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Envisioning the Possibilities in an Interconnected Future

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SUMMARY

How has the convergence of information and operating technologies led to the concept of smarter communities and cities? Some Canadian cities already have started the process of becoming a smart city. Will they make wise investments in a future that allows us to extract new and greater value from community assets such as city parks, fieldhouses, streetlights, traffic signals, train stations, Wi-Fi networks and more? As we go through the process of integrating technologies to enhance existing and future assets, communities naturally are looking to understand the scope and applications. Beyond that, they need guidance on funding sources and natural partners for this transition.

Smart cities have much to offer the diverse stakeholders in a community, leveraging data and technology to make infrastructure more efficient and safer. These technologies improve utilization of civic infrastructure (such as public buildings, parks, streetlights and bus stops); and use real-time data to make smart decisions for everything from how healthcare is delivered, goods are transported, buildings are constructed, and financial transactions are made to how governments deliver their services. Cities need to work smarter and deliver greater services while keeping taxes low to attract and retain residents and businesses, no longer relying on population growth to determine how to expand. Exposure to smart city applications can happen every day—and it's simple enough through our cell phones, location services and pay options. Expansion of technology applies to smart traffic lights, the possibility of biometric scan hospital entrances and household appliances that can order grocers for you. Utilities even have a way into the conversation beyond smart meters—but with customer service use application that can only instantly report outages but allow customers to share renewable energy with neighbours through blockchain.

However, the path to adoption of smart technologies is slowly coming together. Given the conservative nature of municipalities the change will be gradual as technology continues to prove itself. It will likely happen in the private sector first, paving the way for stronger business cases to be built. Municipalities and technology firms will need to start with identifying the areas of low efficiency and/or high safety risk to determine the low-hanging fruit to initiate pilot testing in smaller, controlled environments. These can prove the

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application, validate the technology and its benefit, and confirm the expected operational savings. Municipalities then can weigh the costs in operational savings and/or enhanced safety versus maintaining the status quo to determine the expected payback period for a business case justifying investment.

Utilities and municipalities must partner with technology firms and consultants as they participate in research and development and pilot testing. Electricity and telecommunication are two basic building blocks that any aspect of smart technologies will need, which makes the local electric and telecommunications utilities natural partners in planning and rollout of pilot at full scale. Early adopters are already leading the way. In time, cities will differentiate themselves in the types of services they provide and the talent and employers they are able to attract. By acting quickly, those who pursue the smart cities applications will unlock a wealth of life-improving possibilities, turning what might sound like science fiction into reality.

KEYWORDS

Smart cities, technology, smart city adaption, data and technology

How has the convergence of information and operating technologies led to the concept of smarter communities and cities? Some Canadian cities already have started the process of becoming a smart city. Will they make wise investments in a future that allows us to extract new and greater value from community assets such as city parks, fieldhouses, streetlights, traffic signals, train stations, Wi-Fi networks and more?

As we go through the process of integrating technologies to enhance existing and future assets, communities naturally are looking to understand the scope and applications. Beyond that, they need guidance on funding sources and natural partners for this transition. Smart cities have much to offer the diverse stakeholders in a community. The time to start is today.

WHAT IS A SMART CITY?

Smart cities use data and technology to make infrastructure use more efficient and safer while simplifying the lives of residents. These technologies improve utilization of civic infrastructure (such as public buildings, parks, streetlights and bus stops); remove inefficiencies from the everyday activities and systems we use today; and use real-time data to make smart decisions for everything from how healthcare is delivered, goods are transported, buildings are constructed, and financial transactions are made to how governments deliver their services.

For a long time, our cities have relied on population growth as the catalyst to build out new neighborhoods. The expanding suburbs increased the property tax base paying for essential services such as utilities, roads, bridges, parks, sports facilities, hospitals, schools and libraries. That model is no longer feasible because sprawl has made it cost prohibitive. Increased regulations have raised the cost of building the infrastructure needed to support new neighborhoods; and raising property taxes to pay for it has reached many taxpayers' threshold. Cities need to work smarter and deliver greater services while keeping taxes low to attract and retain residents and businesses.

