

An aerial night view of a city, likely Tokyo, with a dense grid of buildings and lights. Overlaid on the city are several glowing white arcs and lines that represent a network or data flow, connecting various points across the urban landscape. The sky is dark with some clouds, and the overall tone is high-tech and futuristic.

MODELS AND CHALLENGES FOR THE DEPLOYMENT OF NEXT-GENERATION TELECOM SYSTEMS IN CITIES

June 2018

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L'EXPERIENCE DU NUMERIQUE

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Introduction

In the winter of 2018, Montréal asked CEFRIO to lead a research team in conducting a preliminary assessment of the strategic and theoretical aspects of business models for massive deployment of next-generation telecommunications systems.

This report constitutes the conclusion of the iterative decision-making process, which included three workshops involving the municipal and project teams:

Workshop 1: Presentation of preliminary findings from the literature review and discussion on defining key aspects and considerations.

Workshop 2: Using examples from other cities, examination of considerations and theories pertaining to hybrid models of wired and wireless infrastructure.

Workshop 3: Discussion of issues involved in establishing a public 5G policy and, more broadly, the “information hub” concept.

The report does not include all of the information prepared for the workshops, which do however appear in its appendices. It serves primarily as a conclusion of the iterative process, presented in:

- Section 1, offering an overview of the literature review and 5G experiences.
- Section 2, providing an assessment of the regulatory framework.
- Conclusion, with a discussion on public policy directions.

This report is designed to support the city in its deliberations and propose possible questions.

SECTION 1: Literature Review and Experience with 5G

By Cristiano Therrien

The imminent arrival of high-broadband systems is creating turmoil in municipalities throughout the world. Cities must promptly adopt positions on the advent of new technologies that require installation of large numbers of telecom devices on their territories. These next-generation technologies also offer great potentials for cities. The time has come to define municipal positions on the new challenges of 5G, well beyond the scope of issues pertaining to capacities and antennas.

1.1 Municipal Concerns and Findings in the Literature

For the study, it was provided a comprehensive review of literature about the present state of municipal broadband in major cities of the world. The consulted literature consisted of academic, mediatic, corporative, and governmental publications which are listed in the annexes. Most of the documents are available and openly linked to their sources for further consultation, except some of the copyright-restricted academic articles.

The academic articles supported an initial explorative look into the technological elements of the subject, mainly 5G as a new technological trend for the cities. The selected media publications about municipal broadband exposed the social expectations and concerns in the matter, besides a more accessible description of the technologies involved. Corporative materials provided more granular details about commercial tendencies and institutional implications of the new context for fixed and mobile connectivity in cities. The official documents reflected the governmental propositions and actions already in progress which take into account all the previous elements in a more pragmatic approach.

The literature review involved a comparative review of broadband policies and models adopted by municipal governments around the world, with an emphasis on cities with closer characteristics to Montreal. The elements of comparison were presented in the meetings with the city hall employees who have contributed with all the necessary information about Montreal connectivity for the goals of the study. The city staff from various departments have demonstrated a higher level of knowledge about technical, regulatory, and institutional elements about municipal broadband and the singularities of Montreal than any previous in-house documentation could ever provide. The documentation review thus became a complement to the cumulated knowledge and a basis for further evaluations.

Montreal city hall follows one of the major municipal trends identified by the review of the literature: the city is responsively mobilizing academia, community, and government in planning the “connected city” for a near future through the understanding and solving of the present needs and conditions. Despite some distinctive conditions, the city hall shares other common trends in municipal connectivity and could be benefited by the shared experience available about similar cities.

After going through the documentation, it is clear that all major cities are facing similar questions and challenges to the fast-changing context of municipal broadband. The adoption of emerging technologies and new business models with increasing socioeconomic interest—notably 5G and IoT—depend on a massive deployment of consolidated technologies and usual urban practices—mainly fibre

optic and small cell networks—in a high demanding scale and speed for governments and telecom companies. In fact, all the related reports produced by consultants and “think tanks” hired for the public and private sectors come to describe this same diagnostic, however with some different predictions, concerns and solutions to face it.

The most notorious reports referred in media were produced for the use of telecommunications corporations and they describe similar concerns that reflect the point of view of the industry:

- About all concerns, there are the high costs involved to transition the technologies and the elevated investments associated to them that imply a considerable level of risk, in special those related to the (re)actions from governments;
- Municipal governments are seen as key players for establishing conditions of access to Right of Way (RoW) and use of street furniture, both which will be necessary for the deploy of the conjugated technologies of 5G and fibre;
- Telecom corporations are apprehensive that the cities may propose unachievable requirements of land use for the needs of massive deployment of small cells and fibre;
- The industry has also manifested concerns about requirements related to aesthetics and siting of equipment, which are very variated so far and with a lower level standard.
- An increased underground accessibility to conducts for fibre optic and energy are frequently mentioned as a necessary factor for the success in the transition toward 5G, with cities and other urban utility owners playing a great role in many cases;
- The use/rental of a variety of street furniture, in special city-owned poles and lampposts, constitute the main worry for the companies that will dispute the same urban spaces for their equipment, what will require cooperation between the many interested actors;
- Telecommunication companies tend to see themselves in a horizontal relation with governments for the development of their business, therefore they expect a relation of cooperation that should be reflected in regulations related to their needs of 5G and fibre;
- Finally, as governments are described as clients of their services, the reports from private telecom operators avoid mentioning any protagonist role of cities for setting public network infrastructures, despite the increasing number of municipal cases of it.

In an opposed and complementary sense, other reports produced for city governments share other kinds of concerns that compose the point of view of city officials and city dwellers:

- All questions related to costs and budgets are sensitive matters for any city department, so these come to the top of all concerns, considering that, in one way or another, those are going to rise to keep up with the growing needs of connectivity for the municipality;
- Municipal governments tend to see rising connectivity needs in order to keep up with municipal services and facilities that are expanding all over the world to correspond to the growing demands of citizens;
- In the previous periods, the connectivity needs were restricted to internal use in a limited number of facilities, but now the services are developing to reach every municipal equipment, including new services as open Wi-Fi and free public access;
- New technological resources are expected to deliver more cost-efficient and citizen-oriented services, ranging from connected traffic sensors to better decision making based on a data-driven analysis, all depending on reliable municipal connectivity to work;
- As an inclusive and non-discriminatory policy, any new telecom technology with positive economic impact has to aim a full city coverage, not only the more privileged urban areas;

- The deployment of 5G in the cities tend to concentrate in areas with a higher economic return for companies, keeping only 4G for areas of lower interest, thus limiting the expansion of fibre networks that are more beneficial to citizens and municipal services;
- Even on the areas where 5G is expected, many local debates from citizen concerns involving the aesthetics of small cells and fibre networks, possible health implications of 5G frequencies, higher costs of connectivity, as well privacy and security questionings;
- Governments see themselves in a vertical relation with telecommunication companies for the development of their communities, therefore they propose regulations that reflect expected cooperation related to the achievement of their collective needs;
- Finally, as telecom companies are openly lobbying for national regulations to limit municipal requirements, while not attending the local needs of urban areas, many cities are proposing public-owned networks to achieve more power of negotiation with them.

