



# Building Ontario's Next-Generation Smart Cities through Data Governance

## Part 3: Open Architecture

Recommendations for generating value from city data



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# I. ABOUT THE SERIES

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## Building Ontario's Next-Generation Smart Cities Through Data Governance

There are many definitions of a “smart city,” but central to all of them is the implementation of advanced technology for the creation of systems and services to support prosperity and quality of life for people. As cities adopt smart infrastructure, they are beginning to gather useful data. Alone, that data can provide useful insights to help make specific aspects of city life more efficient and more livable. Combined with other data, city data could generate innovative new uses and new value. This emerging opportunity raises important questions on how data might be owned, shared and governed.

It's still early days and cities around the world are still figuring it out, researching and testing new methodologies, and leveraging digital technologies to support them. In such environments, digital research infrastructure is key to the exploration of smart cities data governance.

Rapid advancements in data collection, transfer, and analysis technologies have provided the Government of Ontario with the opportunity to explore new infrastructure systems for economic development. These technologies have enhanced the government's ability to amass volumes of data and interpret them to create data-driven solutions to challenges in infrastructure development and delivery of products and services to the citizens. However, this also raises concerns around privacy, security, individual rights, and privatization of citizen data. In order to balance innovation that leverages this data with individual wellbeing, the Government of Ontario granted Compute Ontario and ORION funding to study smart cities.

To support this deep-dive into smart cities and data governance models, Compute Ontario and ORION convened diverse stakeholders and experts from policy and governance sectors, as well as industry, academia, and research. We brought over 125 stakeholders together at a “Smart Cities Governance Lab” in Kitchener, Waterloo, in March 2019 to discuss and workshop the topic, and assembled a “Smart Cities Advisory Committee” with whom we regularly consulted. The committee gave us direction on project work, areas of exploration, and validated our report recommendations. We also furthered the exploration of three use case scenarios in the areas of health data, personal mobility, and building an open data platform to enhance economic development within the province.

This series of reports is a culmination of these efforts and focuses on resulting recommendations, existing examples of data governance models, and exploring various data principles, commons, collaboratives, and trusts.

In this report from Miovision, we explore an open architecture platform to facilitate equitable access to data and sharing between data stewards, generators, and users.

## ACKNOWLEDGEMENT

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# II. THE PROJECT

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## About Miovision

Miovision is helping build tomorrow's smart cities by transforming the way traffic works are managed today. Backed by the world's most advanced traffic AI, Miovision's innovations in traffic planning and operations have made it possible for cities to improve the transportation experience for drivers, cyclists, and pedestrians since 2005. With offices in Kitchener, Canada and Cologne, Germany, Miovision serves over 17,000 municipalities worldwide.

# Overview of Report

This project explores the legal and technical implications – and practical applications – of a data exchange, focusing on the transportation use case. The report is broken into a discussion of five key investigative areas:

- (1) Insights into the development of a Data Governance Framework
- (2) Recommendations around establishing a Demonstration Test Bed
- (3) Discussion about transportation specific Open Data Use Cases
- (4) Lessons from early development of a Data Exchange Protocol
- (5) Lessons from early Software License Agreement work completed with Miller Thompson

After a brief overview of these areas, this report discusses the alignment of these initiatives to the Province's emerging data strategy.

## Development of a Data Governance Framework

In an effort to advance thinking provincially and nationally about approaches to data governance, this proposal is presented for the creation and ongoing management of a data governance framework. The plan will include consideration for both data assets, as well as the corresponding source code that regulates access and use of data. Concepts of appropriate use, ownership, digital identity and patent collectives are considered. The culmination of this work has led to a proposed legal structure to enable the creation of such a governance vehicle to test the viability of the proposed approach.

## Feasible Pilot Test Bed

Discussions have been held with both public and private sector stakeholders in Ontario to determine a library of use cases that could be used to test ideas related to data governance. One or more of these use cases is put forward in this document as a recommended use case to develop a demonstration of a data governance approach. The use cases use data from multiple parties from both the public and private sectors.

