and analytics

**Vision Zero** - Geofencing in test zone coded with road regulations of speed limit and congestion charge.

Congestion charge, LEZ (Low Emissions Zone), ZEZ (Zero Emissions Zone) enforcement through geofencing as well as sensors

"Blue Group" **Vehicular New Mobility**

Network integration of the different siloed groups from previous phases into a MaaS enabled system

**PU-DO**: Redirect ride-hail activity within corridor geofence to terminal location, terminal integrated within Mobility Hub

**E-com**: redirect e-com to parklet to dispatch last mile delivery

**E-Fleet**: redirect fleets to designated areas

Integrated EV charging and storage of vehicles mapped throughout the area

## Overview

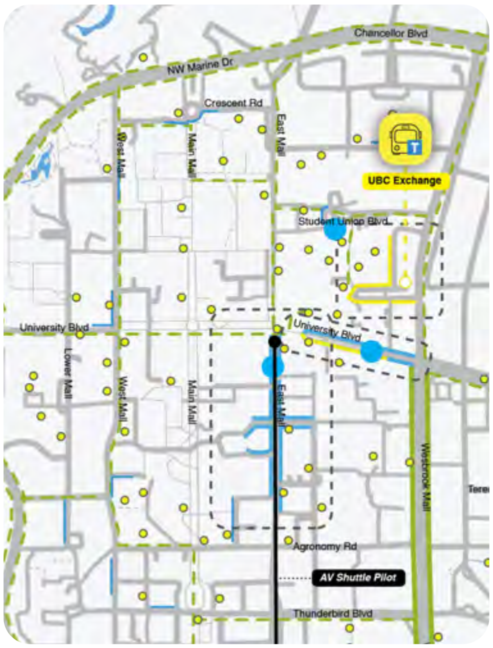
# PHYSICAL

The maps below show how the curb space can be holistically reconfigured within a specific defined zone, with transit as an anchor. There is consideration for different uses of new mobility, public space activation and vision zero initiatives for pedestrian safety.

**0** — **Current situation** *(September 2020)*

**1** — **Phase 1 - Piloting**

**2** — **Phase 2 - Concretization**



**3** — **?**

**Phase 3 - Autonomous**

For this stage with a time frame of around 30 years (2050 for 2020), a Vision Statement document will be created and updated yearly (see chapter 3.2) with the following points of attention:

Adaptable infrastructure for Autonomous transit, shuttles, vans and ride hail, to create equilibrium between PU-DO Terminal and Transit terminal. Explore options in median strip of avenue.
Introduction of low-speed e-cargo bike lanes and cycle infrastructure
Curbless zones for flexible and dynamic allocation of uses throughout the 24h period
Deployment of communication infrastructure (5G, 6G, etc to accommodate IoT

Transit
Bus Curb
Micromobility
AV Shuttle
Piloting Micromobility
Micromobility
PU-DO
E-commerce
E-Fleet
Car-share

## Overview

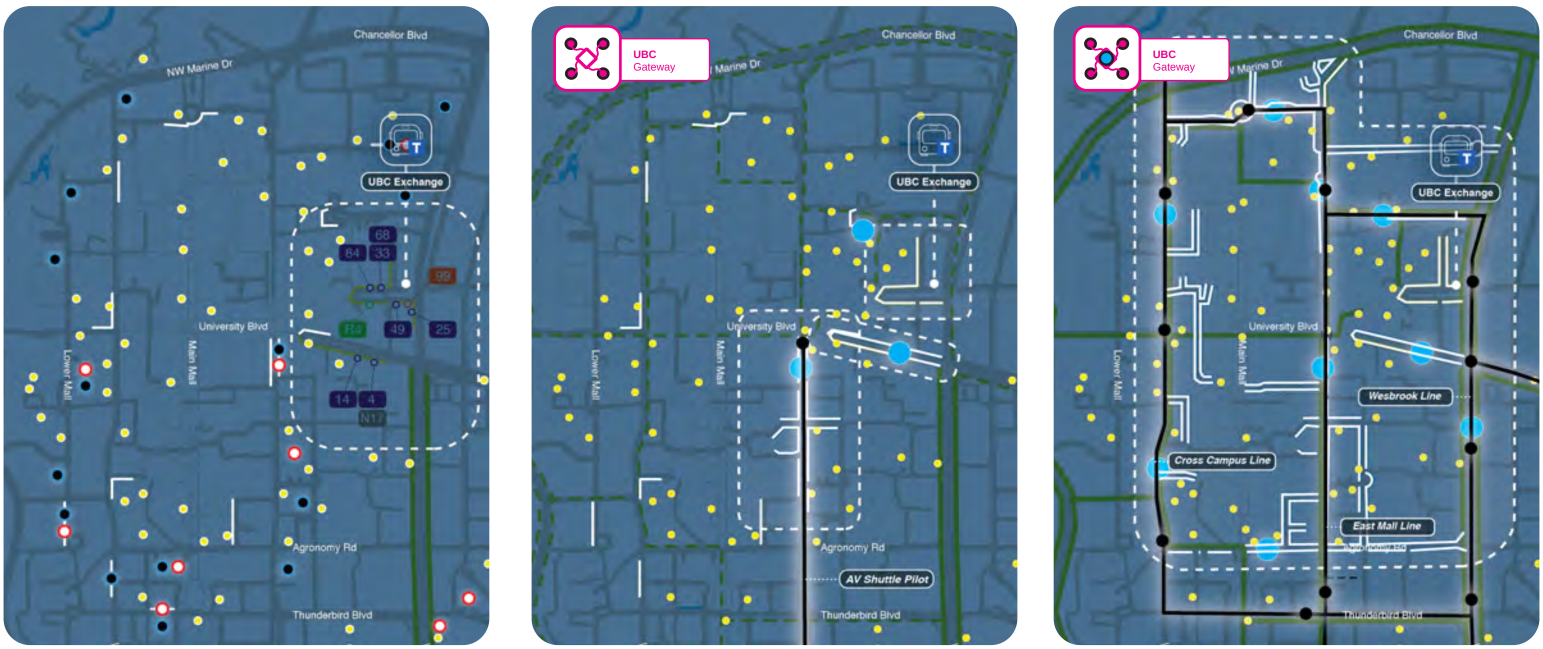
The maps below illustrate diagrammatically the virtual realm and connected new mobility elements as well as special virtual zoning and geofenced areas with special provisions. These measures are proposed to increase in time.

# VIRTUAL

**0** — **Current situation** *(September 2020)*

**1** — **Phase 1 - Silos**

**2** — **Phase 2 - Network**




For this stage with a time frame of around 30 years (2050 for 2020), a Vision Statement document will be created and updated yearly (see chapter 3.2) with the following points of attention:

MaaS integrated network within an eco-sytem platform of mobility management and ground traffic control
Geofencing and geo-zoning as a city-wide / region-wide strategy
EV charging integrated as part of energy internet to manage surcharge and electricity grid
Data exhaust and data management within a cohesive integrated policy framework under federal and municipal oversight

**?** **3** — **Phase 3 - Ecosystem**

| | | | |
|---|---|---|---|
| Transit | Micromobility | PU-DO | E-Fleet |
| | AV Shuttle | E-commerce | Car-share |

# 5.2.7
## Case Seven

**7 Surrey – Langley**
Fraser Highway Corridor


### Mobility Hub Typology

*See Chapter 4.2 for more information on Mobility Hub typologies*

As part of a city-wide network of interconnected Mobility Hubs, this case study investigates the possible implementation strategy for testing the Suburban Gateway Mobility Hub (See 4.2) typology along the Fraser Hwy between Surrey and Langley. This location is in a particularly interesting setting for this typology, as the mobility hub can evolve to include rapid transit in the mid-term future, as the SkyTrain extension gets implemented.