As well, it is necessary to highlight the recommendations in the official documents produced by national ministries and supranational organizations that describe contexts, evaluate conditions, and propose strategies for national, regional, and municipal broadband. Most of those reports are very oriented towards economic competitiveness on a world scale, and they avoid getting into the level of details of local implementation that are of major municipal concern. Anyhow, the issues and challenges identified by national studies cannot be decoupled from the municipal recommendations because the city officials have to meet the national concerns and solutions to achieve common understanding grounds with telecommunication companies and implied national institutions.

Similar questions and propositions are shared by the countries in the front run of the multi-technology 5G test beds and the fibre massive deployments being materialized in major urban areas:

- There is a strategic focus on economic development for the “industry 4.0” and the renewal of the automotive sector (e.g. connected and autonomous vehicles) which will demand active support from governments, including the financing of necessary infrastructures;
- The most urgent topic for national and global agreements relay on the harmonization of the 5G spectrum (frequencies below 6Ghz and above 25Ghz) for which the test results are crucial to choosing the frequencies to be used, with significant consequences for cities;
- Once the frequencies are defined, the expectancies of 5G signal speed/range and fibre densification will be known, so combined efforts need to be done in international and regional levels for a minimal standardization of technologies and business models;
- Despite eventual resistances in the telecom industries linked to commercial strategies, most reports point toward infrastructure sharing for small cell attachments and fibre conducts (locations and equipment) as a common goal to be negotiated and achieved;
- One of the ways of promoting appropriated standards and models for connectivity will be through the adequation of taxation for the use of urban spaces and street furniture, considering the high number of small cells and the massive fibre extension to be deployed;
- Other topics of public relevance are: safety, for the many health concerns around 5G frequencies; security, ranging from national cybersecurity to customer security; and privacy, for the enhanced capabilities of surveillance when combining 5G and IoT sensors;
- National studies highlight concerns about customer accessibility for all economic classes to high-speed connectivity in new mobile and fixed technologies (a subject not clearly detailed in corporative materials), which may cost more than broadband plans of today;
- Finally, some reports emphasize a need of adequation of local policy frameworks for better development of broadband in municipalities, with recommendations that the cities should use this opportunity for the development of their communities.

After considering the most present elements of analysis in the literature, it is safe to affirm that, despite all the similarities, the local conditions and responses from the cities can vary a lot, even when inside the same country or region. Some city cases can illustrate this undefined context.

When going beyond the overview of the literature that looks for patterns in public policies for municipal broadband in major cities, one of the first findings is that there is such a variety of models that it is even possible to say that there is no consolidated model. Every city case has many differences towards the others, many kinds of experimentations are in progress all over the world. Any urban researcher or city authority looking for solutions to the new local constraints related to fibre and 5G will conclude that there are many possible answers, depending on the local context.

The adequate model of municipal broadband policy to follow will be designed accordingly to the peculiar characteristics of the city and the conditioning necessities and forces in action. There are many key considerations to take into account, depending on political, economic, technical, and legal factors that are of difficult assessment for those not in the internal dynamics of a city hall. Many variants have to be put in balance to evaluate and propose a management model for municipal broadband, also depending on the viable partnerships with surrounding cities in a metropolitan area, partnerships with other public entities, or even public-private partnerships accordingly to the conditions in each case.

1.2 Prevailing Business Models

Evolution and Trends

Considering the fast-paced socioeconomic changes in societies due to the dissemination of digital technologies in all human activities in the last decades, it is expected that all governments adapt to the increasing demands of cost efficiency and service performance from their communities and citizens. Cities are considered one of the greatest human inventions of all times, and many of them have survived for centuries exactly for their inherent capacity of adapting to changing times.

In the past reasonably recent, telecommunication services for municipal governments were more limited to communications by fixed telephones and very specific data links for few data systems operated by cities. These limited services of communication were provided by private companies or state-owned companies and they were considered quite sufficient for the data needs at that time.

With a change of paradigm towards a data-driven society, local governments have been pushed to attend to multiplying demands of data-based management and planning in urban areas. More and more data is needed for automation and decision making in municipal systems which are constantly outgrowing the operational capabilities and/or cost limits of telecommunication networks provided by private companies.

Beyond the institutional needs of broadband communications, cities representatives feel the pressure from their communities and citizens to conduct public policies for digital inclusion, public transparency, civic engagement, personal data protection, information security, algorithmic accountability, and techno-economic development towards a data-based society. In order to achieve more responsive governance of all these social aspects and those institutional needs in place, more and more cities are playing a more significant role in the telecommunication networks in their urban areas.

Hundreds of cities have built their fibre optic network infrastructures, in a mobilizing movement that have been taking traction in the last ten years in North America, Europe and other continents. This tendency is clear in small and many medium-sized cities which are bounded by insufficient private telecom networks that negatively impact their urban living conditions. As there is not enough economic interest for telecom operators to expand high-speed broadband in their urban tissues, these cities are publicly engaged in evolving the previous private-based model to a community-based model of telecom networks.

In the major metropolitan cities, the situation is not so clear and depends on many factors, in special the obvious fact that the deployment of 5G depends on the expansion of fibre networks. It is likely that telecom companies provide enough investments in the urban areas with a major economic return, but they will not necessarily provide full urban coverage and attend all institutional and community needs, depending on the geosocial characteristics of the city. For this reason, many major cities are redefining their broadband contracts and policies by combining city-owned networks with public-private partnerships.

Review of Prevailing Models

Regarding municipal broadband—here understood as services of telecommunications between a city government and its communities and city dwellers—there are three main business models to consider:

- All private model – one or more telecommunication companies provide all the services of fixed and mobile connectivity to the city government and citizens as customers.
 - From contracts selected by procurement process, the city hall buildings and equipment are connected through the private infrastructure of a telecom operator.
 - The city frequently becomes a “special client” with some extra rights (SLA clauses), totally dependent on private networks, devices and human resources beyond any city control.
 - It remains the most common case in major cities, but it already lost the previous consensus of “natural choice” for reasons related to costs, efficiency, security and urban management.
- All public model – the city government builds and operates a public owned fixed network in an urban area which provides services to itself and its citizens. The city may offer wireless services as open WiFi in public areas, but telecom operators still have exclusivity for 3G/4G connectivity for citizens.
 - When facing the total or partial lack of investment by private companies, the city hall has to mobilize financial and human resources to create a network to attend the city needs.
 - Hundreds of small cities around the world have been building their public fibre networks for economic development goals and to provide better municipal services to their citizens.
 - The main form of sustaining this model is lending excessive dark fibre to private companies through contracts with a public-owned company or a specific city department.
- Partnership model (PPP/hybrid) – there are many models of public-private partnerships on work and being created which will combine elements of the previous models, accordingly to each context.
 - PPP models for setting up network infrastructures ready for new tech generations, where the main considerations are on who will own, finance, deploy, and assume the risk of it.
 - PPP models for operating the network in pre-determined terms to achieve municipal goals, where the main considerations are on who and how will pay, maintain and upgrade it.
 - PPP models for using the network where the main considerations are on who will “light” the fibre, provide services to citizens and companies, and support the city services with it.