## Provide Insight into Open Data Uses of Transportation Infrastructure

Miovision has a unique set of experiences with devices and software that collection and utilize data from legacy transportation infrastructure using communication networks, cloud and software technologies. This document provides specific insights about the opportunities that exist to leverage data generated from legacy investments in transportation infrastructure to usher in the smart city.

## Prototype Software Development

A demonstration prototype of the Open City Protocol has been built based on distributed ledger technology. The source code supports the following four primary functions:

- (1) Registration of a given type of smart city data with the protocol
- (2) Discovery by third parties of the existence of such data
- (3) Dynamic price discovery of such data based on supply/demand economics
- (4) Purchase of such data from the network

The four functions outlined above are demonstrable upon request.

## License Agreement Development

The final form of the Open City Protocol will be available to any third party who wishes to join the “federated network”. Joining the network will not cost money and will allow members of the network to sell data they own, buy data they have permission to access and provide a series of other network functions involved with running the network. Permitted uses of the network and the interactions with other members in the network will be governed by a software license agreement which was developed as part of the work outlined in this document.

# Alignment to Provincial Data Strategy

The open architecture data governance and exchange mechanisms proposed in this report align closely with many aspects of the Province's emerging data strategy, including promoting public trust and confidence, creating economic benefits, and enabling better, smarter, efficient government. It does this through:

- transparency about data transfers taking place and the terms under which they occur, helping to enable public trust and confidence in the data economy;
- creating strong governance mechanisms for this emerging economy;
- unlocking new potential revenue streams and economic development potential for cities;
- enabling Ontario firms to unlock the commercial value of data;
- serving as a driver of innovation in the public sector, helping create more efficient and effective government; and
- enacting leading, best technical practices that ensure chosen technologies use open software and open standards, and are secure, interoperable, locally procured, flexible, durable, and scalable.

## Data Governance Framework

Much work has been done recently looking at the use of legal trusts as a mechanism for data governance, including work completed recently by MaRS on the concept of Civic Digital Trusts (<https://marsdd.gitbook.io/datatrust/>). The work completed as part of this report considered a number of different data governance structures, including trusts, and ultimately concluded that given the use of software and the ongoing development of software by multiple operating entities, that a more suitable legal structure for the use case considered was a Limited Partnership. The structure allows multiple public and private sector actors to contribute source code, capital and other assets into an effort to stand up and operate a data collective in the same way that a corporation would, while allowing them to treat any income or losses associated with the undertaking in the best way given their unique circumstances. The Limited Partnership structure also allows for parties to come and go from the partnership as they see fit and allows for the separation of governance of the partnership (i.e. General Partner) and contribution to the partnership (i.e. Limited Partners).



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# Transportation Data Insights & Pilot Test Bed

Through the development of this report, numerous use cases were explored. Three such use cases were selected for inclusion in this report:

- (1) Data monetization
- (2) Sale of priority access to infrastructure
- (3) Influence infrastructure demand

## Data Monetization

Increasingly, cities are installing sensors that generate real time information (i.e. intersections, weather stations, transit vehicles, street lights, etc). In many examples, this information has utility beyond its initial intended purpose. For example, information about how many vehicles are going through an intersection is useful for a retailer when planning the location of their next location. Traditionally, this information has not been available to the retailer because cities have not had a means or a motivation to provide access to this information in standardized, ubiquitous ways. Via the Open City Protocol it would be possible for cities to make such information available and turn existing investments in data generation for one purpose, into a new type of income stream.

## Priority Access to Infrastructure

In some instances, it may be desirable or advantageous to provide priority access to certain types of infrastructure assets in exchange for financial consideration. An example of this is called Freight Signal Priority (FSP). In FSP, cities desire to encourage large trucks departing ports of entry to stay on designated traffic corridors. This keeps these vehicles away from traffic corridors where their existence could create safety issues (i.e. school areas). FSP allows cities to charge freight vehicles for priority green light access on those key corridors. This saves the trucking companies money on fuel since they do not need to stop and reaccelerate. It also creates environmental benefits. The Open City Protocol could be used to facilitate this type of transaction, creating a win-win-win for the city, the citizen and the private company.