*Fraser Highway*
*Image: Y Fogelson (Oct 2020)*

# SURREY – LANGLEY

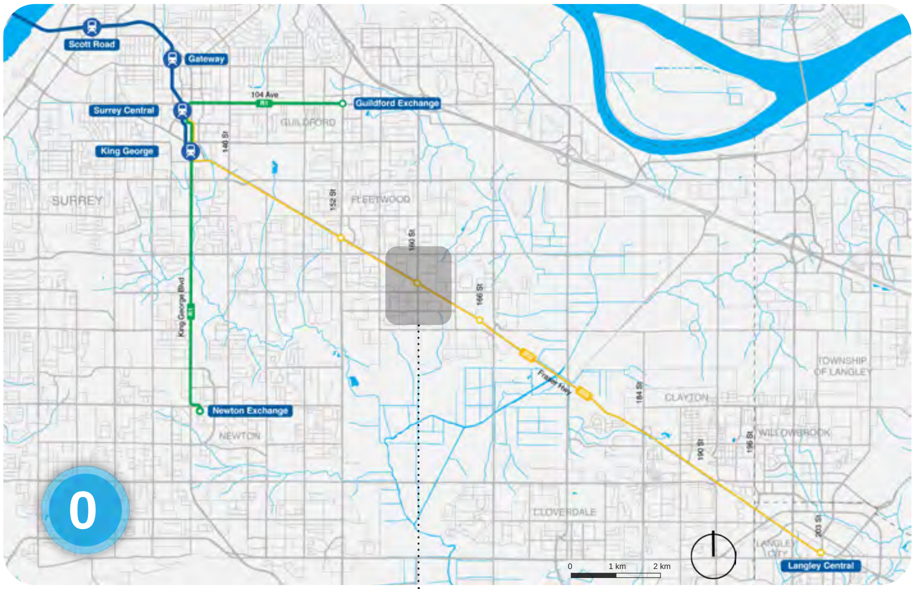
## 0

## Phase 0 | Current Situation | *September 2020*

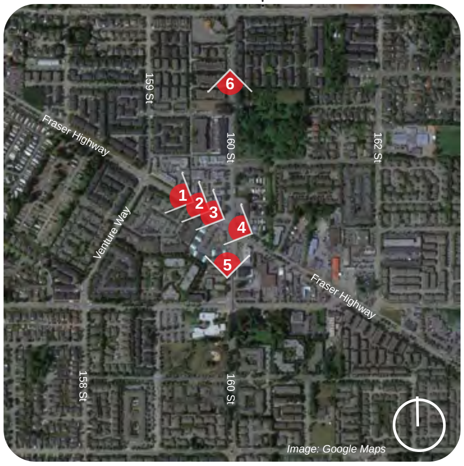
Fraser Highway is located in a predominantly suburban setting, the highway corridor crosses diagonally a grid-like road system of arterial roads. Although there are conventional bike lanes in many of these main roads, there is no network of separated cycle tracks, or bikeways along greenways connecting to transit. The 502, 503 routes serve this corridor and there is pedestrian access to surroundings, although little dedicated pedestrian greenways separate from the road system. The immediate environment around transit is frequently surrounded by strip mall typology and other uses with large parking lots. These commercial areas are most prone to change due to the impact of the new SkyTrain stations. As part of the case study analysis, the immediate vicinity of future SkyTrain station locations were investigated. In this page we can see images from the surroundings of the future 160 St Station. It is noticeable that there appear to be conventional cycle lanes in major roads, however, in a very automobile dominant environment these unseparated cycle lanes appear less safe and utilized.

In general, there is no provision or perceived demand for new mobility services such as car-share or bike-share seen as largely unfeasible in suburban settings. However, solving the problem of attending the need for last-mile trips from transit may become feasible if explored in the context of the Suburban Gateway Mobility Hub typology in combination with Local Community Mobility Hub typology. This is due to the integrational aspect of the mobility hub relating to MaaS concepts of entire journey paid within a single system. This could include city-wide transit combined with local micromobility solutions or on-demand shuttle service to transit.

In contrast to other case studies, this case study stayed at a higher level without focusing on the street scale. This case study is meant as a start an investigation into the applicability or relevance of the Suburban Gateway Mobility Hub typology. As such, a conceptual phasing plan was laid out to simulate how this process may occur, leveraging on existing plans and scheduling of the future SkyTrain extension to Langley. It is worth mentioning, that the understanding of this typology would require further investigations beyond the scope of this research.




160 St / Fraser Hwy







Images 1,2,3 – Bus stop direction northwest, looking northwest


160 St looking North, unseparated bike lane


Location of proposed future Skytrain Station


160 St looking south, unseparated bike lanes

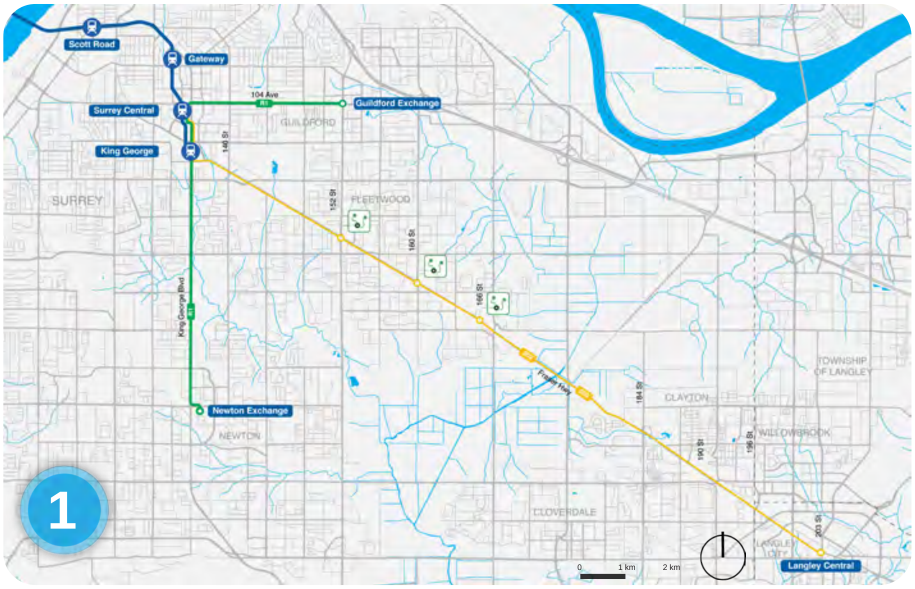
# SURREY – LANGLEY

1&2

## Phase 1 & 2

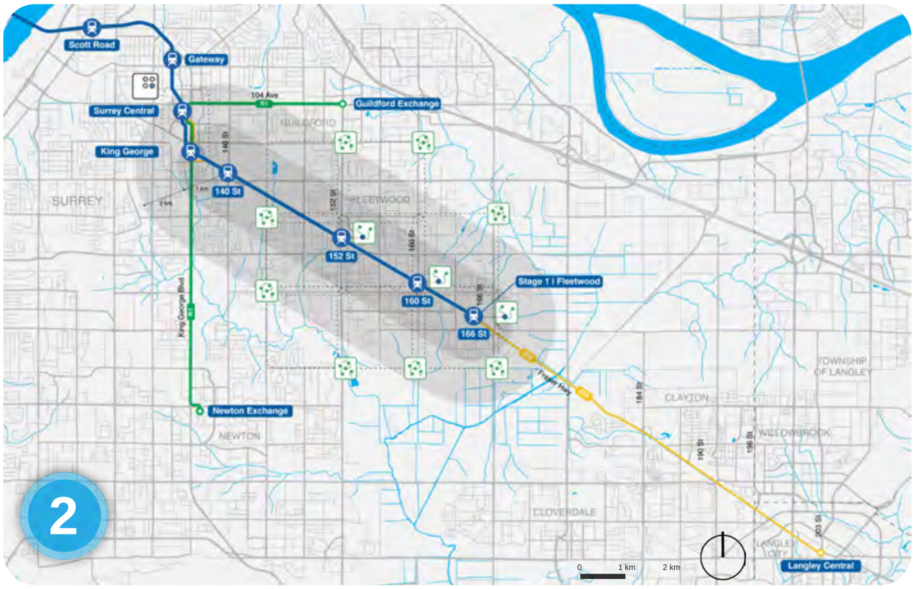
### Phase 1 (Pre SkyTrain Extension)

The first phase being the immediate action in the time frame of 1-2 years. Phase 1 acts as a preparative stage, pre-empting and simulating transit, last mile and new mobility options before the SkyTrain stations become operational, before and during construction period. A tactical BRT system can be tested in the form of dedicated lanes on Fraser Hwy to simulate a large capacity rapid transit service. The locations of future stations can provide car-share locations, which may be located in commercial parking areas adjacent to the bus stops. Micromobility infrastructure can be piloted, more importantly a shared micromobility service which may not be economically feasible at this point, may be tested as a pilot. This can be done in order to ‘prepare the ground’ for the future change in land use and with it change in mobility patterns. The Suburban Gateway Mobility Hub typology can be tested here, at various locations of future stations (152 St, 160 St, 166 St). At this point each location is a separate test site and new geofencing and connectivity technologies can be trialled at a local level.




### Phase 2 (SkyTrain Extension Stage 1)

The second phase represents the mid range (5-10 years), the assumption is that the first stage of the SkyTrain extension to Fleetwood (166 St Station) is complete. The pilots of Suburban Gateway Mobility Hub typology components done in the first phase receive a connection to transit and with it a more permanent configuration. New mobility options such as fleets, car-share and local shuttles can be further expanded and justified through the connection with the stations. Micromobility (shared and non-shared) can learn from piloting done in the first phase to expand the prioritization of cycle infrastructure within the ‘last mile’. As the diagram of phase 2 shows, within a catchment area of 2km distance from corridor, a large extent of the built-up areas are covered by the suburban typology of the Local Community Mobility Hub. In this phase, new mobility services can be integrated within a MaaS enabled network.



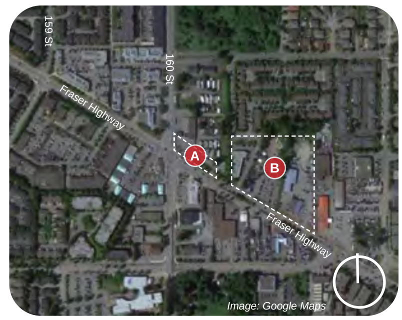
# SURREY – LANGLEY

3

## Phase 3

160 St. Skytrain Station proposal on Surrey Langley Expo line extension stage 1

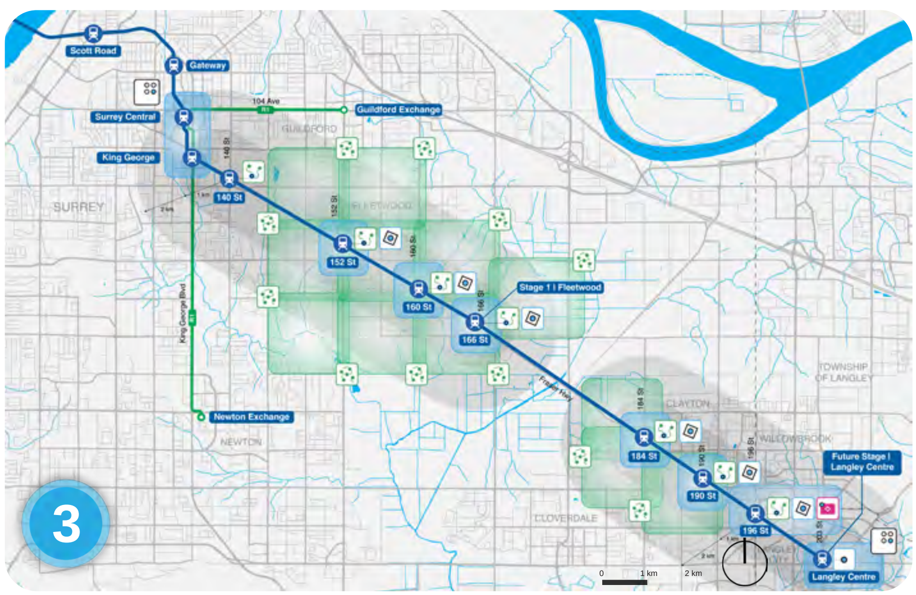
160 St. Skytrain Station proposal on Surrey Langley Expo line extension stage 1