Those are not fully closed models and the last one is prone to constant change because many cities around the world are searching for customized forms of better delivering their services in a network-based society and repositioning themselves in a more competitive scenario.

When it comes the moment to affirm which business model for municipal broadband would be adequate for a specific city—all private, all public, or hybrid—there are some issues and questions to pose, especially considering the context-changing expectancies related to 5G deployment.

Once uncontested, the ‘all private’ business model is the most commonly used by city governments and, by far, the best-known scenario. It carries all the advantages and disadvantages of a traditional full outsourcing model for internal telecommunications services for a municipality. With the future availability of 5G and feasibility of IoT-based sensors for municipal services, there are many questions related to flexibility, security, privacy and hidden costs to be taken in account, accordingly to city plans.

From a public policy perspective, the all private model keeps the city in a “user position” with a lower power of negotiation with telecom companies for meeting public principles and institutional objectives. There is less room to engage the telecom operators which commitments like fair prices, full coverage, and adequate use of street furniture, for example.

The transition to ‘all public’ model in telecommunications may be better understood by public administrations when looking in the past in the case of electricity companies (many moved from the private to the public control) or looking abroad to telecom companies that remain under partial state ownership. In term of cost/benefit relations, there are many possible questions about the capacity of financing, deploying and operating a citywide fibre network for municipal services. Considering the imminent 5G and fibre massive deployment by telecom companies in larger cities, it is expected that many urban areas will be impacted with overlapping fibre networks and small cells on the streets – the city hall may increase or lower this impact.

When a city has a full (or even a partial, if relevant) telecom network, it comes with the advantages of a “major player” for negotiating terms and conditions with telecom companies. This bargaining resources can be added to the political capabilities of city representatives and the institutional powers (even if limited) of the city hall, and be very useful for ensuring the accomplishment of certain public policies.

The ‘hybrid’ model of municipal broadband, better know as public-private partnership, is composed of elements, risks and rewards from the previous models and shall be demonstrated through existing cases.

Studying Different Hybrid Models

Among the larger cities in the world, the literature review pointed some illustrative cases of hybrid business models with contrasting differences that can help to delineate options for municipal broadband.

CALGARY

The city as a provider of a public dark fibre network for public and private users

The city has been installing its own dark fibre for city use over the years and licenses out excess dark fibre to other organizations to encourage innovation, economic growth and competition within the community.

Main features: city-owned network with more than 400km of fibre reaching all quadrants of the city; network operator-neutral (open access); the city provides support 24/7 for itself and customers.

The city expands the network to meet customer premises. The customer is responsible for funding the last mile build cost but will be reimbursed the full value. The city as the ultimate owner of the asset will reduce the lease cost until the full value of the last mile build cost is recovered by the customer.

The city offers fibre services to civic partners and non-profits, schools boards, universities, research centres, hospitals, clinics, data centres, ISPs, carriers, commercial businesses, wireless towers. The city fibre network does not provide Internet services, residential retail service, network and electronic equipment.

BOSTON

Combining telecom operators networks and city equipment and management

The city operates a city-wide network called Boston Optical Network (“BoNET”), which has been up and running since 2008, now connecting more than 180 buildings.

Main features: Comcast and RCN own the network and provide service through franchise agreements. The city owns and runs the network equipment, providing more security and control of data.

BoNET provides agnostic network services to user groups that vary from typical office environments to 24x7 public safety operations. It provides critical, cost-effective infrastructure to the operations of the city, meeting the growing demands of a connected city.

SAN FRANCISCO

The city proposing three different models of PPP for municipal broadband

The city leads an undergoing process to design, build, finance, operate, and maintain a network proposed in three different PPP models: dark fibre network; dark fibre and lit services; dark fibre and lit services and WiFi.

Main features: city-owned, open access, passive optical network with full urban coverage, operated by a private partner (company, consortium, or joint venture) providing services to the city and telecom operators.

The three different models¹ proposed were based on previous studies, city council debates, public consultations, and meetings of city staff and representatives with private companies. The city will make funds available to cover a portion of the project costs through milestone and periodic availability payments.

In the first PPP model proposed, the city would not provide lit services but develop a single dark fibre network, with a partner responsible, under a contract of 30 years, of leasing dark fibre to telecom service providers.

¹ More details about the three models of San Francisco are described in three broadband studies, PPP documents (including the RFP), and two videos of public meetings listed in the annexes of the present report.

In the second PPP model proposed, one partner would be responsible for the dark fibre, and another partner would be responsible, under a contract of 7-10 years, for delivering lit services to competing providers.

In the third and final PPP model, which was detailed in a Request for Proposals, a single partner will provide, under a contract of 15 years, the dark fibre, the lit services and free WiFi in significant areas of the city.

STOCKHOLM

A city company leases a municipal dark fibre network for telecom providers and services for itself

Municipally owned passive dark fibre infrastructure provider, called Stokab, a neutral owner building and operating the basic infrastructure and leasing it on equal terms to competing operators.

Main features: It is the world's largest open fibre network with 1.25 million fibre km, 5,500 cable km, 600 nodes, more than 15,000 access points covering 90% of households and nearly 100% businesses in the city.

This public network interconnects the 4G mobile networks of four operators. The deployment of Stokab's initial network was financed by loans backed by the City, over €600 million on investment in 20 years. Stokab started generating profit after 13 years of operation. Savings are estimated to approximately €7 million/year.

AMSTERDAM

A metropolitan dark fibre managed by a public-private consortium with a smaller public share

A PPP for a passive fibre network infrastructure lead by Glasvezelnet Amsterdam (GNA), a consortium between the municipality, the housing associations and the private sector.

Main features: GNA owns and operates an open fibre network, any service provider can sign up to use the network, even though the telecom company KPN owns 70% of GNA shares.

Each partner invested €6m in return for a one-third stake in the company. €12m in funding was provided as debt financing. 120,000 meters of trenching were needed for the first 40,000 connections to buildings. Roughly 80 percent of the costs were labour costs, while 10 percent were fibre.

