Smart Mobility
Overview and Data Governance Needs
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Smart Mobility involves the movement of people and goods through the application of technology, data and data analytics in a manner that balances safety, efficiency, comfort, sustainability, ability, inclusion, equity and cost-effectiveness.

Smart Mobility encompasses Mobility as a Service (MaaS) and Mobility on Demand (MOD), along with other services for those with a personal vehicle, such as electric vehicle charging, tolling, parking, congestion pricing, etc. Now is the time to consider data governance needs, as traditional intelligent transportation systems are transitioning to Smart Mobility. Strong data governance will support an efficient transition and build a foundation of reliable, complete and secure data. Developing a collaborative working relationship between the public and private sector will be critical to the success of Smart Mobility.
Transportation systems are undergoing major transformations spurred through disruptive technologies such as automated, connected, electric and shared mobility, and the use of new approaches such as machine learning, data analytics and distributed computing.

In terms of value, data is the new oil, and public-sector agencies are increasingly sharing their data and using third-party data to deliver services. Considering data governance needs now, as traditional intelligent transportation systems are transitioning to Smart Mobility, will support an efficient transition and build a foundation of reliable, complete and secure data.

Smart Mobility involves the movement of people and goods through the application of technology, data and data analytics in a manner that balances safety, efficiency, comfort, sustainability, ability, inclusion, equity and cost-effectiveness. Smart Mobility encompasses Mobility as a Service (MaaS) and Mobility on Demand (MOD), along with other services for those with a personal vehicle, such as electric vehicle charging, tolling, parking, congestion pricing, etc. Integrating all of these transportation services that may involve a revenue component into a single, interoperable real-time platform will result in optimized multi-modal trips for passengers or goods based on individual preferences with a single payment system.

MaaS describes the integration of services/modes of transportation accessible from a single app and on demand.1 This is achieved by combining transportation services from public and private transportation providers into a unified platform.1 MaaS can also integrate a ‘Family of Services’ approach where fixed-route and demand responsive transit solutions are integrated into a common platform. MaaS is focused on the movement of people and the shift away from personally owned modes of transportation to providing transportation as a service.

Mobility on demand (MOD), as defined by the US Department of Transportation, is a new concept based on the principle that transportation is a commodity where modes have economic values that are distinguishable in terms of cost, journey time, wait time, number of connections, convenience, and other attributes.11 MOD enables consumers to access mobility, goods and services on demand by dispatching or using shared mobility, delivery services, and public transportation solutions through an integrated and connected multi-modal network.14 MOD is focused on the movement of people and goods.

While MaaS and MOD capitalize on the shift away from privately owned vehicles, they do not consider the broader mobility landscape which includes use of personal vehicles that may or may not be electric and that may use fee for service functions during or at the end of their trip. A new concept, defined as a Mobility Marketplace, would integrate toll services within Oregon in a technology-agnostic, standards based tolling system. The system could even be extended to integrate fee for service functions.1 To truly recognize Smart Mobility, a system that optimizes demand and integrates payment, mode and route selection taking shared vehicles and personal vehicle considerations into account is required. The following diagram shows the relationship between MaaS, MOD, Mobility Marketplace and Smart Mobility.
MaaS and MOD platforms are being tested around the world, including within Canada. For example, three public-private service delivery partnerships related to MaaS include the Transit App (Toronto Transit Commission and Transit Calgary are official partners), the use of Translink’s Compass Card by three local car-sharing and bikeshare companies in a pilot to facilitate payment, and a partnership between Metrolinx and Lyft to support first/last mile connections. Development of a MaaS, MOD or Mobility Marketplace platform is a large undertaking with data governance needs of their own. Considering the broader Smart Mobility perspective at the early stage of MaaS and MOD adoption in Canada will support a staged approach to implementation that will enable a more connected future. This paper describes a Smart Mobility platform, considers how Data Governance can support a Smart Mobility Platform, and illustrates the role that government plays in creating an open, equitable environment for all.
One of the key enablers of Smart Mobility is a platform that creates:

**MARKETPLACE**

A *marketplace* for public mobility providers (public transit), private mobility providers (TNCs, micromobility providers, etc.), toll providers (toll roads, congestion pricing, high occupancy toll lanes, etc.), electric vehicle charging providers and parking authorities to sell their services for passenger or goods movement. This marketplace would be coupled with a clearinghouse to equitably disperse revenue from multimodal trips and a published and fully documented external application programming interface (API).