Proposed New Development adjacent to future 160 St. Skytrain Station

### Phase 3 (SkyTrain Extension Stage 2)

In this visionary phase, in the time-frame of around 30 years, the SkyTrain is anticipated to serve Langley. It is anticipated to cause a significant change in land-use along the corridor, with more high-dense residential and commercial areas in proximity to the new SkyTrain stations. This can eventually lead to the possible implementation of New TOD Mobility Hub typologies around each new station, as an additional layer to the transit connected Suburban Gateway Mobility Hub piloted in the previous stage. In this stage, the suburban typology of the Local Community Mobility Hub can become functional in a series of areas possibly resembling districts whose ideal catchment area is yet to be studied. This area of the Lower Mainland can become an integral part of the city network of connected mobility hubs. The network functions like a rapid transit system, portrayed by a subway system style map as its user interface.



# 6

***Chapter 6*** *concludes this research by summarizes how the case studies of Chapter 5 respond to major ideas explored through-out the research in the proceeding chapters. It reflects on how the research outcomes met the objectives posed in section 1.1. The major findings of the research are listed as eight key points for the reader to take away from this research. Recommendations aimed principally at municipalities and transit authorities are highlighted in section 6.2. In section 6.3 areas of further study are explored, finally, some of the challenges which cities might face as they move forward are discussed.*

# 6 CONCLUSIONS & RECOMMENDATIONS

# 6.1

# Conclusions

This section summarizes how the case studies of Chapter 5 respond to major ideas explored through-out the research in the proceeding chapters, as well as how they demonstrate the transitioning methodology. It then discusses the research outcomes by examining how the research objectives, that were raised in section 1.1, were met. The major findings of the research are listed as eight key points for the reader to take away from this report.

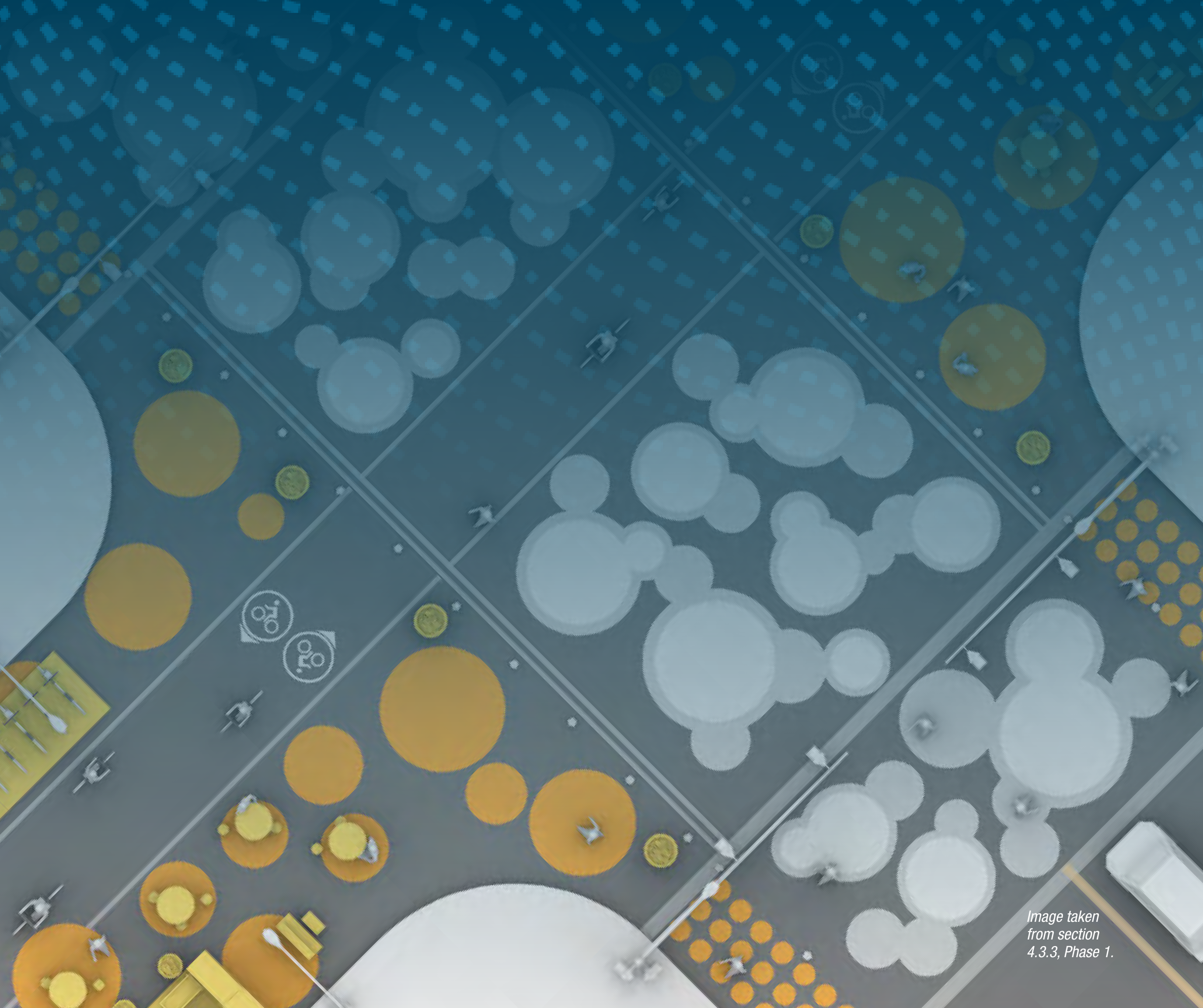


*Image taken from section 4.3.3, Phase 1.*

## Summary

Below is a summary of the major ideas explored throughout the research as reflected in the case studies and explored in the preceding chapters.

### Mobility Hub Typologies

Each of the case studies falls into one or more categories of the Mobility Hub typologies (see section 4.2). In some case studies, variations of the same typology needed to be created, such as the difference between the urban corridor with or without rapid transit in cases 1 and 2 respectively. In other cases, a hybrid of Mobility Hub typologies at different points in time were contemplated, such as case 5 where there could coexist simultaneously several different typologies. The idea of the Mobility Hub network is an area to study and developed further, especially for the typologies which were not explored in this report.

### Transitioning Strategy

The design methodology which the case studies follow, is the phasing strategy previously laid out in section 4.3 that includes three strategic phases (1-2-3) in addition to the current condition (phase 0). This is based upon the logic developed through the Transitional Design Methodology explored in Chapter 3. The case studies did not explore phase 3 with detailed design solutions like the other phases (0-1-2), as that would require a high degree of speculation, as well as a deeper understanding of each of the municipalities' vision, which was out of the scope of this research.

Each case study followed a systematic approach, enabling standardization across different municipalities which would allow them to follow a set of similar concepts, but adapt them to their unique local conditions. This is especially important for the understanding of the coding of digital infrastructure in the virtual urban realm, which can become more of a metropolitan endeavour rather than a municipality-by-municipality approach.

### Piloting

The Piloting strategy explored in Chapter 3 uses tactical urbanism methodology to test out new configurations of spaces, this has been widely explored both in the case studies in Chapter 5 as well as the design proposal in Chapter 4, in phase 1 of the Mobility Hub design and its components. Phase 0, with its exploration of Covid curbs is also explored.

### Digital Transformation

Some of the ideas and concepts discussed in Chapter 2 regarding the digital transformation of public space, are taken into account in the designing of the case studies in Chapter 5. Ideas like the 'Airportization of Mobility' and the 'Virtual Curb' are incorporated in the fundamentals of the design. Although the case studies do not go into depths detailing the visionary third phase, it is explored throughout Chapter 4 in the context of a hypothetical location. The case studies in Chapter 5 are based on the assumptions made from the Transitional Design Methodology in phase 3 and on the design proposals in Chapter 4.