FORTALEZA

Partnership of city, state and federal governments for building and managing a shared fibre network

The city network started as a public partnership between the city, state, and federal governments, each one with a third of fibre pairs, with all partners cooperating for extending the network accordingly to their needs.

Main features: the municipality shares parts of its 260 Km fibre network (Fibrafor) with the state government fibre network (Cinturão digital do Ceará) and the federal government research network (Gigafor).

The Fibrafor interconnect city buildings and 16 WiMax towers to wirelessly connect over 600 schools and health clinics with WiMax small cells. Telecom contracts have been progressively replaced by the FibraFor. All partners use the same equipment to minimize technical risks. The network was used for FIFA World Cup.

CAPE TOWN

The city as a neutral host of fibre networks and cell towers providing services for telecom operators

The City provides an open access telecommunications infrastructure and backhaul services to commercial operators to extend their networks across the city's infrastructure, including masts in high sites for wireless.

Main features: the city-owned "Cape Town Metro Area Network" consists of 848 km of fibre-optic cables and 27 switching facilities. Fibre-optic cables and microwave links are used to connect over 400 city buildings.

Cape Town does not provide services to end-users, like ordinary businesses. The network involved CAD\$ 180 million of City initial investment in 7 years. It combines partnerships with national and state governments (IT, Police, hospitals etc.) and education networks.

ADELAIDE

Two PPP networks in the same metropolitan area - Ten Gigabit Adelaide & GigCity Adelaide

The Ten Gigabit Adelaide was Included in the City 2016–2020 Strategic Plan and the city council started a PPP process to connect 1.000 buildings through 100 km optic fibre network. The GigCity Adelaide network is a 1 gigabit network composed by the South Australian Broadband Research and Education Network

Main features: The private partner TGP owns the network "10 Gigabit Adelaide" and the city is its main promoter. "GigCity Adelaide" ownership is shared by State government and Escapenet, a private provider.

The City council released the PPP in December 2016 and announced the partner TGP a telecom operator, in December 2017. The city council will spend AU\$10 million over a "few years" under the partnership.

The GigCity Adelaide network was announced in 2016 and launched in August 2017 by the state government, which will invest AU\$35 million in expanding its fibre broadband network.

SECTION 2: Scope and Limits of Municipal Authority

By Pierre Trudel

Various factors must be considered in defining the city's position on next-generation networks. The first is clearly the legal framework.

A city has, or should have, authority over the deployment of a 5G network in two areas: (1) Infrastructure, use of public space and urban property. (2) Data, and in particular, how the city should apply its efforts to ensure members of the public that data generated by their movements and actions will comply with their fundamental rights with respect to its use.

2.1 Infrastructure and Urban Property

The advent of 5G networks sheds new light on the old question about the respective authorities of cities and telecommunication providers in building telecom infrastructure, especially in public spaces.

5G assumes the existence of an *ambient intelligence* environment. Deploying 5G means installing equipment, antennas, sensors, conduits and other facilities on public property. The challenge is to ensure that such installation is consistent with the many rules pertaining to the development of such spaces.

It is important to consider how legislation currently distributes authority among city governments and telecom firms. In view of the conditions imposed by the existing legal framework, we must clearly consider measures to increase the predictability of 5G infrastructure deployment conditions. We must also envision procedures for updating applicable legislation and prepare to advocate the importance of a legislative framework complying with the need for an orderly rollout of 5G environments, as well as with the sound planning and development of public spaces.

The 5G legal framework also depends on changes that are sure to come in terms of corporate authority and methods for installing the equipment needed to provide services.

Such a framework means that the areas in which cities have authority to act and set conditions for using of public property within their territory must be defined. We must also identify proactive efforts to promote changes in the legal framework for telecommunications that will be consistent with the requirements of a city that increasingly assumes the form of an information platform.

2.2 Municipal and Telco Powers Under Current Legislation

As explained in *Vidéotron c. Ville de Gatineau*,² the *Municipal Powers Act* permits cities to “make by-laws on the placing of wires,” “use of a public road,” “excavations,” “construction,” and “maintenance of works over or under a public road.” In exercising its regulatory powers, a municipality may require obtaining permits for which it sets the cost.

By the same token, s. 29.19 of the *Cities and Towns Act*, permits cities to enact by-laws “as regards the occupation of the public domain.” Municipalities also have the power to set tariffs under s. 244.1 to 244.4 of the *Act Respecting Municipal Taxation*.

Furthermore, the federal Parliament holds exclusive authority to regulate telecom firms, under s. 92A. (1) of the *Constitution Act, 1867*:

92. In each province, the legislature may exclusively make laws in relation to
[. . .]

10. Local Works and Undertakings other than such as are of the following Classes:
(a) Lines of Steam or other Ships, Railways, Canals, Telegraphs, and other Works and Undertakings connecting the Province with any other or others of the Provinces, or extending beyond the Limits of the Province:
[. . .]

The courts have extended the meaning of “telegraphs” to include the set of activities pertaining to telecommunications.

It follows from these constitutional provisions that a municipality cannot exercise its powers in a manner that interferes with the operations of telecom firm.

In *Alberta Government Telephones v. (Canada) Canadian Radio-television and Telecommunications Commission*³ the Supreme Court of Canada stated that: “The case law clearly establishes that if a work or undertaking falls within s. 92(10) (a) it is removed from the jurisdiction of the provinces and exclusive jurisdiction lies with the federal Parliament . . .”

In *Public Service Board et al. v. Dionne et al.*,⁴ the Supreme Court explained that “there cannot be a separation” between the carrier system, the physical apparatus and the equipment used to build and maintain these systems:

² 2017 QCCS 3571 (CanLII), <http://canlii.ca/t/h570z>

³ *Alberta Government Telephones v. (Canada) Canadian Radio-television and Telecommunications Commission*, [1989 CanLII 78 \(SCC\)](#), [1989] 2 SCR 225, p. 257.

⁴ *Public Service Board et al. v. Dionne et al.*, [1977 CanLII 207 \(SCC\)](#), [1978] 2 SCR 191, p. 197.

[. . .] where television broadcasting and receiving is concerned there can no more be a separation for constitutional purposes between the carrier system, the physical apparatus, and the signals that are received and carried over the system than there can be between railway tracks and the transportation service provided over them or between the roads and transport vehicles and the transportation service that they provide. In all these cases, the inquiry must be as to the service that is provided and not simply as to the means through which it is carried on. Divided constitutional control of what is functionally and interrelated system of transmitting and receiving television signals, whether directly through air waves or through intermediate cable line operations, not only invites confusion but is alien to the principle of exclusiveness of legislative authority, a principle which is as much fed by a sense of the constitution as a working and workable instrument as by a literal reading of its words. [. . .]