**ENGINE**

An *engine* that uses data analytics and predictive algorithms to optimize the network, reduce congestion and determine the best mode and route choice based on user preferences while enabling public policy levers to be implemented through a variety of measures including pricing.

**INTEGRATED USER INTERFACE**

An *integrated user interface* for users of mobility services to complete multi-modal trip planning that is seamless and based on real-time information, preferences, connection location and payment reconciliation being shared securely, while protecting personal information. Similarly, a grocery store that is using mobility services to deliver packages needs assurance that the packages will arrive on time and undamaged. Clearly, there is much work to be done to reach the end state of Smart Mobility.

The following diagram summarizes the key components of a Smart Mobility Platform. Data will play a key role in system functioning. For example, a user taking a trip that is comprised of multiple modes of transportation will need to be comfortable that the connections between the various modes occur seamlessly with customer information,
Smart Mobility Platform

Integration of all mobility options and provision of on-demand multimodal trip services with the ability to influence mode options through policy and incentives, and to promote accessibility, equity and balance of costs, etc.

**OPEN MOBILITY MARKETPLACE**

- Common Application Programming Interface (API)
- Open Data Protocol
- Free market for vendors to enter and exit
- Policies and levers to encourage the use of certain mobility options

**CLEARING HOUSE**

- An intermediary responsible for clearing and settling exchange activities and contracts between participating mobility service providers.
  - Audit and oversight
  - Account Statements
  - Bill management
  - Cost sharing
  - Collection and maintenance of margin
  - Facilitation of Fund Transfer
  - Financial reconciliation
  - Monitoring of transactions
  - Payment processing
  - Reporting of performance
  - Revenue management with mobility service providers

**CUSTOMER ACCOUNT**

- Management of account, including trip preferences and pricing options such as pay-as-you-go, prepaid and subscriptions plan, can be selected.
  - Customer Account Setup
  - Customer Account Management
  - Escalations (Inquiries)
  - Payment Info
  - Pricing Options
  - Tagged relevant user profiles (e.g. wheelchair access needs)
  - Trip Rating (final trip price)
  - Trip History
  - User Preference

**MULTIMODAL TRIP PLANNING**

- Convenient one-stop shopping for all mobility options to complete a trip journey.
  - Fare Assignment
  - Ticket Booking
  - Trip Assembly
  - Trip Building
  - Trip Reservations & Management (e.g. rescheduling & cancellations)
  - Trip Optimization (time-of-day, route choice, mode choice, etc.)

**DATA ANALYTICS & MANAGEMENT**

- Process of analyzing different data sets to enable performance monitoring, predictions and other data patterns to support the Open Mobility Marketplace.
  - Audit and oversight
  - Business Intelligence
  - Algorithms, Rules and Logics
  - Data Warehouse
  - Integration of different data sources
  - IT System Monitoring
  - Key Performance Indicators (KPIs) and Service Level Agreement (SLA) Monitoring and Reporting
  - Performance Dashboard
  - Resource Allocation

**Examples of Data Sources:**
- Connected Vehicles
- Construction
- Parking Authorities
- Real-time Traffic
- Transportation Network Companies
- Road Conditions
- Unplanned Events
- Weather
- Others (e.g. Google, Waze)
Data governance is a framework that considers all aspects related to the identification and management of data.

It can include roles, policy and legislation, standards (how data is shared), what data means (data dictionaries), how data is secured and metrics related to timeliness, accuracy and quality. Each of these topics are discussed below in more detail and with information on the current framework within Canada.

As Smart Mobility evolves, additional work will be required to identify the data governance organization structure, who owns the data, who are the data stewards, players and users, and how we define relationships between them. Data governance is critical when data is being shared or provided by multiple providers. Without it there is confusion, uncertainty and possible loss of trust.
Role of Data

Data will play a critical role in the success of a Smart Mobility Platform. There are a number of different types of data. Some key types include:

- **PERSONAL DATA**
  This includes account information (name, addresses, financial), travel preferences, accessibility needs, travel patterns and possible access to calendar information to enable trip planning and generation.

- **BUSINESS DATA**
  This includes account information (name, addresses, financial), goods information (temperature controlled, fragile, etc.) and business information such as general delivery times, etc.