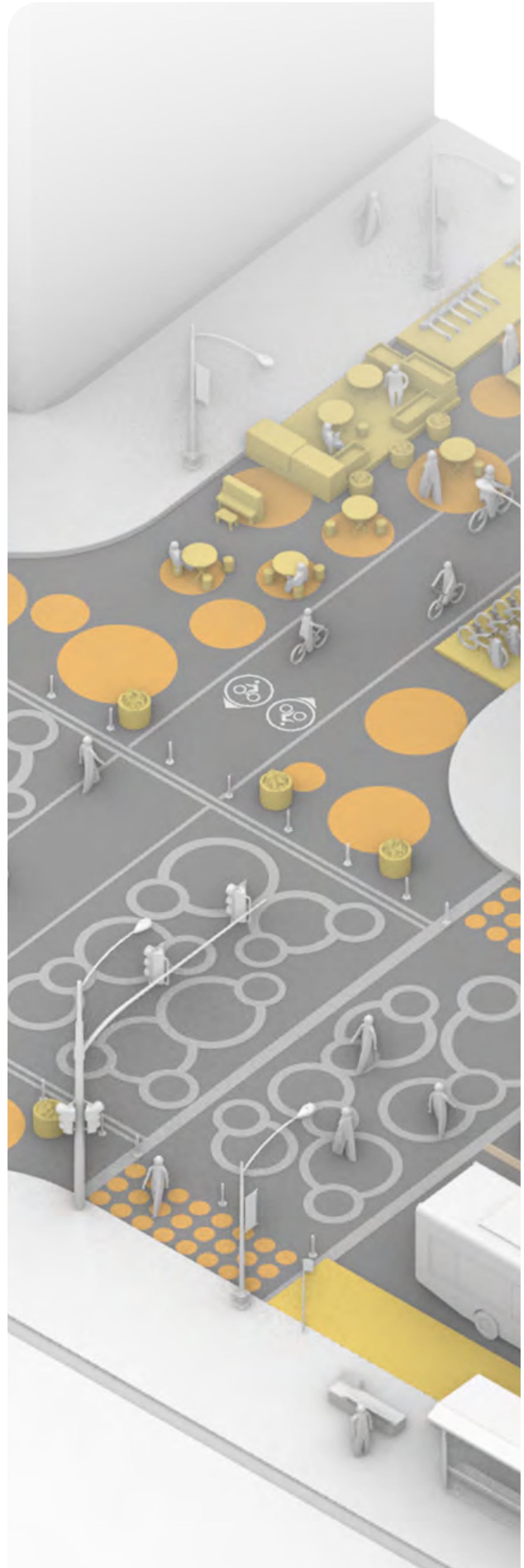


*Image taken from section 4.3.3, Phase 1.*

## Research Outcomes

The objective to design an urban mobility network is met through the speculative design proposal of the 'Urban Mobility Hub Network'.

The following section explains how objectives regarding the urban mobility network mentioned in section 1.1 were met. It is divided into three categories: Sustainability, Transition, and Innovation.

***Sustainability Objective 1:** Design an urban mobility network that prioritizes sustainable modes of transportation and is anchored around transit.*

- This objective was met through a speculative design for a 'Mobility Hub Network' explored in Chapter 4. In this design, the design of each mobility hub is anchored around high-capacity transit in locations with potential high demand of curb space use. The design investigates the re-allocation of dedicated public space to sustainable modes, strategically and incrementally. For example, space has been allocated to sidewalk extensions, plazas, cycle infrastructure, in a progressively increasing way from each phase to phase.

***Sustainability Objective 2:** Leverage new technologies and advances in automation in order to help achieve the cities' sustainability targets.*

- The design of the 'Mobility Hub Network' prioritizes sustainable modes of transport as mentioned above, it requires leveraging of new technologies of automation and network managing and operation systems, to make the concept of the mobility hub possible.
- The network that is conceived in this research links the sustainability targets of cities to the optimization strategy of (re)allocation of public space (with a focus on curb space) to more sustainable modes.
- Increasing the reliability of transit service and other mobility services can increase the use of more sustainable modes of transportation. New automation technologies can be leveraged to increase connectivity within the investigated urban Mobility Hub Network explored in Chapter 4. The more connected, systematized, and responsive the network is, the more it can be automated and uncertainty reduced. Uncertainty can be reduced in a closed system, this is explored through the idea of 'Airportization' in section 2.3. Reliability can be achieved by reducing uncertainties. This can be done by managing the availability and quality of mobility service in origins and destinations of desired trips between the mobility hubs within the network.
- Increased road safety has the potential to increase the use of active modes of transportation. Geofencing technology is leveraged for road safety, some features are included in section 4.4.3 Vision Zero.

***Transition Objective 1:** Design an urban mobility network that is adaptable to rapid changes and uncertain outcomes associated with digital innovation and disruption.*

- Through the use of a strategical phasing methodology, the 'Transitional Design Methodology' explored in chapter 3, the design is optimized to adapt to frequent change and facilitate pivoting when piloting is unsuccessful.
- The methodology explored uses a holistic and incremental approach to transitioning which is believed to avoid abrupt change associated with disruption.
- Through a continuous design influx approach, the design process is constant and therefore able to potentially better respond to urging needs during the process, such as concerns around data privacy or

*Image taken from section 4.3.4, Phase 2.*

the use of innovation in a way that harms the collective good.

- Reduction in uncertainty in the implementation of future technology is achieved by focusing on incremental steps which can be taken in the immediate time frame, following the 'Transitional Design Methodology'

***Transition Objective 2:** Design an urban mobility network that can be reconfigured frequently and respond to real-time demand of movement of people and goods across the city.*

- The design methodology, proposes the use of tactical urbanism and piloting strategies to reduce the time it takes to reconfigure physical space, therefore increase frequency of update. This is needed to match physical and virtual infrastructure, as discussed in section 3.3.
- Optimization of operation and management for Transport Demand Management (TDM) can be achieved through the use of connected 'Virtual Curb Space' as explored in section 2.4. This can help to test and see how the mobility network responds to real-time demand, through continuous real-time analytics of data on curb space stock city-wide.

***Innovation Objective:** Increase collaboration in innovation between the public and private sectors with regards to infrastructure, shared mobility, and civic entrepreneurship.*

- The explored design solutions of the mobility hub, leverage the use of public space real estate with high demand of use in a strategic way to test out innovation. In such a way the public sector can offer its physical space as a valuable resource. The corresponding space which this research looks at is strategically located curb space associated with location of high accessibility and connectivity to the rest of the city.
- New technologies can be tested through the idea of dedicating space for incubation, this is explored in section 3.3.3. This can allow increased collaboration between the public and private, as the space provided (by the public sector) could provide a more systemic and standardized framework on which to work. Limitation of the problem to be solved can increase certainty in innovation (by the private sector). On the other hand, the public sector can better control these spaces as they are defined and can increase in accordance to a strategic plan.
- Civic entrepreneurship can be promoted through initiatives proposed in this research regarding use of civic space, explored in section 4.4.2.

*Image taken from section 4.3.5, Phase 3.*

## *Major findings of the research*

There are eight key takeaways from this research: Holistic approach towards ‘Value’; Future Curb Space (as ‘building block’ of Urban Mobility Hub Network); Inventing the ‘Digital Twin’; Inventing the ‘rules of the game’; Bridging the Virtual-Physical divide; The Transition into Automation; Incubation and Pre-Automation; and From Silos to Networks to an Ecosystem. Each is explained as follows:

1. ***Holistic approach towards ‘Value’*** – The research argues that there is a ‘conflict of values’ (monetary value, coding values, value system) playing out in curb space. Therefore, a holistic approach is proposed, which can be used to evaluate, categorize and systematize all the different activities utilizing curb space real-estate, both physically and virtually. This holistic approach means goals are set by the government, visioning the best possible outcome for all members of society. As such, this sets the direction and the desired vision. The challenge here is for decision makers to set values that are agreeable with the public in a way that serves the collective public good.

2. ***Future Curb space*** *(as ‘building block’ of Urban Mobility Hub Network)* – The curb space of the future can be seen as a network of shared monetizable public space, used for the movement of people and goods in a city-wide network, favouring sustainable mobility modes. As such, it can be seen as the building block for the ‘Urban Mobility Hub Network’, a network which can be managed and operated to a large extent remotely.

3. ***‘Inventing’ the Digital Twin*** – There arises a need to ‘invent’ (rather than create) Digital Twins of the urban realm, connecting between physical and digital infrastructure. Initially it can be used for management and optimization, later for operation, enforcement and charging for usage of urban infrastructure. This research proposes a conceptual ideation of one of such Digital Twins, namely the ‘Urban Mobility Digital Twin’, which can be initiated through building blocks in the form of curb space virtual real estate and physical public space. The collection of these spaces forms the ‘Urban Mobility Hub Network’ which is explored in this research.

4. ***Inventing the ‘rules of the game’*** – In order for the Digital Twin to be functional, it needs to adhere to a clear set of rules, as algorithms cannot be ambiguous (even though they can be biased). The research argues that the ‘rules of the game’ need to be defined and consequentially coded based on a set of values (defined in the first point). This task is to be confined in the hands of the public sector, as it can define the equity and sustainability values it wants to attribute to. In turn, these values need to then be translated to a coding value system.

*Image taken from section 4.2*

5. ***Bridging the Virtual-Physical divide*** – The research recommends that designing and planning activities of the urban physical realm should consider digital infrastructure and its related activities, both at the local and the macro scale. Likewise, when designing digital infrastructure and its reliant services and activities, there is a need to design in unison with the physical implications of use and implementation in the urban realm. For these considerations, the research proposes to match the virtual and physical update frequency rates. This can be done in the physical realm through the use of tactical urbanism and modularity, which shorten the time it takes to reconfigure space. On the contrary in the virtual realm, there is a need to slow down the update rate by coupling its activities with on-ground testing (in the physical realm) before pivoting or rolling out services on a wider scale.

6. ***The Transition into Automation*** – Bridging the gap between unpredictability and predictability, the research argues that there is a conflict between the unpredictable outcomes of disruptive innovations and the need for predictability inherent in automation. Unpredictability is a part of complex systems like cities, it plays out in disruptions associated with technological advances, along with uncertainty associated with geo-politics, economy and other crises such as Covid-19. On the other hand, greater predictability can be achieved in a 'closed system', explained by the idea of 'Airportization' which the research explores. This can be applied to the mobility network system and realized through the 'Mobility Hub Network'. However, in order to deal with unpredictability, a 'Transitional Design Methodology' is proposed, which favours the incremental, scalable and iterative that is in a constant state of re-design or update, a design in-flux.