In 2017, in *Rogers Communications Inc. v. Châteauguay (City)*,⁵ the Supreme Court of Canada reiterated that “the siting of radiocommunication antenna systems is at the core of the federal power over radiocommunication. It is the appropriate and specific siting of radiocommunication antenna systems that ensures the orderly development and efficient operation of radiocommunication . . .”

A city may have a voice in, but cannot decide on, such matters.

The actual nature of regulations enacted by a city government must be assessed in determining how far a municipality can go in regulating the telecom systems of one or more telecom providers without infringing on federal authority.

The legislation’s primary purpose or prevailing characteristics must be defined in examining the true nature of the rule and its focus. This effort means evaluating the legislation’s legal implications and actual effects.

The actual objective of the legislation must be described. Courts do so by weighing intrinsic and extrinsic evidence. This analysis of effects must include an analysis of the legislation’s legal and practical implications.

A law that falls within the scope of the legislature that enacts it may incidentally touch on topics falling outside its jurisdiction without necessarily affecting its constitutional validity. The key is the law’s primary focus.

The courts have consistently recognized Parliament’s authority over tele- and radio communication. Peter W. Hogg wrote that:

*The Bell Telephone and Winner cases established an important rule, which has been consistently reaffirmed in later cases, that a transportation or communication undertaking is subject to the regulation of only one level of government.*⁶

This means that provinces and cities cannot, per se, regulate a telecom system’s planning, construction, management, siting, operation and maintenance, or a decision to maintain or not maintain such a system.

⁵ *Rogers Communications Inc. v. Châteauguay (City)*, [2016 SCC 23 \(CanLII\)](#), at paras. 65 and 66.

⁶ P. W. HOGG, *Constitutional Law of Canada*, vol. 1, 5th edition, Toronto, Thomson Reuters, loose-leaf, p. 22-8.1.

Similarly, telecommunications content falls squarely under the authority of the federal Parliament.⁷ Cities cannot regulate the content of messages that may be transmitted by communication systems through the spaces they govern.

Similarly, provincial legislation cannot regulate the construction, maintenance or siting of telecommunication on public roads, or require rent for using the right-of-way⁸. A provincial authority cannot impose restrictions or requirements on the service.⁹ The province cannot determine the siting or minimum heights of telephone lines over highways.¹⁰

In the same vein, a city cannot charge rent to telecom providers for using public right-of-ways.¹¹ Municipal by-laws requiring the city's approval for installing telecommunications systems and permitting the imposition of conditions are constitutionally unenforceable.¹² A notice of reservation prohibiting the installation of radio antennas on municipal land is unconstitutional.¹³

Ultimately, federal law regulates the facilities necessary for or essential to the operations of telecom providers.

In *Edmonton (City) v. 360Networks Canada Ltd.*¹⁴, the Federal Court of Appeal held that ss. 42 to 44 of the *Telecommunications Act* “should be read as comprehensive, exclusive code for regulating carriers’ access to public places for purposes of constructing, maintaining, operating transmission lines.” These provisions of the Act grant telecommunications providers access to public roads “for the purpose of constructing, maintaining or operating its transmission lines and may remain there for as long as is necessary for that purpose, but shall not unduly interfere with the public use and enjoyment of the highway or other public place.” Such access is subject to approval by the provincial and municipal governments. In case of dispute, however, the CRTC sets conditions for such activities:

42(1) Subject to any contrary provision in any Act other than this Act or any special Act, the Commission may, by order, in the exercise of its powers under this Act or any special Act, require or permit any telecommunications facilities to be provided, constructed, installed, altered, moved, operated, used, repaired or maintained or any property to be acquired or any system or method to be adopted, by any person interested in or affected by the order, and at or within such time, subject to such conditions as to compensation or otherwise and under such supervision as the Commission determines to be just and expedient.

(2) The Commission may specify by whom, in what proportion and at or within what time the cost of doing anything required or permitted to be done under subsection (1) shall be paid.

⁷ *Re C.F.R.B. and Attorney-General for Canada et al.*, [1973 CanLII 788 \(ON CA\)](#), [1973] 3 OR 819 (leave application to the Supreme Court of Canada denied).

⁸ *Toronto Corporation v. Bell Telephone Company of Canada*, cited above, note 117; *Bell Telephone Company of Canada v. Corporation of the County of Middlesex*, [1946 CanLII 31 \(SCC\)](#), [1947] S.C.R. 1.

⁹ *Re Public Utilities Commission and Victoria Cablevision Ltd.*, (1965) [1965 CanLII 498 \(BC CA\)](#), 51 D.L.R. (2d) 716 (C.A. B.-C.); *Montréal (Ville de) c. Bell Canada*, JE 84-1035 (C.A.).

¹⁰ *Mission Paving Services Co. v. British Columbia Telephone Co.*, [1982] BCJ No. 1740 (BSCC).

¹¹ *Montréal (Ville de) c. Bell Canada*, JE 84-1035 (C.A.).

¹² *Telus Communications Co. v. Toronto (City)*, (2007) [2007 CanLII 6243 \(OONSC\)](#), 84 OR (3d) 656 (Ont. S.C.).

¹³ *Rogers Communications Inc. c. Châteauguay (Ville)*, [2016 SCC 23 \(CanLII\)](#).

¹⁴ *Edmonton (City) v. 360 Networks Canada Ltd.*, 2007 CAF 106 (leave application to the SCC denied).

43(1) In this section and section 44, “distribution undertaking” has the same meaning as in subsection 2(1) of the *Broadcasting Act*.

(2) Subject to subsections (3) and (4) and section 44, a Canadian carrier or distribution undertaking may enter on and break up any highway or other public place for the purpose of constructing, maintaining or operating its transmission lines and may remain there for as long as is necessary for that purpose, but shall not unduly interfere with the public use and enjoyment of the highway or other public place.

(3) No Canadian carrier or distribution undertaking shall construct a transmission line on, over, under or along a highway or other public place without the consent of the municipality or other public authority having jurisdiction over the highway or other public place.

(4) Where a Canadian carrier or distribution undertaking cannot, on terms acceptable to it, obtain the consent of the municipality or other public authority to construct a transmission line, the carrier or distribution undertaking may apply to the Commission for permission to construct it and the Commission may, having due regard to the use and enjoyment of the highway or other public place by others, grant the permission subject to any conditions that the Commission determines.

(5) Where a person who provides services to the public cannot, on terms acceptable to that person, gain access to the supporting structure of a transmission line constructed on a highway or other public place, that person may apply to the Commission for a right of access to the supporting structure for the purpose of providing such services and the Commission may grant the permission subject to any conditions that the Commission determines.