## Influence Demand for Infrastructure

Building new infrastructure, such as new roads or new lanes, is very expensive. In an effort to defer some of this cost, cities are often looking for ways to encourage users of infrastructure to smooth out their demand. We see this in the energy sector with things like time of day pricing. In transportation, some jurisdictions have implemented congestion charging or tolling in an effort to shape demand. The Open City Protocol would enable cities to implement zero sum schemes, where users occupying high demand parts of the infrastructure could pay into the system and users occupying low demand parts of the system could draw down. This concept could be applied to time of day use and/or heavy/light traffic corridors.

## Pilot Demonstration Site

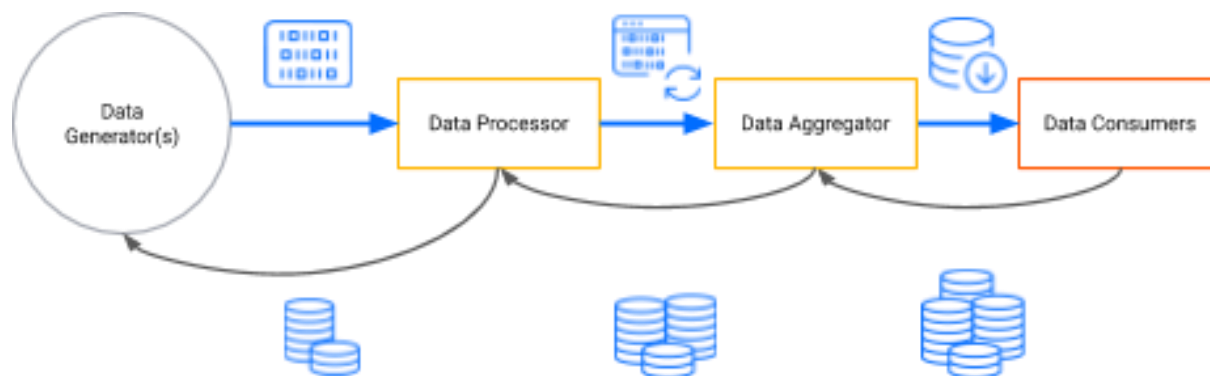
A number of discussions have been had with existing customers of Miovision about the possibility of applying the Open City Protocol to civic data. Several of these public sector customers have expressed interest. In one example, the mayor of a medium-sized Ontario municipality indicated that if the Protocol could increase municipal revenues by even 1%, this would be a huge benefit to the city. Given the three categories of use cases outlined above and given the proximity Miovision has to the Region of Waterloo, the region is proposed as a suitable demonstration partner, should an opportunity arise to further the development of the Open City Protocol in partnership with Compute Ontario, given their expertise in computing. The Region of Waterloo is a good potential fit for a demonstration project given the maturity and diversity of the local technology sector, a forward-thinking local government, and its recent achievement in the federal Smart Cities Challenge, where it reached the finals of the top category.

# Prototype Software Development

Through the development of the prototype version of the Open City Protocol, several design considerations were explored and decisions about optimal design were made. The following section outlines the problem the protocol is aiming to address and provides a high-level summary of the design decisions that were made.

## Traditional Data Markets

To understand the reasons behind the development of the Open City Protocol, it is necessary to review how traditional data exchange transactions occur in the market today. The typical workflow is as follows:



Working backwards, a data consumer purchases aggregated data from the aggregator, who in turn has purchased processed data from a processor, who initially purchased raw data from a generator. In many cases, these functions are performed by the same entity, however the flow and value exchange is typically the same.

It should be noted that the data generator who deployed the data capturing technology sees the least value in this exchange. The aggregator who employs costly business development and sales teams see the most. As a result, there is less incentive for data capturing technologies to be deployed as the return on investment is relatively small.