7. ***Incubation and Pre-Automation*** – The transition explained above, follows an incremental design approach using tactical urbanism and the idea of a Minimum Viable Product (MVP) to experiment and pilot mobility solutions in parallel on-ground and digitally. The idea raised in this research is the creation of an incubation space, physically and digitally. Physically, designated selected curb space segments in the city can take that role, as they can expand easily if necessary. Digitally, the incubation will allow to test the functioning of urban and user interfaces, as well as back-end technological, logistical and regulatory solutions. In that sense, in preparation for autonomous urbanism, one is simulating design solutions in a pre-automated context. Some of the solutions tested may therefore become successfully functional and applicable prior to automation and therefore reduce the need to depend on the full automation of fleets or other devices.

8. ***From Silos to Networks to an Ecosystem*** – The incremental approach used in the 'Transitional Design Methodology' builds upon a scalable expansion of change which is a characteristic of disruptions. In the virtual realm, it recognizes the importance of starting off with silos, which is the current situation of many applications deployed in the urban realm. From isolated silos it proposes a process of grouping of similar silos (for example of competing apps providing the same service), these can then correspond to a dedicated physical space. These grouped silos evolve into simple, interconnected networks. This, in turn, creates the 'network effect' of self-organization and scalability of an ecosystem.

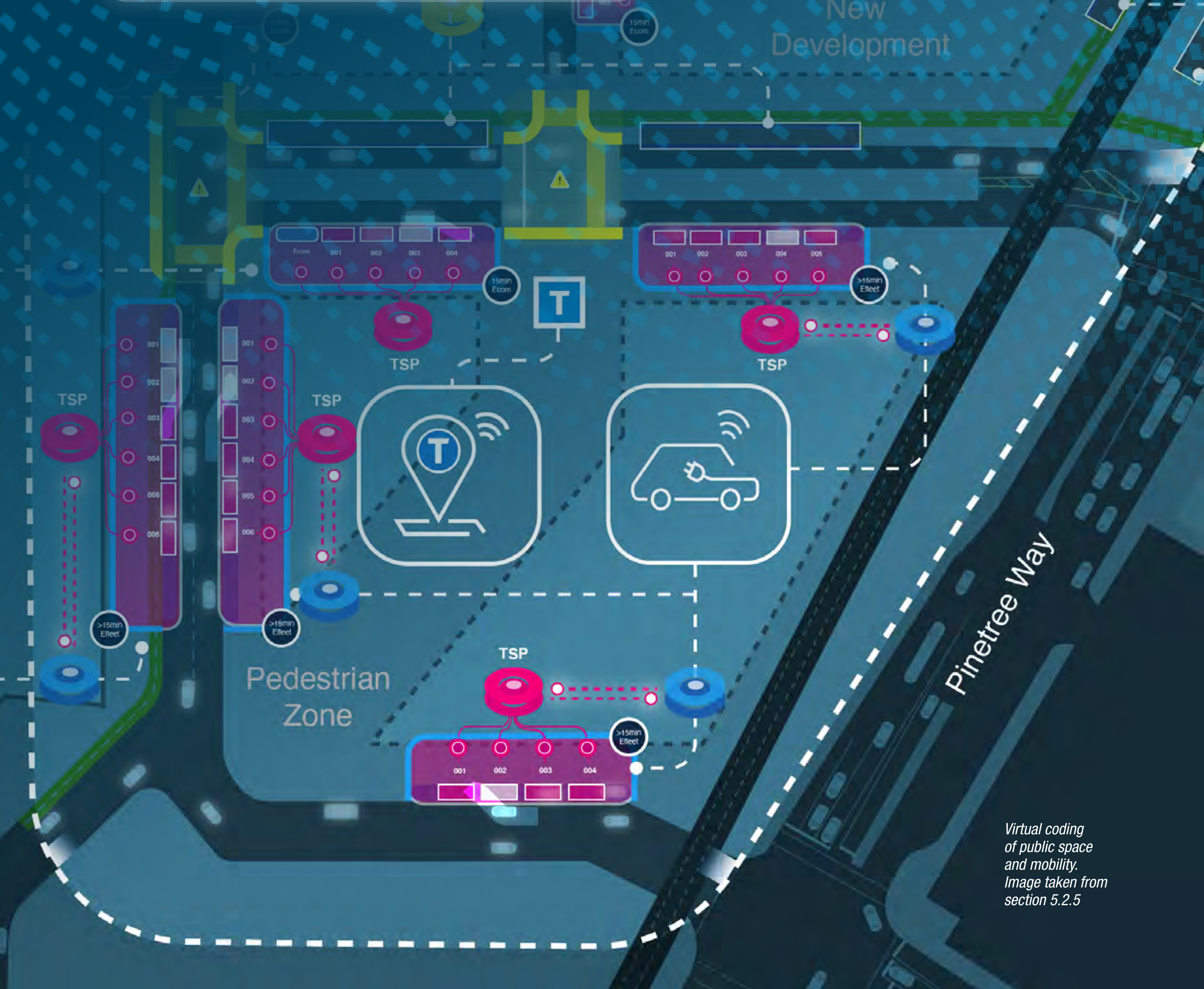
*Image taken from section 4.2*

# 6.2

# Recommendations

Recommendations aimed at municipalities, transit authorities and the industry are laid out as considerations in this section. These respond to the snapshot regarding where cities stand in the challenges of incorporating new mobility and the digital transformation. These were perceived through interactions with municipalities and the transit authority as part of the case studies investigated in Chapter 5

The recommendations explored in this section have been divided into two orders of magnitude. The higher level, relevant to city or region wide challenges, and the local level, dealing with smaller scaled design and implementation features.




*Virtual coding of public space and mobility. Image taken from section 5.2.5*

## *Higher Level*

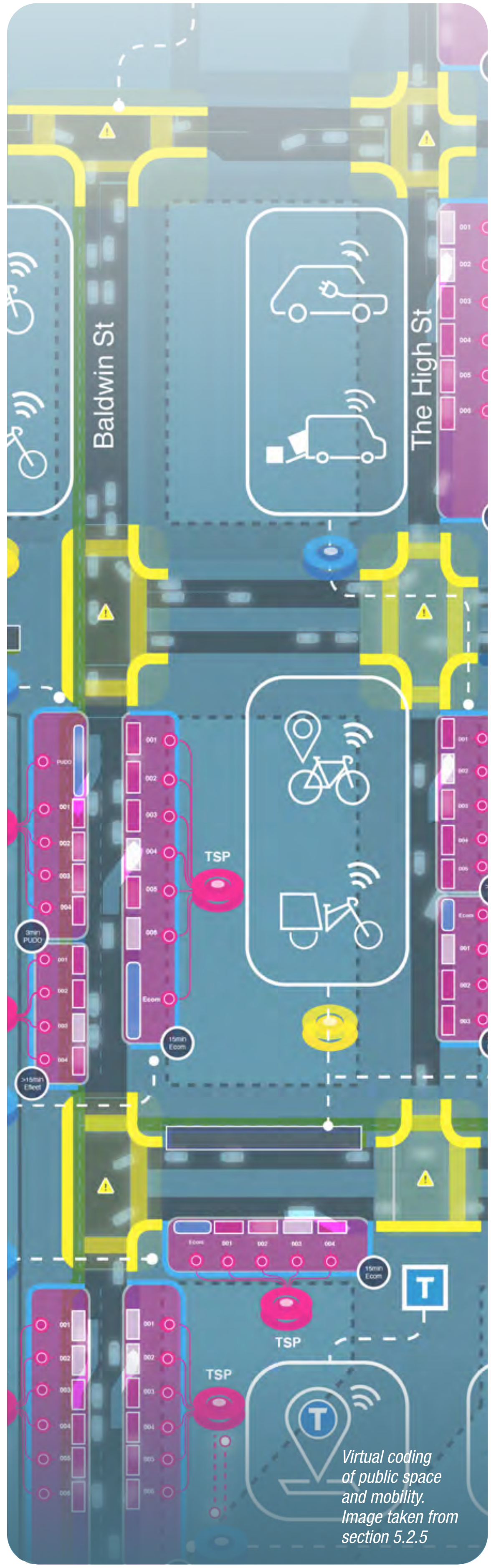
In the higher level, concepts that are looked at include: city-wide integration of new mobility; insertion into the Data Economy, innovation incubator, municipal challenges associated with the digital transformation; virtual zoning and geofencing technology.

### *New mobility as a regional mobility issue*

- New mobility services cross municipal boundaries, as origins and destinations of trips often span various jurisdictions. Ideally, it should be dealt with through a regional lens, in the same way that transit is considered a regional, cross-municipal boundary issue, and is dealt with by regional transportation authorities (such as TransLink in the case of Metro Vancouver).
- Although the physical allocation of road space and curb space is considered a municipal issue, different municipalities are facing similar challenges and apply similar solutions. Often small municipalities feel unequipped to implement anticipated large-scale changes and prefer to follow suit of larger municipalities with more capabilities.
- It may be helpful for municipalities to explore a more regional approach to the dedication of space for new mobility uses together. Similar to the way road space is allocated for transit stops, bus and HOV lanes, regardless of the municipal jurisdiction boundaries. For example, transit corridors of regional significance may pass through several municipal areas, each with its own local needs (for example Case 2). Likewise, this could provide consistency for new mobility providers.

### *Municipalities and digital transformations*

- Often municipal government separates its internal departments responsible for “technology”, in its various outlets, from the other various business units. For example, units like planning and engineering, which are the ones that are responsible for the actual building of cities, are not well integrated with its technology departments. The divisions in the organizational structure can be reflected in the outcomes of implementation of digital infrastructure in the urban realm. Better integration between ‘physical’ and ‘virtual’ responsibility within the organizational structure of a municipality is needed in order to narrow this gap.
- Municipalities can benefit from the integration of goals pertaining to digital transformation with municipal strategic business/corporate planning cycles. In this way, it can be independent of changes in council, or changes in funding positions from the provincial or federal government.
- Municipalities can benefit from the integration of the operational business processes in technology services and physical development processes. Cities have really long planning/development/rezoning processes that can span years. The challenge is to tie the digital transformation processes to those processes so that they both evolve simultaneously in order to deliver the expected technologies and business value at the same time. The ‘Transitional Design Methodology’ proposed in section 3.1, as well as the ‘virtual-physical matching’ explored in section 3.3, can be used as a guideline to achieve this goal.