44. On application by a municipality or other public authority, the Commission may

a) order a Canadian carrier or distribution undertaking, subject to any conditions that the Commission determines, to bury or alter the route of any transmission line situated or proposed to be situated within the jurisdiction of the municipality or public authority; or;

b) prohibit the construction, maintenance or operation by a Canadian carrier or distribution undertaking of any such transmission line except as directed by the Commission.

The CRTC holds the authority to resolve disputes between cities and businesses, including matters of cost.¹⁵ The CRTC takes in account a variety of legal, economic, social and political factors in performing its functions, meeting the objectives of the *Canadian Telecommunications Policy* and ensuring that provider services and rates are “just and reasonable.”¹⁶ The CRTC can rule on matters of law and fact, with such decisions being “binding and conclusive”.¹⁷

¹⁵ From 1970 to 1976, the Canadian Transport Commission held this power. The *National Transportation Act*, R.S.C. 1970, c. N-17, s. 51; *National Transportation Act*, R.S.C. 1985, c. N-20, s. 54; from 1906 to 1970, the Board of Railway Commissioners held this power: *Railway Act*, S.C. 1903, c. 58, amended by the *Act amending the Railway Act*, 1903, S.C. 1906, c. 42; *Railway Act*, S.C. 1919, c. 68; *Railway Act*, R.S.C. 1927, c. 170; *Railway Act*, R.S.C. 1952, c. 234. Also see: Pierre TRUDEL and René PIOTTE, “La réglementation des infrastructures de télécommunications au Québec,” (1978) 13 R.J.T., pp. 139-202.

¹⁶ *Telecommunications Act*, ss. 7 and 47.

¹⁷ *Telecommunications Act*, ss. 52, 60 and 61.

A by-law that is confined to management of public rights-of-way may be valid. For example, a city could require providers to give information on planned projects, coordinate work by different utilities, ensure public safety, etc.

2.3 Promoting a Predictable Regulatory Framework for 5G

The city has every interest in promoting a predictable framework for rolling out 5G systems on its territory and avoiding a case-by-case approach based on decisions over disputes with telecom providers arbitrated by the CRTC.

The city must acquire mechanisms for participating in the review of radio communication and telecommunications legislation to be enacted, according to announcements in the latest federal budget.

In any event, the city should promote a predictable framework with the CRTC in particular, as well as other regulatory agencies, in consideration of the 5G infrastructure's inherent characteristics. This could obviously be done more easily through close coordination among municipal governments across Canada.

2.4 Data Governance Framework in 5G Environments

Montréal holds certain powers with respect to a vast group of devices directly and indirectly involved in 5G systems, primarily under the *Municipal Powers Act*. Typical 5G connected environments involve the production and dissemination of all kinds of data, including data used by security systems, data generated, transmitted and required for automated (or not) connected devices and data used to provide public services.

Furthermore, data is becoming increasingly central to controlling municipal and quasi-municipal activities. That is why the city should adopt a policy on data flowing within its territory, using facilities located on its territory and on public property. In typical 5G ambient intelligence environments, the city, in its role of local government, is responsible for ensuring public information security. It must develop an approach guaranteeing that the deployment of 5G services will comply with personal rights and freedoms.

It is not only important to ensure compliance with rules on collecting and using personal data that might be generated by the various 5G services the city might authorize or install, but to establish measures ensuring that the data generated are protected like other personal information and as a communal resource available for everyone's benefit.

The formulation of a data policy means identifying requirements (legislation and other municipal obligations associated with different data categories). These requirements can be defined in terms of the rights and obligations of those concerned. Such requirements can be described with respect to the data life cycle (collection, transmission, access rights, use, change of platform and destruction).

In practice, such a policy should transfer the rights and obligations of the various stakeholders pertaining to topics including:

- Data capture, as by sensors.
- Data access rights.
- Information-sharing conditions.

- Guidelines on who can use data such as that generated by self-driving vehicles in the city and how such information can be used.
- Rules on transmitting information pertaining to areas falling under municipal authority.
- Access to information/data rules.
- Data retention rules.

Ultimately, a 5G policy for Montréal will involve the establishment of guidelines on what can be done with the data processed in areas falling under municipal authority.

Proposed Principles for Montréal

The following principles could guide Montréal in selecting its options for deploying next-generation telecom systems.

Privacy and other basic rights	Ensuring the public's ability to use the Internet while being protected (autonomous decision-making)
Security	Ensuring the physical security of infrastructure and cybersecurity
Ongoing assessment	Conducting impact assessments to monitor results, ensure compliance with principles and anticipate possible adverse implications.
Equity and inclusion	Supporting universal equality in obtaining services (financial, numeracy and other factors).
Coverage	Ensuring coverage throughout territory (physical factor).
Public interest override	Public interests prevail where public and private needs conflict.
Economic development	Promoting economic growth, innovation and employment.
Public health	Ensuring that public health risks are taken into account.
Urban design	Encouraging a harmonious appearance to brand the city's design.

These principles are based on those proposed by CIRAIG's research team (2017) in its study on creating an Internet of Things in Montréal.

SECTION 3: Formulating a Municipal Public 5G Policy

By Daniel J. Caron

Once a legal framework has been clearly defined, the process of establishing a public 5G policy should be implemented, one step at a time. This section outlines these steps, as well as questions to be answered.

Deploying 5G poses a variety of challenges to towns. Some of these challenges are operational, but others more strategic, including the development of broad guidelines that become public policies. The city's choices will not only have an impact on its operations, but potentially on the creation of new civil and penal responsibilities, as well, since these such options may extend beyond its traditional roles of planning or administering data pertaining to its management responsibilities. Such functions are the central issue, since the advent of 5G raises new questions about the municipal role in data management. This is the point of departure for planning, beyond mere issues of urban property and wireless deployment. Cities in which 5G rolls out will become de facto information hubs. The basic question beyond legislation and regulations that will determine what the city can or cannot do are based on the extent of its involvement in the data production chain. Various steps, some more tangible and others, less, make up the data production chain. In this new environment, the city must make choices at each step of the way, align these choices with general public policy guidelines and ensure that it can put these choices into action.

3.1 5G and Public Policy

Studies on 5G have, to date, produced little information on public policy. This makes sense, considering how new the issue is. At most, such information concerns exploratory attempts to propose approaches in formulating a regulatory framework. However, as discussed in Section 1 of this report, many deployments are now underway in different countries, each with its own distinctive characteristics. Any overview of these efforts would be only partial. First, this is because all of the projects are quite recent and have not received rigorous scrutiny to date. Second, this is because operating parameters, including the traditional practices of stakeholders in these areas and legal/regulatory frameworks may differ substantially from one jurisdiction to the next. Third, we have little information on these frameworks. Fourth, we do not know the origins of such deployment—or in other words, the roles of various institutions in supplying and using these technologies, prior to the advent of 5G. Additional studies have shown that most of these rollouts have been built around local frameworks based on customary practices with respect to these issues, in these settings. In other words, it would be risky to place too much emphasis on lessons learned or best practices based on this incomplete and shaky foundation. On the other hand, the descriptions we found through our study provide an excellent picture of what different communities are trying to achieve and how they plan to do so. This gives rise to several questions, including the following three, as starting points:

- To what extent are government officials involved in the data production chain?
- To what extent are public agencies involved in the different stages of data production?