- **OPERATIONS DATA**
  For shared mobility, this includes trip-level data such as fixed-route schedules, headway schedules, location and availability of assets (bikes, e-bikes, scooters, etc.), origin-destination data including pickup and drop-off times, waiting times for connections, vehicle accessibility, vehicle occupancy, Transportation Network Company (TNC) location and availability, etc. For personal mobility this includes travel time information, road closure information (planned and unplanned), parking availability, e-charging availability, managed lane location and attributes (i.e. 2+, 3+, priced), etc. Weather data including current and forecasted will also drive the trip generation engine. For goods data, this includes delivery window and origin-destination data including pickup and drop-off times.

- **FINANCIAL DATA**
  This includes all components that make up the cost of a trip such as fixed, zone or distance based rates for transit, surge pricing trends from transportation network companies (TNCs), average fares, and pooled versus non-pooled rides\textsuperscript{22}, parking fees, charging fees, other fees such as tolling, congestion pricing, high occupancy tolling and possible future road usage charges. The clearing house would also need to reconcile and distribute the collected trip fees to the appropriate service provider.
In addition to the data types identified above, other types of data include customer satisfaction, vehicle servicing information, etc. Many of the data types identified are currently in use but not integrated into a common platform. For example, in the UK, the Transport Systems Catapult (TSC) created an Intelligent Mobility Data Hub (IMDH) which supports aggregation of a variety of data sets from public sector and private sector transportation organizations. Data is aggregated, analyzed and stored and includes information such as vehicle emissions, national roadworks data, mobile network data, traffic movement patterns and haulage journeys. While this information isn’t real-time, lessons learned from this hub would be relevant to the Smart Mobility platform.

Consistency in data formats will be important to ensure information that is shared is consistent. One of the areas that could be problematic is in defining the location where a user transfers between different modes. Transferring between fixed route services, for example regional rail to bus, is typically done by using stop/terminal names as opposed to GPS location. In contrast, the location of an e-bike that will be used to complete a trip could be identified by a GPS location. Understanding the distances between points of connection is necessary to create traversable trips that take mobility restrictions into account.

Data Policy & Legislation

In Canada, open data policies are in place from the Federal Government through to cities where static and some real-time data is made available free of charge through open data portals. Not all data is available this way, but many data sets are and are defined in open data catalogues. Many transit agencies make planned and real-time schedule information available using the General Transit Feed Specification (GTFS) based on internal policy decisions. According to the Open Data Barometer published by the World Wide Web Foundation, Canada is ranked 2nd in the world in meeting the foundation’s objectives that:

- open data must be for everyone — a right for all;
- open data must be the data people need; and
- open data must be data people can easily use.

The Open Data Barometer considers many more data sets than just mobility, but is indicative of general support within Canada for open data policies.

In January 2018, Finland enacted a new law on transport (The Transport Code) that mandates all mobility providers to open data and API’s to third parties. This made Finland the first country in the world to regulate an open market for mobility services for passengers and goods. Through this process, they realized that “mobility suppliers feel a high degree of ownership to their customer base and are almost instinctively against a new party (MaaS provider or agent) in the value chain between the service offering and the consumer.” Building support in the supplier community will be an important step in this process.

Implementing legislation that would regulate an open market at the federal or provincial level would further enable development of a Smart Mobility Platform. Data privacy would need to be considered while developing policy and legislation. Compliance with the Personal Information Protection and Electronic Documents Act (PIPEDA) and the Data Privacy Act, an amendment to PIPEDA, will be a requirement as well as any changes that arise through Canada’s Digital Charter.
Data Standards

There are a number of data standards that exist which can support a Smart Mobility Platform by defining the data format and defining how the data is shared. These International (ISO, IEEE), European (CEN) and US (GTFS, GBFS, NTCIP, SAE) standards include, but are not limited to:

**GENERAL TRANSIT FEED SPECIFICATION (GTFS)**

The GTFS began as a standard focused on a common format for sharing static and then real-time schedule information and has expanded to include fare information, demand responsive transit information, service changes, pathways (or ways to route riders, in particular those in wheelchairs, through stations) and bus attributes such as bike capacity, boarding restrictions and accessibility. [https://gtfs.org](https://gtfs.org)

**GENERAL BIKESHARE FEED SPECIFICATION (GBFS)**

The GBFS is the open data standard for bikeshare real-time data feeds to support incorporation of data into map and transportation based apps.

**CONNECTED VEHICLE STANDARDS**

This concerns connected vehicle or Dedicated Short Range Communication (DSRC) standards. Messaging standards are being developed by SAE (J2735 and J2945), while many communications (Wireless Access in Vehicular Environments (WAVE)) standards supporting connected vehicles (CV) are being developed by IEEE.

