Smart Traffic Signals

Recommendation

That the June 5, 2018, City Operations report CR_5728, be received for information.

Previous Council/Committee Action

At the February 27, 2018, City Council meeting, the following motion was passed:

> That Administration provide a report on smart traffic signals that includes the following:
>
> 1. The average age of our traffic signals across the city, estimated lifespan, and replacement costs of all traffic signals.
> 2. An overview of how the current traffic signals work in Edmonton (ex: communication with other signals, ability to respond to traffic flow for people who drive, use transit, walk, and/or bike).
> 3. An overview of the differences between signals that we use in Edmonton and the smart traffic signals that are currently available and being tested in cities such as Toronto and Pittsburgh.
> 4. The estimated impact to travel times and emissions between standard and smart traffic signals.
> 5. How smart traffic signals fit in with our Smart Roads plan.
> 6. How smart traffic signals will work with automated vehicles.
> 7. A proposal to pilot the use of smart traffic signals in Edmonton.

Executive Summary

New and emerging smart technologies have the potential to change the way people and goods travel. As the City of Edmonton prepares to adapt its roadways for emerging technologies, Administration continues to collaborate across all departments to assist with the transition over time.

Smart traffic signals, or adaptive traffic signal controls, are one element in the smart roads toolkit. This report provides an overview of Edmonton's traffic signals, including lifespan, how they operate, potential upgrade costs, and how they compare to smart traffic signals used or being piloted in other cities.

In September, 2018, Administration will present its Smart Transportation Action Plan to City Council along with a capital profile request for 2019-2022. The plan will focus on

automated, connected, shared and electric mobility technologies as well as smart traffic signals. Follow up to the plan may include a pilot project in 2019 to test smart traffic signal technology.

Report

Traffic signals in the City of Edmonton are designed and operated in accordance with national guidelines developed by the Transportation Association of Canada (TAC). Traffic signals improve the safety and mobility of pedestrian, cyclist and vehicular traffic. Ongoing operations also support City initiatives and policies, such as the Active Transportation Policy, Transportation Master Plan – The Way We Move, the Smart City Strategy and The Edmonton Road Safety Strategy 2016-2020 Vision Zero.

“Smart” traffic signals, or adaptive traffic signal controls, are typically defined as technology in which signal timing changes (or adapts) based on actual traffic demand.

1. The average age of our traffic signals across the city, estimated lifespan, and replacement costs of all traffic signals.

Age and Lifespan

The operation and maintenance of Edmonton’s traffic signals is broken into two parts: the traffic signal cabinet (the “brains”) and the infrastructure (e.g., signal poles and fixtures). The average lifespan of the City’s traffic signal cabinets is 20 to 25 years; the average lifespan of the infrastructure is between 25 to 80 years depending on the treatment used on the pole (galvanized poles have a longer lifespan).

While the signal infrastructure will not change as smart traffic control technology is implemented, the cabinets (or “brains”) will require upgrades. Currently, the average age of Edmonton’s traffic cabinets is nine years. A more detailed list of the quantity and age of the cabinets is provided below.

Age (years)	**0 - 5**	**6 - 10**	**11 - 15**	**16 - 20**	**21 - 25**	**> 26**	**Total**
Quantity	417	238	172	100	64	96	1,087

The ability for Edmonton’s traffic signals to communicate with other signals varies according to the age of the equipment. By 2019, roughly 545 traffic signals will be upgraded through the Traffic Controller System Conversion Program (capital profile 15-66-2511). This upgraded equipment will make the traffic signals compatible with smart traffic signals and will allow Administration to monitor intersection controls remotely.

Replacement Costs
There is significant investment required to replace and modify the traffic signals not compatible with smart signal technology. Administration has identified two scenarios that will impact the funding required to transition to smart traffic signal technology:

- Scenario one: Install additional equipment at signals that are already compatible. This involves adding detection, cabling and auxiliary devices for adaptive control. The anticipated cost would be approximately $100,000 per intersection.
- Scenario two: Install additional equipment and upgrade traffic cabinets that are not compatible. This involves adding detection, cabling and auxiliary devices for adaptive control as well as replacing older traffic signal cabinets. The anticipated cost would be approximately $200,000 per intersection.

Complete rebuilds may be required at some intersections with aging signal poles and fixtures. In these cases, Administration would coordinate with other capital rehabilitation projects to optimize savings. The estimated cost may be as much as $400,000 per intersection.

The chart below illustrates the approximate costs per intersection to implement adaptive traffic signal controls. These are high-level estimates, given there has been no technology selected and no estimates for supply and installation.

Signal Types	Approximate Quantity	Conceptual Cost Per Intersection	Total
Existing adaptive signals	0	n/a	n/a
Compatible Signals	700	$100,000	$70 million
Signals Requiring Upgrades	400	$200,000	$80 million
Estimated Total			$150 million

2. An overview of how the current traffic signals work in Edmonton (ex: communication with other signals, ability to respond to traffic flow for people who drive, use transit, walk, and/or bike).

Edmonton's traffic signals operate in a conventional manner: timing schedules are predetermined and developed based on historical traffic counts in either fixed time or actuated time. To ensure timing schedules match traffic patterns, Administration reviews and adjusts signal timings on a four-year cycle, or based on requests.

Fixed time signals automatically change with each signal phase and provide regular and consistent time intervals at which to cross. They are used in busy urban areas, such as downtown, for network organization, increased predictability and to reduce unnecessary delay.

Actuated time signals adjust green times for some or all movements based on detected pedestrian, bicycle and vehicle demand (i.e., push buttons or loop detection). Approximately 70 percent of Edmonton's traffic signal inventory operates with actuated signals.