Consumer demands are changing, too. Many millennials prefer living close to work in higher-density neighborhoods and close to city amenities such as entertainment, parks, theater, public transit, restaurants and cafes within walking distance of a home where they don't have to do yardwork or shovel snow. A majority of Canadian newcomers arrive from Asian and European countries with high-density urban populations, and many prefer to live in similar high-density neighborhoods close to work and play.

Technologies from supercomputing and instrumentation to communication and robotics have matured to the point that, when combined, they produce intelligent systems that collectively work to automate mundane and routine tasks. In a way, this revolution is no different than the mechanized industrial revolution of the 20th century that brought us kitchen appliances, vehicles, airplanes and factories. The logic has always been that whoever can produce more for less money wins, and the societies that embrace technology sooner advance more quickly than others. In the early 1900s it was proliferation of electricity, then mechanization, that delivered that efficiency and productivity; in the late 1900s and early 2000s it was telecommunications and computing; and in the next several decades it will be the confluence of those four technologies along with portability of abundant energy that are merging to give us artificial intelligence and robotics.

A GLIMPSE INTO A SMART CITY

To understand how this revolution may impact cities and lives, let's consider some examples of everyday activities and imagine how they might change in a smart city. Imagine going out for dinner to a restaurant, and by the time you get there the restaurant already knows what you're going to order, whether it is a work dinner or a romantic evening, and where you prefer to sit based on your past selection and user preferences. A just-in-time, freshly prepared hot meal is delivered to your table as you sit down. Once finished, you walk out and your phone automatically transacts the payment on your behalf, saving you time and frustration, so you have more time to enjoy the company you're with.

When you're traveling out of the country, your cell phone company might notice that you've entered a roaming zone. It knows the plan you're on, whether you have roaming coverage and what roaming rate options you have. When you arrive, your phone gives you those options, prompting you to choose your coverage. You select one of the options and now you've got coverage without the frustration of going online or logging into your app, looking for roaming costs and then making a payment. It's not a pleasant experience for those who've gone through it, and it's not something you should have to think about right before hopping on a plane for vacation.

For another application, think of going to the airport. Imagine your phone has already checked you in. You walk through a security screening zone where you don't have to remove your shoes, belt and jacket, and your phone has already ordered a taxi for you. It's waiting outside as you walk out at your destination, making your airport experience much smoother and efficient.

Think of a traffic system in your city where — based on traffic volume, predicted congestion zones and any accidents that have just occurred — the traffic management system changes signals automatically to direct or detour traffic through less congested or alternate routes that wouldn't otherwise get used, maximizing utilization of the available routes, reducing congestion on the main thoroughfares, and saving you much frustration and time.

Implications in healthcare are tremendous. Next time you're sick and feel the need to see a doctor, suppose you could describe your symptoms to a phone app to scan your body temperature, perform a retina scan, offer a blood and glucose scan, as well as scan any injury. The app uploads the information to a supercomputer that can virtually diagnose your condition and, depending on the severity of your condition, determine if you need to rest at home, send a prescription automatically to your nearest pharmacy, or determine that you need to be seen by a doctor for further diagnosis or go to an emergency room. Then, when you arrive at the hospital, there's no need to check in at the triage desk because the biometric scan at the entrance has already identified you. Your app tells you which unit you're supposed to go to, saving you and the healthcare system tremendous costs while delivering higher quality and timely healthcare.

Next, consider a scenario in which your home appliances, furnace/air conditioner and water heater are smart enough to know which rooms are occupied and when electricity pricing is cheaper. Your house uses that knowledge to move air to occupied rooms, run your laundry cycles, and heat or cool the house to optimize energy usage, maximizing comfort when you're home while minimizing your energy consumption when you're not. There are many such

intelligent applications in the kitchen, where your oven could detect, based on the ingredients and tray, that you're baking a cake. It knows the temperature and humidity needed to get the texture and crust coloring you want and automatically turns off the oven when the cake is baked. It notifies your phone of the baking progress and when it is done baking, letting you go about your daily activities in the meantime. Similarly, your fridge could automatically order your groceries when it recognizes that you're running low on milk, eggs, butter, ketchup or other staples. It would know the types and brands of groceries you like, order them for you and have them delivered to your house. Your house could detect a water leak, fire or robbery and call a plumber or notify the fire station or the police while you're at work or on vacation and keep you posted on progress.