- What forms do such activities take?

Such information should clarify issues and help explain certain cause-effect relationships between the 5G system's components (from down - to upstream), in designing a production model, proposing alternatives for creating potential business models and formulating recommendations.

3.2 Public Policy Components

Since most of the literature on 5G deployment is investigative, it primarily focuses on 5G's concepts and functions, such as big data and ultra-high-speed broadband, as well as questions on how collected data will be managed. When the public issue is discussed, however, it is often poorly defined, in a fragmentary manner. Such a discussion is rarely accompanied by an overview, focusing, for example, on urban property or the protection of personal information. While the issue of data management, arising out of open government and the release of data sets or the creation of an Internet of Things, precedes 5G, the advent of 5G places broader questions on the policy agenda, which transcend it.

This is because 5G opens the door to infinite options, in areas that never previously fell within the scope of municipal government or public organizations. 5G's nature could change things—and this is the choice that cities must make. That is because, in addition to the high-speed Internet that characterizes 5G, such a system permits massive collection of all kinds of information that will result in unprecedented data applications, with commercial, personal and public uses. Management of such data is a core issue—and not just matters of wireless service and urban property. This is because the municipal government will permit such data collection on its territory and, to some extent, according to the terms that the municipality decides to offer, to encourage through incentives or to impose with by-laws, within the scope of its existing or future powers, as Section 2 of this report describes. This is what government officials must decide. This is where they will determine the extent of their involvement in making 5G a reality. This approach must proceed by assessing the existing legislative and regulatory framework and evaluating the work to be done or limits to respect in making the public desire to take action a reality. When and only when this analysis has concluded, city officials can draw up one or more scenarios of roles and responsibilities of the stakeholders concerned, in implementing policy goals.

In terms of the chain of results to consider, two elements stand out clearly. First, there is a disconnect between the different tangible and intangible portions of the issue. The tangible component consists of two elements—wireless service and urban property. The intangible aspect consists of four elements: data capture and transmission, management of cloud storage, cloud navigation management (algorithms and apps) and, finally, public participation in community life.

Urban wiring and property are issues that are already on the agendas of municipalities, which, along with private telecom providers, play an independent role in this arena. 5G is paving the way to new possibilities in terms of the intangible. Capture and transmission of public data is a fresh issue that also falls within the scope of a smart city supported by an Internet of Things. Some options have already been discussed in this area, but remain to be validated. Management of and navigation in the cloud are additional issues highlighting the need for clear public policy directions, particularly as to whether municipalities should address typically municipal needs or to take broader action with respect to all data acquired.

The answer to this question will shed some light on what may be considered the “smart city” and the “information hub.” The more the city is committed to global data management, the more appropriate the “information hub” label, while a tighter focus on the city’s operational needs will support a concept closer to that of the “smart city,” in the strict sense. The sparse literature on the topic does however suggest that data is a public good that should be used accordingly. In such a context, this statement might also imply that the city could develop its own Internet with its own search engines and algorithms.

In terms of public participation, the issue raised—and the one we should bear in mind—is that data and algorithms produce information that should also permit public participation in different community issues. The central question is ensuring a place for participation, collaboration and deliberation, beyond the analytical and predictive abilities of algorithms.

For each of the elements listed, various problems are outlined: data/information governance and management, as well as security, robustness of infrastructure, data protection, data use, etc. Such civic concerns boost the intensity of the public problems and the authorities must be able to address them. The literature contains an ever-growing number of questions about harnessing big data. Generally, such questions are associated with issues of data governance and management, as well as public involvement in community life. There are fears of algorithms that are not controlled by government or public authority (in the sense of “commons”).

Finally, some questions for this portion of the public program require hard decisions. The scope of the activity must first be defined. Will it include all wiring or only that portion pertaining to municipal needs? Will urban property be covered by a universally applicable by-law? Second, what kind of ownership is desired for each component? Will the city own all the wiring? The storage space? Third, how will the system be governed (setting its broad orientations)? Should the public be involved? Just the city? Or the city with the private sector? Finally, how will the work be done on an operational level? By whom? These questions will lead to the creation of structure, determination of the desired degree of centralization, etc.

Table 1 provides an overview of the kinds of choices to be considered and discussed for each program component adopted by the city in its policy. This constitutes the first issue for the city—formulating a strong policy.

Table 1	Scope of Activity	Form of Ownership	Governance Model	Management Method
Wiring				
Urban property				
Capture and transmission				
Cloud (storage)				
Navigation (apps, algorithms, etc.)				
Uses				
<i>Choices: Private, public (in the sense of “commons”) and governmental</i>				

3.3 Information Management Abilities of Municipal Institutions

The advent of 5G, the smart city concept and the Internet of Things all depend on the growing ability to harness all information formats (both the traditional *document* and *data*). In today’s information environment, paradigms are always changing, the most important being the shift from paper to electronic documents.

Our review of the preparedness of public organization for information management is not very rosy. As we know, public organizations are rarely models for data/information governance or management. Their main shortcomings include:

- Lack of strategic content governance.
- Focus on technology (information resources are often defined as primarily being technology management).
- Fragmented content management, as required by services.
- Fragmented management of information question, according to expertise.

These factors cannot ensure the integrated information management needed by a smart city or information hub.

Finally, the “information hub” accompanying the advent of 5G is more than the smart city, or at least those defined like the King Abdullah Economic City (Saudi Arabia), Songdo (South Korea), and Tianjin (China). First, in contrast with “pure” smart city experiences, information hubs will not start from scratch. They are built on existing foundations. Next and most importantly, they not only address operating efficiency and effectiveness, but they create a role for the public in community life and policies, as well as in data management and governance. Questions about and deliberations on a municipal public policy should be anchored in data governance and management. This is the issue. 5G is a resource or a tool.

These are the main pitfalls to avoid and challenges to meet:

- Clear strategic guidelines.
- Establishment of suitable standards.
- Regulatory and financial resources and abilities.
- Mechanisms enabling the public to play roles on two levels:
 - o Participation, cowork and coproduction should be promoted to prevent municipal affairs from seeming “robotic.”
 - o There should be a public consensus on issues of data governance and management.