**ITS STANDARDS**

These are standards developed to support Intelligent Transportation Systems such as Advanced Traveler Information System (ATIS), International Traveler Information Systems (ITIS), Location Referencing Message Specification (LRMS), Transportation Communications for Intelligent Transportation System Protocols (TCIP), Traffic Management Data Dictionary (TMDD), and Emergency Management (EM).
NTCIP
These are standards that describe several communications stacks and a common set of data for managing, controlling and monitoring field equipment such as weather sensors, traffic signals, Closed Circuit Television (CCTV), etc.

CEN/ISO GEOGRAPHIC DATA FORMAT (GDF)
Similar to OGC standards, GDF map and data standards focus on transportation features and navigable maps. Much of the feature definitions are derived from European Committee for Standardization (CEN) data modelling efforts such as TRANSMODEL. The EU performed a gap analysis of GDF with respect to Connected ITS (C-ITS, similar to the US CV initiatives), Smart Cities and MaaS.

CEN PUBLIC TRANSPORT STANDARDS
These include a data specification TRANSMODEL. It serves as the data dictionary and object model for other implementation models. Implementation models and specifications include Network Timetable Exchange (NeTEX) and Standard Interface for Real-time Information (SIRI).

OPEN GIS CONSORTIUM (OGC) (TC 211)
OGC standards describe methods and formats to share spatial data files, including map and feature geometries, imagery, addressing, linear referencing, and positioning services. OGC and TC 211 work cooperatively to promulgate standards.

OTHER CEN FAMILY OF STANDARDS
DATa EXchange standards (DATEX), similar to NTCIP and ITS Standards – ATIS and TMDD, are not compatible with US standards. The standards are used to provide information on current traffic network status.

OPEN MOBILITY FOUNDATION (OMF)
The OMF developed Mobility Data Specifications (MDS) comprised of a set of Application Programming Interfaces (APIs) that create standardized two-way communications for cities and private companies to share information about their operations related to dockless micro-mobility programs (including shared dockless e-scooters).

Existing standards will cover many of the data components in a Smart Mobility Platform; however, there will still be gaps. Developing a standards road map to identify applicable standards and areas where standards are needed would support a Smart Mobility Platform.
Data Metrics

The rollout of traveller information systems or 511 systems in the early 2000’s revealed a number of challenges with integrating different data sets. Even a simple element, such as a highway name, wasn't necessarily consistent between data sets. With the Smart Mobility Platform requiring real-time data integration and combining multiple service providers delivering an integrated trip, data quality and consistency will be an important metric.

Data quality covers a number of characteristics including accuracy, timeliness, completeness, reliability and relevance. Ensuring that the data format is well-formed and validated against its corresponding data schema will support accuracy as well as identifying when the data was captured and how long before it is invalid will support timeliness. Completeness of data is critical. Some data may be optional, but other data elements such as accessibility needs are mandatory. Having trust in the data's reliability is required. For example, knowing that there are actually four e-bikes (and not two or three) in good working order available for use at a particular location ensures that planned trips can actually be delivered. Third-party data providers often generate travel time by leveraging data from a portion of the traffic volume, therefore if that data provider delivered volume data it would not be relevant as total volumes are the useful information. The travel time data would be relevant because it is indicative of the general traffic movement.
Opportunities

There are a number of opportunities for the public and private sector to work collaboratively to create an environment that supports the ultimate development of a Smart Mobility Platform.

A first step is initiating dialogue between the public sector and mobility service providers to begin to build consensus and support on the ultimate vision for an open environment.

Secondly, government could support the development of a standards road map to identify applicable standards and areas where standards are needed. These steps would support a Smart Mobility Platform. By working with the private sector to define these standards, current best practices or de facto standards could be leveraged.

Thirdly, a scan of industry best practices could be completed to fully understand the global landscape. We expect there will be more examples in the MaaS and MOD areas as the Smart Mobility Platform concept is new. This best practices scan would also consider deployment models and partnership arrangements that have yielded positive working relationships between the public and private sector. Flexibility in procurement models will be important to implement a Smart Mobility vision.

Finally, legislation could be enabled at the federal or provincial level to mandate mobility providers to open data and APIs to third parties. A review of PIPEDA and the Data Privacy Act would be required to ensure that the legislation maintains compliance.

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