Augmented reality has made big leaps, and it continues to improve. There are many potential applications of augmented reality, such as training new skilled trades in operating a new system, or remotely troubleshooting an equipment failure so that an experienced person can guide a junior apprentice through an issue. Training of soldiers or police could be enhanced by creating war or crime scenarios that could be experienced safely while being immersed in lifelike situations. Simulations of complex concepts or mechanical processes for students might be facilitated.

Picture a school bus whose whereabouts you can look up on your phone. As it arrives at your house, it notifies you and your kids that it is time to come outside. It also notifies you when your kids are dropped off at home. The same concept could apply to public transit, which could send similar notifications of a bus' location and arrival time at a stop.

A major shift in the transportation sector is underway toward greater electrification and intelligence in cars, buses, trucks and rail systems, as well as the coming of autonomous vehicles. Perhaps as technologies mature, we will find it cheaper, more convenient, safer, environmentally friendly and more productive to have an autonomous taxi drive us to work, shopping or to visit a friend. Today's private vehicle ownership could be much reduced, especially in urban areas. Similarly, the public transit buses and rails will be driven autonomously and powered by batteries or overhead electric wires. We have already heard about the Tesla Semi, portending the move toward electrification in commercial goods movement.

UTILITY OPPORTUNITIES BEING IMPLEMENTED

Many inefficiencies are primed to be tapped in our current regulated rate models of the municipal utilities. Competitive industries typically are more efficient because market forces have made them lean to stay viable, while municipalities have been sheltered by their regulated framework. Imagine roads and bridges, buildings or utility infrastructure that don't require annual or monthly inspections by field crews to check the integrity of the system. Instead, there are sensors in place that monitor cracks, vibrations, rusting and coloring to determine the health of the asset and notify municipal authorities when repairs are needed.

We're starting to get a taste of what these technologies will look like. For example, Hydro Ottawa has a call-in center where utility customers can connect or disconnect service or pay their bills. The unusual thing about Hydro Ottawa's call center is that it uses voice-recognition software to identify its customers. Its system knows, based on voice, who is calling and provides access to their information, instead of requiring a call center

representative to ask questions to verify the customer's identity. Banks, hospitals and your insurance company could potentially apply this model. Alectra, a utility in the Toronto area, is experimenting with blockchain to permit peer-to-peer transactions to allow, for example, a customer with rooftop solar to sell electricity to a neighbor down the street.

Oakville Hydro, an Ontario utility, has implemented an advanced distribution management system using fault location isolation and restoration (FLISR). This allows the system to detect outages swiftly when a power line or pole falls because of a storm. The system automatically notifies the utility control center to send in repair crews. It identifies the location where the repair is needed, making the repair much quicker. In the past, the utility might have to wait for a customer to call in to report an outage; then crews had to drive around the neighborhood to determine where the fault was and the cause of the issue, whether it was a blown transformer, broken conductor from a fallen tree, or someone having backed into a pole. Speedier reaction improves the reliability of the power system, making residents happy while allowing the utility to function more efficiently and thus keep electricity rates low.

FIRST STEPS START WITH IDENTIFYING INEFFICIENCIES

The lines of demarcation are blurring as newer technologies allow utilities, municipalities and technology firms to overlap each other's traditional territories. How far those boundaries will stretch and who the winners or new market entrants may be, no one can say with certainty. To understand what a smart city could do for you, think about the routine, mundane tasks of daily life, from paying a utility bill to interacting with your bank or a government agency. Then think of the inefficiencies in the system and how they might be removed, or how poor utilization of an asset like your car could be improved. An average vehicle gets used only 10 percent of the day; the remaining 90 percent of its life is spent sitting in your garage or parked at work or a store. Would it not make sense for a ride-hailing service to provide you transportation? You could link your schedule with that service and have a car automatically sent when you need to go to work or a doctor's appointment or the airport.