Additionally, due to the expensive nature of developing new markets, it is uncommon for data to be sold to multiple buyers for multiple purposes. This represents missed opportunities for the generator, processor, and aggregator. In traditional data markets we typically see the following situations arise:

Limited value in data generation

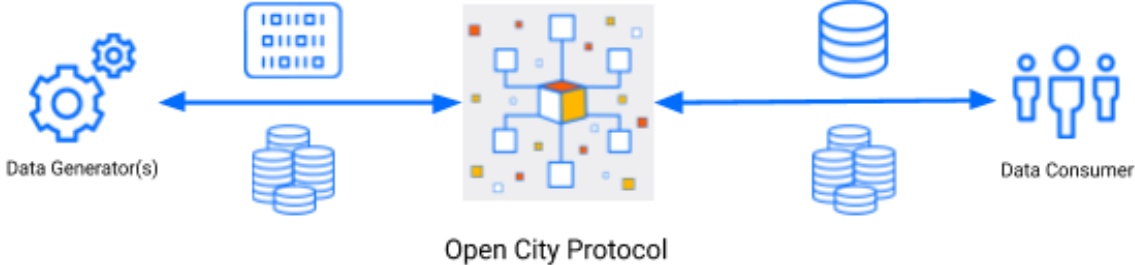
Largest portion of value is earned by processor/ aggregator

Reduced incentive to reach data generating ubiquity

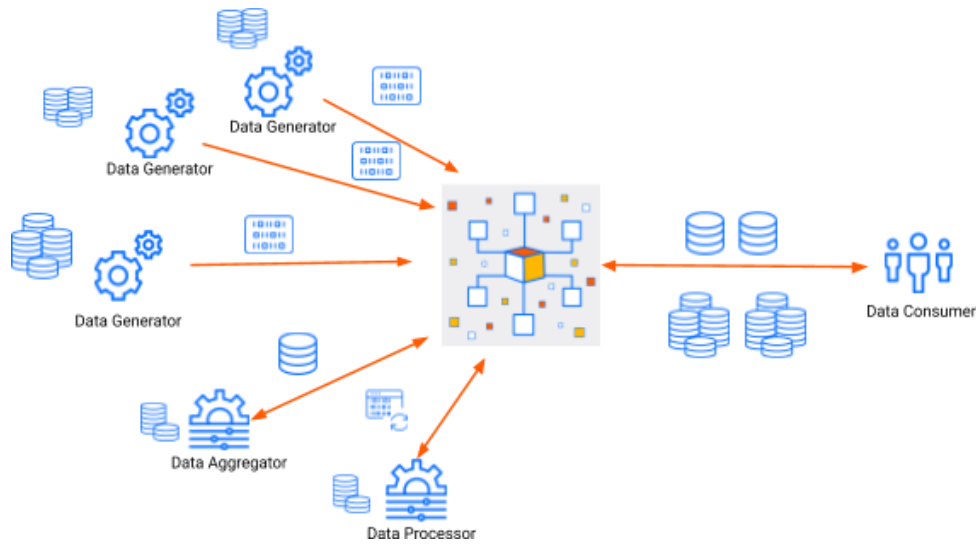
Data is often sold once for a single purpose