*Virtual coding of public space and mobility. Image taken from section 5.2.5*

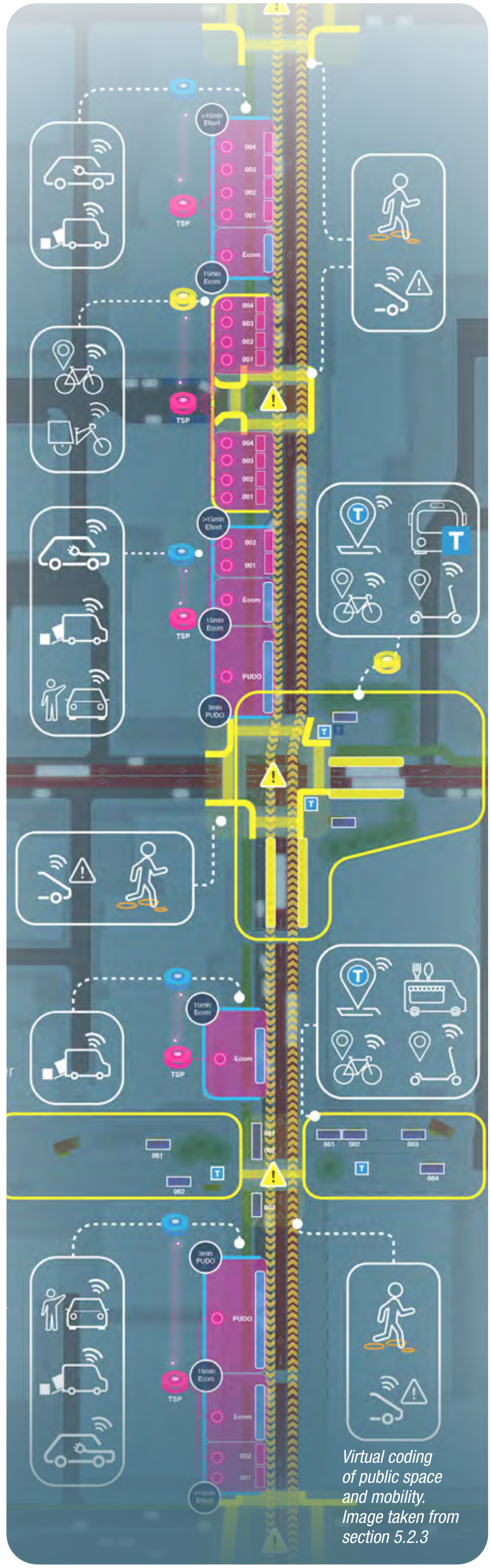
- Municipal staff often lack the capacity or mandate to deal with challenges brought up by the broader effects of organizational digital transformation. In this context, dealing with digital transformation of public space and mobility is loosely taken up by staff with expertise in fields of urban and transport planning, GIS and IT departments. This could be improved by setting a clear political mandate to address the needs of the digital transformation, which can then be allocated to dedicated staff.
- Ever increasing demands from technology companies and mobility service providers will eventually only be met through a proactive action plan, rather than a reactive case-by-case approach.
- Municipalities, especially smaller ones, often prefer to wait for larger ones to lead the way in changing policies. In response to this attitude, most of the changes which new mobility brings with it are regional and can be addressed in a similar way across jurisdictions.

### *Insertion into the Data Economy / Revenue model*

- Revenue based models derived from the temporary usage of public space need to be tested and rolled out in a strategic, incremental and conscious manner. The transition from a 'parking meter' model (whether physical or through an app) to a data-economy model, will require an overlap period where multiple incompatible models coexist. In this context, it is important to frame and limit the trialed models in a separate context in order to avoid users taking advantage of potential loop-holes caused by the parallel double system use.

### *Innovation incubator*

- Municipalities should seek to incentivize innovation within a framework in order to allow greater freedom for new entrants, while guaranteeing a set of rules and predefined limitations.
- The idea of a physical urban public space dedicated to testing innovative solutions may be perceived by the public as a form of privatization. In order to avoid this, it needs to be clearly defined and communicated. Public engagement is crucial.
- Working in partnership with provincial and federal levels of government is recommended to respond to the greater demand that the digital transformation is presenting. It is also important for guaranteeing additional access to funding for the purpose of innovation incubators, which can be deployed in different cities and provinces or states. This is crucial as it also creates a learning network and exchange of expertise sharing data over the testing conducted.



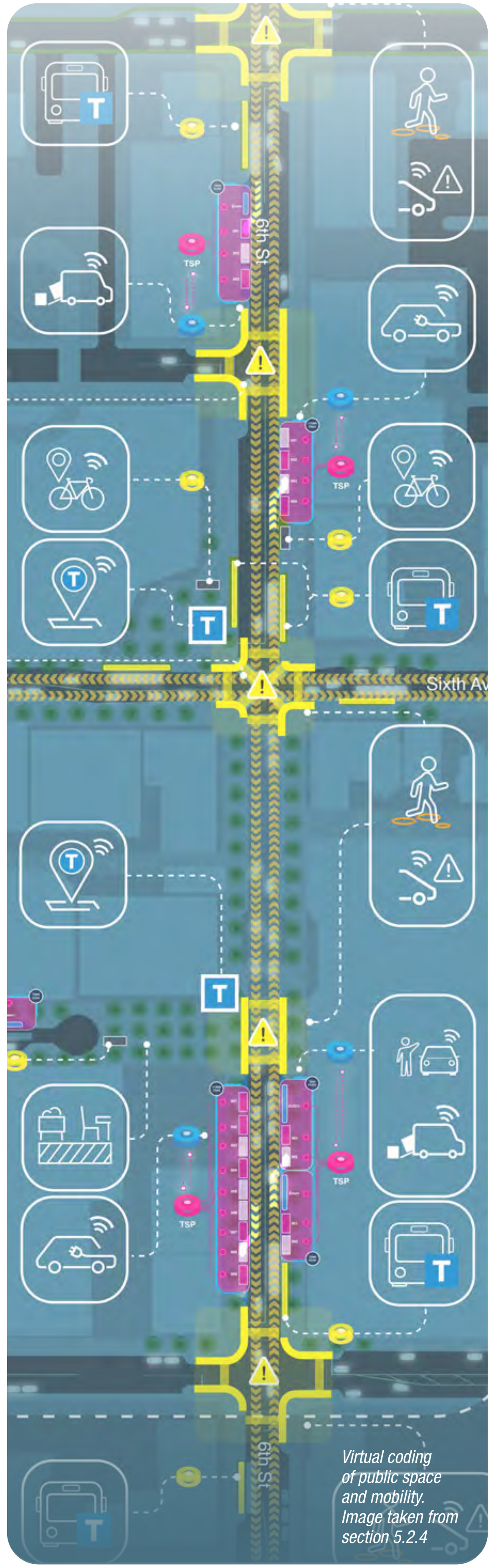
*Virtual coding of public space and mobility. Image taken from section 5.2.3*

### E-zones

- Congestion charge, LEZ (Low Emissions Zone) and ZEZ (Zero Emissions Zone) zones are currently discussed as municipal imposed restrictions. However, these affect the region as a whole and often affect commuters from outside municipalities more than the local municipality (as in the case of the City of Vancouver's proposal to impose a central core congestion charge).
- Geofencing technology can be used as a tool for increasing road safety, charging E-zone fees, and eventually enforcing road rules for connected private vehicles and public transportation. Congestion charge and other low emission zones may be geofenced in a more fine-grained manner, to the level of individual curb spaces which experience high demand.
- This can be done in a dynamic way and respond to real time use, resulting in dynamic pricing fluctuation. Fine grained data can lead to potential optimization and maximization of congestion charge in some areas, while incentivizing other areas through artificially lowering the surcharge.

### Geofencing for innovation rather than restriction

- Geofencing in its initial deployment is mainly used for restrictive purposes, for example for imposing pickup drop-off fees on ride hail services in a specific district of a city where there is more congestion and curb space contention.
- Geofencing in a more advanced form may eventually be used as a mechanism to book, reserve, check-in and check-out of curb space use in a virtual setting. This activity may be inevitably linked to a usage service fee where additional taxing may be included (for example for non-electric vehicles or for low occupancy). In such a way, the fee currently imposed can be an integral part of the integration of usage, rather than a toll or surcharge fee.




Virtual coding of public space and mobility. Image taken from section 5.2.4

## *Local Level*

This section summarizes recommendations at the local level including micromobility, civic space, ride hail, and car share.

### *Micromobility local yet integrated*

- The deployment of a micromobility system such as bike-share, e-bikes or e-scooter, dockless or docked, all have their geographical constraints and may require allocation of stations in a continuous geographical area. Therefore, having multiple local providers in geographically contingent areas and providing usage of different modes is logical.
- While multiple micromobility providers may populate adjacent or overlapping zones, the business model of small scaled providers is challenging, unless it is integrated within a MaaS-like metropolitan system. Here it is important that while contracts with micromobility service providers are done with municipalities, they should feed into a regional framework of users and predefined mechanism of space allocation, in order for new entrants and small-scale companies to have access to the regional customer base.
- While the space allocation is a municipal responsibility, its business and operations model should fall under a consistent regional umbrella. Regional guidelines can secure the standardization of a framework in which new and existing companies can plug in and out. This in turn allows for lowering the threshold for innovation and piloting of new modes and new business models.