One great demonstration of efficient use of an asset is the use of batching in the oil transmission pipeline industry to transmit liquid fuels. Pipeline operators routinely intermingle batches of different commodities back-to-back. For example, the pipeline operators will routinely inject a batch train of jet fuels for several hours, then switch to a batch of diesel for the next day, followed by gasoline the following day. Using the same pipeline to transmit many commodities is far more efficient than requiring separate, dedicated pipelines for each commodity. Complex batch scheduling and measurement processes at both injection and delivery points ensure various commodities are delivered to the right point in the right quantity and of correct specification. Innovative thinking and technology facilitates this; a single pipeline asset is utilized efficiently, minimizing energy consumption, land disturbance, environmental impact and toll costs. This kind of thinking needs to expand to other assets to get maximum value from our infrastructure.

The reality is that no one knows which technology will proliferate or when, but being engaged helps you take baby steps and gradually ramp up at the pace of innovation. Moving into this space when technology has fully evolved will be difficult and finding the right skilled resources may be a challenge.

THE PATH TO ADOPTION OF SMART TECHNOLOGIES

This puzzle will be solved as the various pieces slowly come together. Given the conservative nature of municipalities — from exposure to public scrutiny, property tax implications and

election cycles — the change will be gradual as technology continues to prove itself. It will likely happen in the private sector first, paving the way for stronger business cases to be built. Municipalities and technology firms will need to start with identifying the areas of low efficiency and/or high safety risk to determine the low-hanging fruit to initiate pilot testing in smaller, controlled environments. These can prove the application, validate the technology and its benefit, and confirm the expected operational savings. Municipalities then can weigh the costs in operational savings and/or enhanced safety versus maintaining the status quo to determine the expected payback period for a business case justifying investment at full scale.

It's important for interested parties to be aware of potential available funding opportunities. For example, to jump-start municipalities and utilities, the Canadian federal government launched several initiatives in its 2017 budget to provide funding for cities, municipalities, utilities and First Nations communities. These initiatives will support research, feasibility studies and planning to adopt new technologies, enhance asset management, become energy efficient, and improve public transit and infrastructure. Among these funding mechanisms:

- Smart Cities Challenge — \$300 million allocated toward city planning, digitally connected technology, clean energy systems and smart roads.
- New infrastructure bank — \$35 billion allocated toward projects in transportation, green infrastructure, clean energy, and rural and northern community infrastructure. The bank also has a mandate to bring additional financing by arranging public-private partnership opportunities.
- Rail Safety Improvement Program — Transport Canada provides grants to improve rail safety.
- Allocation of \$180 billion in infrastructure funding over 11 years, focusing on public transit, transportation infrastructure, electrification and development in aboriginal communities.
- Disaster Mitigation and Adaptation Fund — \$2 billion to mitigate changing climate risks, such as floods, wildfires and droughts, by building or reinforcing constructed and natural infrastructure.

CONCLUSION

Utilities and municipalities must partner with technology firms and consultants as they participate in research and development and pilot testing. Electricity and telecommunication are two basic building blocks that any aspect of smart technologies will need, which makes the local electric and telecommunications utilities natural partners in planning and rollout of pilot projects. Partnering in this way will also help shape the development of technologies, so that the final products will work to meet municipal needs. At the same time, such partners will gain valuable insights and experience with the new products in development. Equally important, the city and utility engineers will be able to sketch long-term plans to better position future utility and transportation infrastructure with provisions to readily adopt the new technologies when they hit the market. As the convergence of technologies paves the way, we will see many changes in how our cities and municipalities function and how residents get their services. Technologies under the marquee of smart cities — electrification, automation, robotics and artificial intelligence — are starting to unfold, giving us a glimpse of what the smart city might deliver. Early adopters are already leading the way. In time, cities will differentiate themselves in the types of services they provide and the talent and employers they are able to attract. The Canadian federal government has several grants to help communities and utilities begin planning for implementation. By acting quickly, those who pursue the smart cities applications will unlock a wealth of life-improving possibilities, turning what might sound like science fiction into reality.

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