# The Open City Protocol Distributed Application

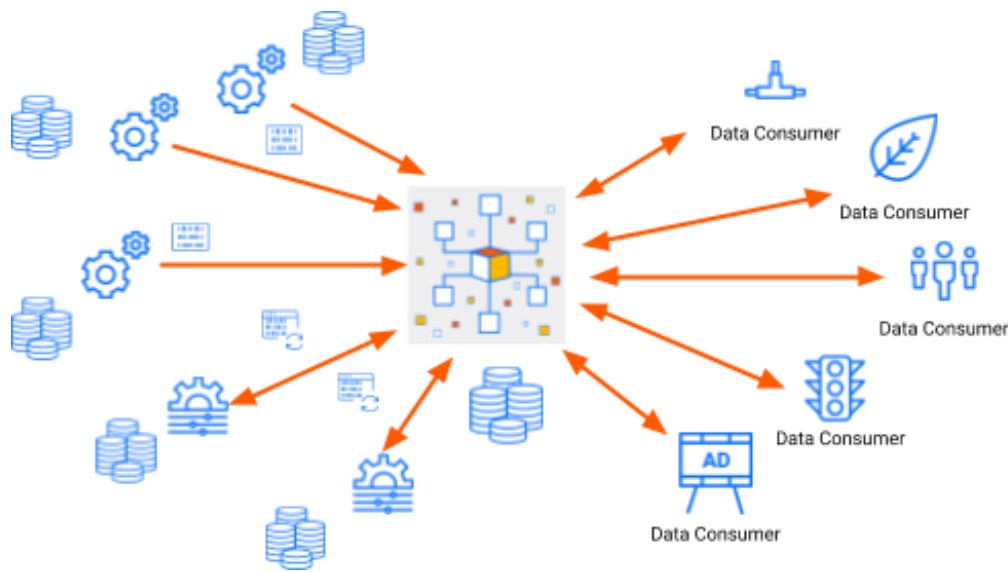
The Open City Protocol distributed application (dApp) facilitates the data exchange between data generators and data consumers, removing expensive process and overhead in between. Data processors and aggregators are treated similarly to generators. However, in this model, the value earned is directly represented by the value-add of their function. In a simplified view, the workflow is as follows:



Using underlying blockchain technology, the economic transfer of value is carried out directly within the protocol, removing the need for sales, business development, and financial institution overhead traditionally provided by middle men in the process. This economic value exchange is abstracted using the application's Open City Protocol token. Considering the traditional marketplace example, the following diagram depicts the roles of all involved parties:



The power of the Open City Protocol dApp becomes more evident as more data consumers join the system and begin utilizing existing data.



Here we see the true value of the Open City Protocol dApp. As an example, using intersection vehicle count data (generated) originally targeted for an engineering firm (consumer), we can see that this same data may be used by the water works department, environmental agencies, traffic operations departments and advertising agencies. The true value of the data can be recognized by the generator by exposing it for easy consumption via the Open City Protocol dApp.

In practical terms however, the data generator still doesn't have their own sales team, they don't know the value of their data and they don't know how to provide their data in a usable form to the consumer. The Open City Protocol dApp resolves these challenges by providing the following functionality:

## What does the DataCoin dApp Provide?

<b>Data &amp; Schema Discovery</b>	Search	What schemas are available What data is available
<b>Maximized Revenue for Data Generator</b>	Price Discovery, Rewards & Honesty	One-sided market fair pricing, transaction fees/ penalties and “Buy Now” option
<b>Economic Value Exchange</b>	Transaction, Data Storage and Fulfillment	Payments, delivery of data to consumer
<b>Security, Reliability</b>	Decentralized, Distributed & Trustless	Powered by Ethereum Blockchain dApp platform

## Data & Schema Discovery

This function provides the ability to search the index of available data (represented by schemas) in the Open City Protocol dApp. The system is built such that third parties may consume the index and expose a value-add service to provide search and discoverability of data within the application. These third parties may compete for the best search engine in a similar fashion to the World Wide Web search wars of the 90s and 2000s.

## Maximized Revenue for Data Generator

At the heart of the Open City Protocol dApp is the price discovery mechanism. Price discovery is critical to the valuation (and therefore price setting) of the data submitted to the system. The Open City Protocol uses a proprietary scheme using one-sided market (buyer) information to determine the price at which the data generator will achieve the maximum return. Inherent in this scheme are transaction fees, and rewards that ensure fair and honest behaviours. The price discovery mechanism transaction fees are used as a reward mechanism for honest buyers. More details on the price discovery mechanism can be found in a technical whitepaper that is available from Miovision upon request.

## Buy Now

As the system uses one-sided market dynamics to determine the price of data, it follows that a clearing period must take place and some bids will not be sufficient to purchase the data. As an alternative to repeated attempts at purchasing data, a “buy now” option for the data consumer is provided to guarantee the purchase of the data, albeit at a premium price.

## Economic Value Exchange

The Open City Protocol token is the atomic unit of value exchange inside the Open City Protocol dApp. This token effectively creates the means for a transactional economy allowing generators and consumers to buy and sell data through the application without traditional overhead.