### *Robust micromobility infrastructure*

- The integration of micromobility and transit is essential to providing (near) door-to-door solutions for last mile trips from transit to destinations or origins. As such, an infrastructure whose aim is to connect transit, rather than provide longitudinal and latitudinal cross city connections, is important to take into account in the implementation of new cycle / micromobility infrastructure.
- The inclusion of ample parking facilities for private bicycles and docking stations for shared micromobility is crucial in this context. The locations of these facilities need to be pegged to transit and be adaptable towards changing real time demand, which can be gathered from bike-share usage data.
- The increase in use of e-cargo bikes can mitigate the increase in demand for e-commerce and delivery of goods and fresh local produce. Here, robust bike-ways are crucial to accommodate these uses, redundancy of cycling infrastructure can be seen as preferable in this context (i.e., bike-ways on both sides of a large avenue in a commercial corridor).
- The deployment of delivery bots of various sizes are facing various challenges, regarding sidewalk use (sharing space with pedestrians) or road space use (sharing space with automobiles). Depending on the speeds of these autonomous devices, the cycling infrastructure can prove a valuable network, as it is marked in a consistent way and is generally free of obstacles.

*Image taken from section 4.3.5, Phase 3.*

### *Civic space*

- Encouraging gatherings and public community activity can be achieved through linking the online public space, such as social media, official municipal and non-profit organizations websites. The reclaimed pop-up plazas and other public spaces adequate for small gatherings can be used for experimentation with new initiatives, which can evolve into more robust policies to be implemented on a wider scale.
- Street vendors, food trucks and other public space related commerce can be encouraged through a space allocation system, similar to the curb space allocation approach. In this way, municipalities can incentivize certain uses and users (for example local small-scale entrepreneurs with a one-off food truck business) over other corporate users (such as a global coffee chain fleet seeking a similar use of space).
- Public space allocation to different uses can benefit from a universal e-permit system to unify permit for food truck, temporary patios, street vendors or other activities. This will facilitate the systemization of booking / allocation system and can be scaled up to a wider policy.

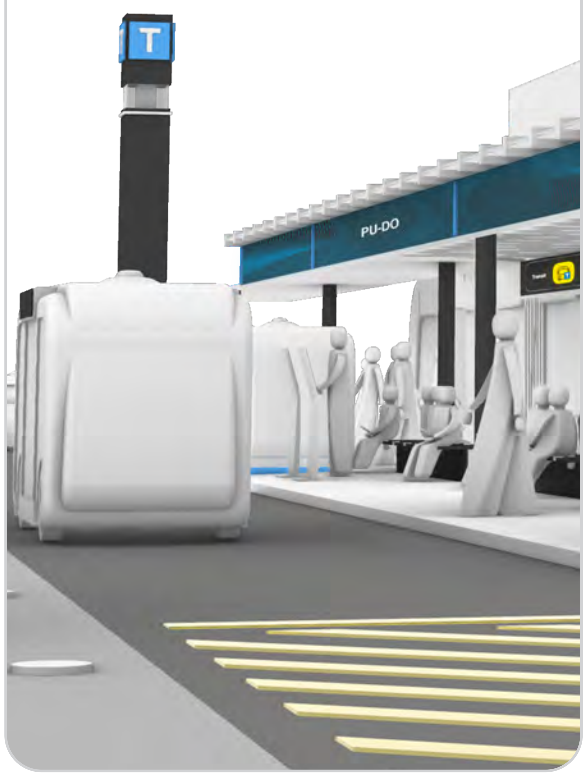
### *From Ride-hail to PU-DO Zones*

- In order to facilitate the spread of designated pick-up drop-off (PU-DO) zones through-out the city, a systematization process should be used. These zones should be treated as small terminals, which can start off as a simple parklet / bus shelter hybrid and evolve into a multi-functional point of start or end of journey, urban interface.

### *From Car share to E-Fleets*

- Currently shared individual vehicular mobility is categorized as car-share, either one-way use or two-way use. One-way use may be more suitable for on-street deployment as it is based on a more on-demand and location sensitive usage. Two-way use can be more suitable for off-street deployment in condos and parking lots, as a monthly rental system can be incorporated and a booking system may benefit recurring users.
- As car-share moves towards a fully electric fleet, the charging of these car-share fleets can be integrated with EV charging in both on-street and off-street options. Here the cost of usage and energy can be used as a means to charge for usage of occupying public curb space real estate, or alternatively parking garages in private condos.
- The physical allocation of designated curb space for E-Fleets instead of specific car-share providers, can facilitate the entrants of new small- and large-scale fleets with various business models suitable for one- or two-way usage. These fleets can potentially be of different corporations, car companies or organizations. It is suggested that these would potentially be able to occupy any fleet designated public or private charging space as the framework of regulation of usage.

*Image taken from section 4.3.5, Phase 3.*



# 6.3

# Further Study & Challenges

This research cuts across a wide array of fields beyond the narrowed focus of curb space design and management. As such, many concepts have not been looked at in sufficient depth. This section highlights areas discussed in this research, as well as areas that were not looked at, that are interesting candidates for further study. This section concludes with a discussion on some of the challenges that may be faced moving forward, as cities continue to adapt and respond to new demands of mobility needs. Major challenges need to be faced if cities are to realize the vision proposed in this research. With regards to municipal and transit authorities, some of the obstacles that need to be overcome are discussed.

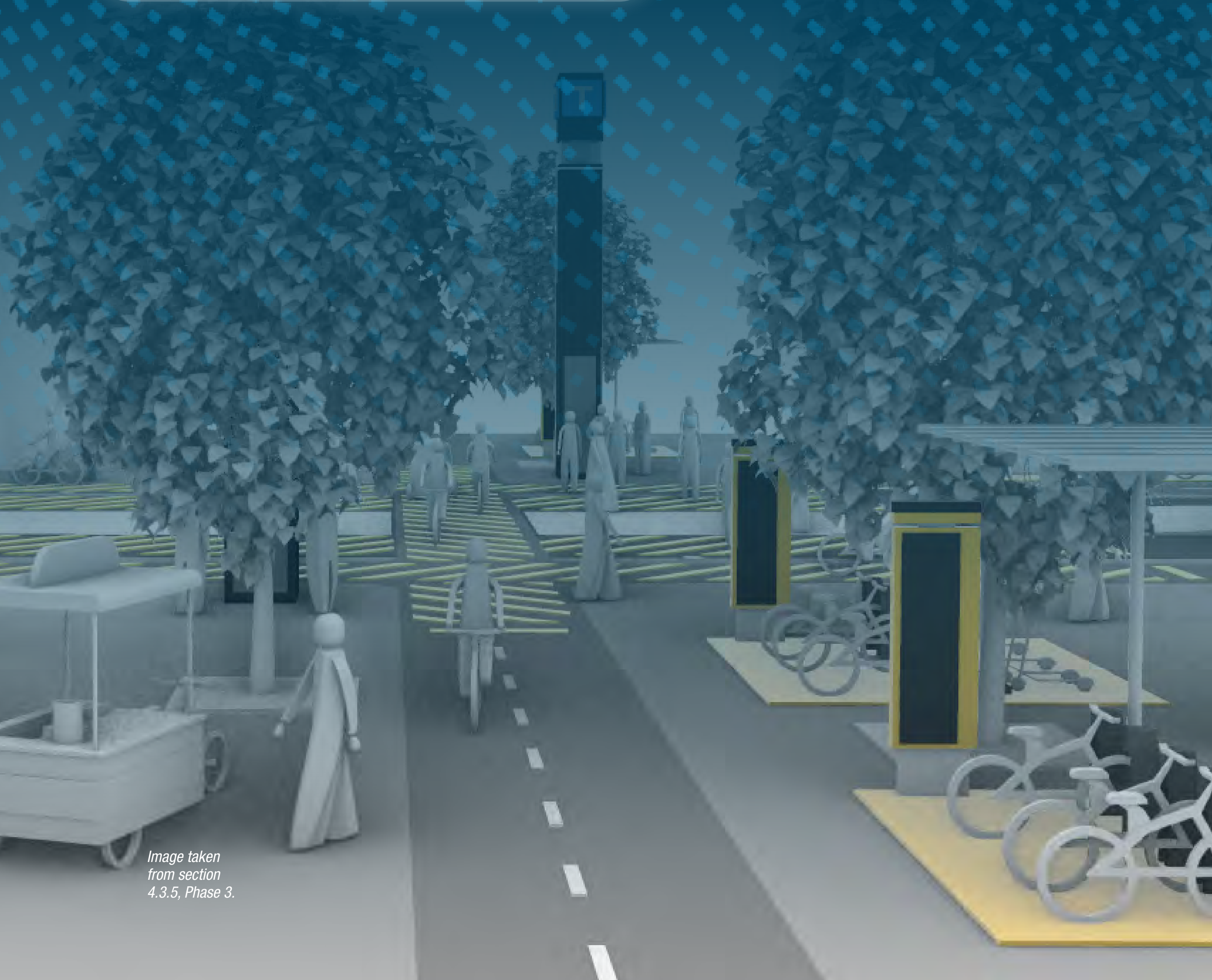


*Image taken from section 4.3.5, Phase 3.*

## Areas of Further Study

The following areas, further detailed below, were identified as main areas which require further study: ethical concerns, digital transformation, accessibility & equity; design vision; transition.