Conclusion

This report represents the conclusion of the iterative decision-making process on next-generation systems conducted by CEFRIO's team and the Ville de Montréal.

In short, the report demonstrates that many deployments are now underway. Each is different, responding to a variety of regulatory, legal, political and cultural settings. Not all of the cases cited in the literature have been evaluated. They are experimental and should accordingly be seen as fallow land.

The report then poses legal and regulatory issues specific to Canada. This overview shows that existing regulations may be fairly limiting and restrictive, depending on intended municipal roles and responsibilities. The framework currently governing the telecom industry imposes a variety of restrictions on municipalities with respect to final decision, whatever the kind of issue posed by 5G. It is, accordingly, necessary for the city to begin considering now how it wants to deal with regulatory agencies (such as the CRTC) in seeking to define a comprehensive, predictable approach, rather than an emerging, case-by-case strategy.

The third part of the report described the importance of 5G not only with respect to traditional issues of urban property and rights of passage, but as a matter of data management and governance. The municipal policy to be developed must accordingly address the entire data production chain made possible by 5G. Various questions, such as the scope of municipal involvement, type of ownership, etc., should be the object of serious consideration for each stage of the production chain. These answers can be used to create public policy scenarios intended for 5G. This section also highlights the importance for city agencies to deal with information management. This role is crucial in perfecting and developing great capacity to deal with new challenges that will accompany the advent of 5G.

The appendices provide a host of information to support the deliberative process.

First, a list consulted structures is presented, grouped by topics, with hyperlinks to the documents concerned. Over 430 references are available, organized as follows:

- *Resources/items provided by Web sites*
 - o By origin:
 - North America: Canada (General and cities: Calgary, Ottawa, Toronto, Vancouver) and the United States (General and cities: Boston, Chicago, Denver, Los Angeles, New York, San Francisco, San Diego, Seattle).
 - Europe: General and France, Germany, Netherlands, Spain, Sweden and the UK.
 - Africa: South Africa (Cape Town and Johannesburg) and Kenya.
 - Asia: China, India, Japan, South Korea.
 - Oceania: Australia, New Zealand.
 - South America.
 - o By topics:
 - 5G and "small cells."
 - Street lamps, telephone poles and urban property.
 - "Municipal broadband."
 - "Small cells" and health.
 - Smart cities and connectivity.
- *Documents*

- By topic:
 - 5G, “small cells” and urban property.
 - Academic texts.
 - Cities.
 - CRTC.
 - Fiber and “municipal broadband.”
 - “Neutral Hosts.”
 - Smart cities and IoT.

The deliberative documents used in Workshops 1 and 2 supplement the appendices.

The project team thanks all those who participated in the workshops and contributed to enriching the deliberations. The discussions were broad and engaged, which added to the pleasure of carrying out this stimulating project.

Literature Review—By Topic

MUNICIPAL BROADBAND | SITES INTERNET

(CLICK ON TITLES TO VIEW DOCUMENTS)

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2. 5G In Canada Depends on Feds Setting A Date, Telecoms Say
3. Bell applauds government commitment to next generation 5G wireless
4. Bell Can't Deny Fibre Optic Access to Smaller Competitors: CRTC
5. Canada and New Zealand announce major 5G tests, but national service remains years off
6. Canadian governments partner with global tech companies to prepare for 5G future
7. Cities choose sides in high-speed Internet battle
8. City Councils Strike Back in Bell Broadband Battle
9. Consultation on Releasing Millimetre Wave Spectrum to Support 5G
10. Council of Cochrane updated on state of dark fibre network
11. CRTC says big telecoms must share high-speed networks with competitors
12. Everything you need to know about 5G in Canada
13. Experts peer into the future of Canada's wireless 'spectrum' and predict seismic shifts
14. Fast fibre-optic internet arrives in many small towns before big cities
15. Fibre optic cable battle: Smaller players want in on Big 3 networks
16. Fibre Optic Network | City of Penticton
17. Here are the three most important files awaiting new CRTC head Ian Scott
18. New Canadian partnership in next-generation wireless technology | Canada.ca
19. Ontario and Quebec gain access to 5G wireless corridor
20. Relationship woes: Canadian cities don't want to split costs with telecoms for data
21. U.S. companies announce 5G launch dates, but Canadian telecoms stay mum
22. We're at the brink of a technological revolution: Joe Natale on the future of Rogers
23. What Canadians Should Know About the CRTC's Internet Decision
24. Why Ottawa Must Continue to Invest in Wireless Technologies
25. Report Finds Canadian Wireless Broadband Pricing Offers Least Bang for the Buck in Developed World

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26. City of Calgary CIO: "It's important to invest in our infrastructures."
27. Telecom Commission Letter Addressed to Matt Lonsdale (Law Department, City of Calgary) | CRTC
28. The City of Calgary - Access the City of Calgary's dark fibre
29. The City of Calgary - Dark fibre: What is it and how can it benefit me?
30. The City of Calgary - The City's Digital Strategy

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31. Rogers, Ericsson to test 5G technology in Toronto, Ottawa | Financial Post
32. The Battle Over the Future of Broadband in Canada: Mayors Tory & Watson v. Nenshi
33. 'This is not about the mayor': Leiper asks council to support competition for fibre-optic Internet access

Toronto

34. Rogers, Ericsson to test 5G technology in Toronto, Ottawa | Financial Post
35. The Battle Over the Future of Broadband in Canada: Mayors Tory & Watson v. Nenshi
36. 'This is not about the mayor': Leiper asks council to support competition for fibre-optic Internet access

Vancouver

37. Rogers, Ericsson to test 5G technology in Toronto, Ottawa
38. Toronto | Advancing Broadband Infrastructure and Internet Connectivity | City Council
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40. Toronto's cell tower radiation guidelines to stay
41. Why Mayor John Tory is against competition for access to affordable fast broadband

United States

42. 5G wireless pits cities against telecoms and their friends in the FCC
43. 10 Key Issues for California Cities & Counties on the Challenges of Small Cells & “Not So Small Cells”
44. AT&T's and Verizon's 5G networks are coming this year, your internet speeds will be insanely fast
45. AT&T to provide 5G to 12 markets by end of 2018, fibre to 82 metros by mid-2019
46. AT&T announces Dallas, Atlanta, and Waco as first three 5G cities for 2018
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49. Colorado Cities Keep Voting to Build Their Own Broadband Networks
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61. Verizon to FCC: Streamlined pole access will facilitate small cell, fiber deployments

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- 62. Boston spends \$10 million to expand fiber to schools, housing, city buildings
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- 87. In San Diego, a lamppost can tell you where to park
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- 99. Fibre to enable Europe's 5G ambition
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- 111. How Amsterdam was wired for open access fiber
- 112. T-Mobile Netherlands activates first antenna with 5G technology in Amsterdam

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