## Security and Reliability

Using the Ethereum blockchain and dApp platform, a well-established blockchain, transactions occur securely and reliably. The application becomes decentralized, meaning no central authority or entity has the power to disable or control the application and transactions are immutable. This provides a clear history and guaranteed audit trail for licenses and ownership of data.

## Purchasing Data Licenses

The transactions described thus far have all been described as “buying” or “selling” data. In reality, these transactions do not transfer ownership of the data, rather they describe the selling of a license to use, analyze or derive further data. The ownership of the data asset remains with the original owner and future transactions of that same data will continue to be paid to this owner. As a licensor of the data, the buyer is entitled to derive new forms of data, transform, and aggregate it with other sources. This new data may be submitted back into the Open City Protocol dApp under a new schema. Due to the nature of the blockchain, these transactions and rights are completely transparent and immutable.

## Licensed Data vs. Data Assets

In addition to facilitating the exchange of data licenses (the right to use and analyze data) a data generator may elect to sell the data asset itself. In this scenario, the ownership of the data asset is transferred to the purchaser and all subsequent data license transactions are paid to the new owner. Data generators interested in larger one-time sales of their assets may choose this option as an alternative to smaller on-going sales. Likewise, data “investors” may choose to buy up as many data assets as they can – speculating that license revenue from these assets will continue to grow.

## Software License Agreement

The software license agreement (SLA) provides a legal overview of the design of the Open City Protocol. The SLA was developed by Miller Thompson LLC and follows best practices for software license agreements. The sections that are specific to the Open City Protocol deal with a Code of Conduct meant to ensure legal, ethical and moral use of the protocol, and terms that outline the responsibilities and allowable actions of Data Purchasers, Data Providers, Token Holders and the activities of those providing the services of the network, known as Miner.

# III. RECOMMENDATIONS

## Conclusion

The emergence of the smart city is raising numerous governance, ownership, ethical and technological questions about the type of digital city infrastructure that is appropriate for use in the 21st century. The benefits of technology applied to the built form of our cities could be immeasurable, but so to are the risk inherent with such application. Striking a balance between protecting the privacy and security of citizens, while at the same time enabling the safety, efficiency and environmental sustainability advantages that are afforded by technology will be key to ensuring the future of cities is inspiring and positive.

This project explored technological and legal mechanisms to allow cities to generate added value from city data. What's now needed are the public policy best practices that cities can use to ensure these emerging tools can be used to maximise the benefits of smart city data for cities and their citizens.

To help develop policy best practices, Miovision has become a founding member of the Open City Network (OCN), a not-for-profit organization that's mobilizing a working coalition of public, private and non-governmental organizations (NGOs) to build Canadian smart city architecture, standards and protocols in the public interest. The OCN calls this building digital public infrastructure and argues that approaching smart cities like public works will protect city institutions, drive government innovation and nurture a vibrant Canadian technology ecosystem. We encourage other technology companies and policy experts to join OCN and contribute to this important dialogue.



## Next Steps

This report is written by Miovision and solely represents the views of that organization. Miovision is also a founding member of the Open City Network (OCN), a Canadian not for profit building a cities-first approach to smart cities. The OCN Cities First approach calls for

1. A strong, modernized regulatory framework for smart cities that tilts strongly towards the public interest;
2. Open architecture as our technological foundation;
3. The public sector to retain the full rights and control over public data; and
4. Investments in the digital and cultural modernization our local democratic institutions.

While the OCN has only recently launched, it has started to welcome new public, private and NGO members, and to build partnerships across these sectors to advance the agenda outlined above.

In addition to advocacy, the OCN's work program includes:

- Regulatory modernization
- Building digital public infrastructure
- Public policy, governance and innovation

While the founding members of the OCN are Miovision peers from the Canadian technology sector (ESRI Canada, MappedIn and Geotab), as its work intersects with the public interest, the organization has created three new board seats reserved for the public sector, which are currently being filled. Its membership is also open to the public and NGO sectors as a common vehicle to advance this urgent work. The proposal outlined in this report will in time be considered alongside others within the OCN membership.



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