### Ethical Concerns

- The process of transitioning into automation has the potential to bring with it a shift in power in authority and decision making from the physical to the virtual, as authority is automated, this is described in section 3.2. Here, further study is needed to evaluate the ethical implications of technologies of surveillance which may be implemented in the urban realm. These technologies may not be designed for the purpose of surveillance, but through the mechanisms of the Data Economy, personal data may be valuable for private interest, as described in section 2.2. This area is a strong candidate for further study.
- The surveillance spectrum of new technologies can be visualized as Surveillance Capitalism (where corporations have asymmetric power over data and knowledge of the population) on one extreme and State Surveillance on the other extreme (where governments have asymmetric power needed to control the rights of the population). Moving too far to any of the extremes may cause potential serious and irreversible consequences on society. Further study is needed to assess more equitable and ethical models of deployment of surveillance technology in the context of the urban realm.

### Digital Transformation

- In terms of the digital transformation of public space, further research is necessary to develop conceptual frameworks for the topic discussed in Chapter 2, as well as other relevant areas which were not discussed in this research.
- Mobility as a Service is explored in this research both in terms of its seamless integration of transportation modes through the digital services, as well as in the physical configuration of urban design. This was identified as a potential area of further studies in a study about MaaS done by TIPSLAB.[67] That research also identified the need to further study how MaaS can be leveraged to prioritize and incentivize the use of healthier and more sustainable transportation modes. This research further emphasizes the need for further study in this area, which is a crucial element for the success of the speculative design proposal laid out in Chapter 4.
- The economic model of the Virtual Curb Space Real Estate concept discussed in section 2.4 requires further study in the fields of real estate and economic feasibility and regulation. What is the legal feasibility of such a construct, what are the regulatory limitations which stand in the way of implementation of this concept?
- The testing of a booking system of public space, as laid out in section 2.4, requires further studies, regarding the legal and regulatory feasibility and implications of this concept. This may include the equitable allocation of a booking and reservation system for temporal use of a defined space within the civic space.
- The concept of Airportization is a metaphor used to understand the multi-layered operational logistics required to manage the virtual mobility system, this is discussed in section 2.3. The exploration of how this concept adds to the conversation on mobility requires

67 Meyboom, Annalisa, et al. Mobility as a Service (MAAS) – TIPSlab. Sept. 2019, https://blogs.ubc.ca/tipslab/projects/mobility-as-a-service/.

further study, in terms of expanding on this analogy and seeking the value of this model for an urban mobility system. The control over freedom of movement of individuals within the physical context of an airport design may be impossible to implement within the context of public space design.

### *Accessibility & Equity*

- Access to mobility services may be drastically different than its current state in the context of the design vision which is laid out in this research. The accessibility needs of different groups from different socio-economic demographical background needs to be further studied.
- The user interface both physical (through wayfinding and urban design) and digital (through digital accessibility and digital literacy) needs to be designed to be accessible for a wide range of the population and age groups. Alternatives for non-virtual payment need to be further explored.
- Accessibility, consideration of needs of the elderly or disabled who require mobility solutions that offer door-to-door services is another opportunity for further consideration. For example, the PU-DO terminal proposed in phase 3 of the design vision (Chapter 4) does not offer a clear solution for door-to-door needs. This needs to be studied further and additional alternatives built in the system for those that require these services.
- The shift towards digital currencies and mobile pay fall in line with seamless Mobility as a Service technology. However, the move towards a cashless society may leave those without access to banking, or those not willing to transition to digital currencies, behind. This means that accessibility to commonplace mobility services, may eventually exclude a part of the population. Further research is needed to explore the introduction of mechanisms in the system that will prevent this, or find equitable alternatives.

### *Design Vision*

- The visionary phase (Phase 3) was conceived for the purpose of this research. However, alternative designs and approaches should be encouraged to be used and compared.
- Exploration of different urban contexts in different geographies and demographics should be explored, in order to challenge the designer's bias of this research.
- The Mobility Hub typologies explored in 4.2 could be further broken down into their specific designs, categorizations and levels of service. The design solution explored in 4.3 for the case of a 'Community Mobility Hub' could be emulated to represent the typologies which were not explored to the same extent.
- The components of the Mobility Hub design have been grouped in a particular way (4.4). Further study can explore different groupings of uses and different configurations which may better respond to different demands or physical configurations

### *Transition*

- Hypothetical speculative design proposals, like the one laid out in this research, can assist in decision making and choices of approaches to planning. However, the sharpening and adapting of transitioning strategies is only possible through the generation of data and knowledge through a real-life implementation of urban pilot project. This research identifies an essential need for trial and error to occur as part of the transition design process. As the large number of variables in complex urban environments create a 'wicked problem'[68], it can be beneficial to conduct non-hypothetical piloting and testing to learn by doing.

## *Challenges Ahead*

The research lays out conceptually a framework within which it possible to rethink the way that the public space is used for mobility, by incorporating the virtual realm within the planning and design process. This naturally lends itself to great challenges, as the framework requires systemic change to evolve.

Implementation is seen as the natural progression of this research. The case studies explored in Chapter 5, highlight a phasing strategy which can be used to set a framework by municipal and transit authorities. In particular the initial phase (Phase 1), provides an imaginable step towards possible short-term experimentation with technologies and practices available today. However, the solutions shown are only hypothetical within the scope of this research project, and essentially require real-world experimentation. Herein lies the challenge of starting off with experimentation without a clearly defined framework and without clear communication to the public. Clear and accurate communication with the public about what is being tested, proposed and envisioned, can mitigate the risk for a digital backlash (a tech-lash). It is also necessary to communicate how this is done, and in lieu of a clearly defined framework, it may be challenging to gain support of the constituencies.

With regards to municipal and transit authorities, the obstacles that need to be overcome can be separated into external (the population) and internal (the organization).

Externally, the general population needs to be addressed, there may be a communication obstacle, as the ideas of digital transformation are complex and difficult to communicate, often they deal with intangible infrastructure. Therefore, there is a need for a strong communications channel with the population, one that can engage with the population's daily use of the city in an accessible way. This can be done virtually, through on-line information and application, and physically, through wayfinding responding to its user experience.

Societal changes are ongoing affecting the mobility needs of the population, which adjust accordingly. The challenge is to find a balance between responding to these needs and shaping mobility behaviour patterns of the population towards achieving desired public health and sustainability outcomes. Increased digital connectivity has caused a major change in behaviour, and increased the time people are connected and utilize on-line services. Civil society and the public sector need to participate in the shaping of public behaviour and fill the void currently taken up predominantly by private corporations.

With the monopolistic position of tech-giants to enter field of innovation in urban mobility, comes the challenge of how to lower the bar in order to allow for greater innovation and foster local entrepreneurship. For this the research mentions the need to 'invent the rules of the game' (section 6.1.2), in this way, innovation that the public decides to promote can be allowed to the level playing field.

The questions around data privacy and unethical use of user data are a major challenge which may have the tendency to become increasingly universal and in more spheres of our lives. To address this challenge, the type of user data that these companies may obtain and use needs to be clearly defined and regulated to address ethical concerns.

68 'Wicked Problem'. Wikipedia, 23 Mar. 2021. Wikipedia, https://en.wikipedia.org/w/index.php?title=Wicked_problem&oldid=1013760651.

The data economy incentivizing surveillance capitalism on the one hand, and tighter control over the population incentivizing forms of state surveillance on the other hand. The reality of surveillance is a major challenge and area of high risk. It is arising to the public debate and this research encourages the further study of its possible effects on the right to the city [69], the right to public space use and the right to the virtual layer of the city and its public space.

It is crucial to clearly define where the responsibility of one sphere starts and where the other ends. The obstacle here is for policy and decision makers to define these clear limitations which today are often lacking or unclear. In order to overcome this challenge, there is a need for the private and public spheres to sit around the same table, which may be challenging in itself.

Internally, in municipal and transit authorities, organizational restructuring needs to occur to integrate the technology and digital infrastructure related responsibilities, within traditional departments such as planning and engineering. The restructure process is an obstacle which needs to be dealt with, as it requires the possible formation of new departments or responsibilities. This obstacle can be dealt with through taking a holistic approach and looking at the greater benefits for the population.

Organizations that do not address current challenges with sufficient agility, may not have the capacity to respond to changing demands and innovations that have not yet been regulated, as precedents are formed.

As mentioned in recommendations, section 6.2, municipal responsibility over new mobility services can benefit guidance decided upon on a regional level. This can also be beneficial for the implementation of a city-wide mobility network that crosses municipal jurisdictions. The obstacle here is in reaching a consensus between municipalities. This obstacle may be overcome by starting a pilot project initiated by a regional body, which coordinates between municipalities but may use specific selected areas as testing zones, or zones for incubation of mobility and civic innovation. Even if this is just a few parking spaces in each municipality to begin with.

Where should one ultimately start? The findings of this research highlight that the curb space is an ideal contender, it is widely available as a mutable infrastructure which is overlooked by the public sector. This space can be used for the testing of civic and mobility related innovation. It can be done in different municipalities simultaneously.

However, no matter how small the scale, even a single parking space, there is still the need to define its value, as explored in section 1.4. The value of the virtual curb space real estate can be defined as a combination of societal value, monetary value, and coded value. Ultimately, the societal value needs to be quantified in order to be coded which is the first challenge this research recommend to tackle. Ideally, this should be initiated by the public sector and happen as early on as possible.

Finally, the digital – physical divide is elastic; however, one must be aware of widening the gap to a point where a new reality is set, before one can address it. The recognition of these multiple realities, the virtual and physical realms, is perhaps the clearest contribution that this research is offering, and it is the most important first step that needs to occur in order to move forward and transition into new mobility.

69 Harvey, David. 'The Right to the City'. International Journal of Urban and Regional Research, vol. 27, no. 4, 2003, pp. 939–41. Wiley Online Library, doi:https://doi.org/10.1111/j.0309-1317.2003.00492.x.

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