The City also incorporates Intelligent Transportation Systems (ITS) applications with traffic signals. Traffic signal preemption (or traffic signal prioritization) is used to give signal priority to emergency vehicles (fire trucks), heavy and light rail (LRT) traffic and to provide transit priority. The emergency vehicle preemption system uses global positioning system (GPS) on fire trucks to turn traffic signals green for approaching trucks in order to improve response times.

3. An overview of the differences between signals that we use in Edmonton and the smart traffic signals that are currently available and being tested in cities such as Toronto and Pittsburgh.

Edmonton uses conventional signal operations, as explained above. Alternately, adaptive signal control technology provides:

- adjustments to green light time to account for real-time traffic demands;
- the ability to improve travel time reliability by progressively moving vehicles through green lights; and
- a reduction in congestion by creating smoother flow.

In 2012, Pittsburgh launched a pilot program to test smart traffic signals and is still in the process of collecting data. Toronto began a similar pilot in November 2017. Toronto will pilot 22 intersections along two corridors, testing two different technologies, and will collect data for a year before presenting its findings.

The majority of traffic signals in Pittsburgh and Toronto operate in a conventional manner, similar to Edmonton's, with predefined scheduled timing plans.

The table below summarizes the number of traffic signals in several North American municipalities, broken down by conventional and adaptive signals.

Municipality	Number of Signals	Number of Conventional Signals (Fixed/Actuated)	Number of Adaptive Signals
Edmonton	1,100	330/770	0
Toronto	2,300	Info unavailable	22/330*
San Francisco	1,230	980/250	0
Ottawa	1,170	230/915	25
Portland	1,100	330/754	16
Calgary	1,040	200/840	0
Vancouver	880	260/620	0
Winnipeg	850	170/680	0
Pittsburgh	600	Info unavailable	50

**The current pilot of 22 intersections is to determine replacement technology for Toronto's 330 signals that operate an adaptive technology deployed in the early 1990s.*

4. The estimated impact to travel times and emissions between standard and smart traffic signals.

Smart traffic signals are most beneficial where traffic patterns vary significantly (i.e., irregular events). Adaptive technology suppliers claim up to nearly 40 percent improvement in travel time and delays and a 30 percent decrease in vehicular emissions compared to when conventional signals are used. Administration will monitor Toronto and Pittsburgh's findings to determine actual results.

The beneficial impacts of the smart signals technology will vary depending on several factors, including the technology/system used, the number of locations piloted, the existing traffic signal performance and the congestion levels.

5. How smart traffic signals fit in with our Smart Roads plan.

Administration is developing a Smart Transportation Action Plan to prepare for automated, connected, shared and electric mobility, as well as adaptive traffic signals. The plan will guide the long-term integration of these technologies within Edmonton's transportation corridors and identify the City's short-term actions. Administration is collaborating across all departments to design an integrated system that supports the City's goals and outcomes.

The Smart Transportation Action Plan will be presented to the Urban Planning Committee in September 2018 (CR_5567). The plan will also inform the update to the City's Transportation Master Plan and Municipal Development Plan – The City Plan.

6. How smart traffic signals will work with automated vehicles.

The integration of smart traffic signals and autonomous vehicles (AV) is yet to be evaluated, due to the recent emergence of AV technology. Current AV technologies being developed by the private sector are designed to operate independently of adaptive traffic signal control.

The City of Edmonton and Government of Alberta are actively involved in a partnership with the universities of Alberta and British Columbia through the ACTIVE-AURORA project. Connected and AV applications are being developed to improve the safety and efficiency of the transportation network. ACTIVE-AURORA is expanding research and development of connected and autonomous vehicles. It is currently operating three sites on municipal/provincial roads in and around Edmonton as part of Canada's first connected vehicle testbed network.

7. A proposal to pilot the use of smart traffic signals in Edmonton.

Administration will present the City's Smart Transportation Action Plan (CR_5567) in September 2018, which could provide direction on conducting a feasibility study to better understand the benefits of adaptive signals in Edmonton, ultimately helping to identify adaptive-ready corridors for implementation. Associated funding will be requested through the 2019-2022 Capital Budget profile as aligned to the Transportation Innovation Council Initiative.

Selection of a pilot corridor for implementation will be determined based on locations that have compatible traffic control equipment and the greatest potential for traffic improvements. The City could find efficiencies and cost-saving measures by implementing adaptive traffic signal control in conjunction with planned upgrades to existing traffic signals.

<u>Conclusion</u>

While smart traffic technologies optimistically promise to increase efficiency in traffic flow for pedestrians, cyclists and motor vehicle users, technologies are still developing and significant financial investment will be required to see improvements. Monitoring the successes and challenges experienced by other municipalities will benefit Administration as it works toward implementing Intelligent Transportation Systems in coordination with the development of the Smart Transportation Action Plan.

Corporate Outcomes and Performance Management

Corporate Outcome(s): Goods and services move efficiently			
Outcome(s)	**Measure(s)**	**Result(s)**	**Target(s)**
Goods and services move efficiently	Number of intersections with pilot technology	N/A	TBD pending resources for pilot (from Smart Transportation Action Plan)
Corporate Outcome(s): Edmonton is a safe city			
Edmonton is a safe city	Number of intersections with pilot technology	N/A	TBD pending resources for pilot (from Smart Transportation Action Plan)

Others Reviewing this Report

- S. Padbury / R. Kits, Acting Deputy City Managers, Financial and Corporate Services
- C. Campbell, Deputy City Manager, Communications and Engagement
- A. Laughlin, Deputy City Manager, Integrated Infrastructure Services
- L. McCarthy, Deputy City Manager, Urban Form and Corporate Strategic Development