

BUILDING A **SAFE** AND **RESILIENT CANADA**
Public Safety Broadband Network
Temporary National Coordination Office

A Public Safety Broadband Network (PSBN) for Canada

A Canadian approach to implementation of the next generation of public safety communications

Emergency Management Partners in Collaboration with the Government of Canada

This publication outlines recommendations for advancing a Public Safety Broadband Network in Canada.

Aussi disponible en français sous le titre : *Un réseau à large bande de sécurité publique (RLBSP) pour le Canada : Une approche canadienne à l'égard de la mise en œuvre de la prochaine génération de communications de sécurité publique*

Public Safety Canada, Communications
269 Laurier Ave,
Ottawa, Canada K1A 0P8
ps.communications-communications.sp@canada.ca

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Executive Summary

Public safety and emergency communications around the world are in a state of transition. With new technologies emerging, the public safety community needs access to up-to-date communications capabilities to ensure that they are able to protect Canadians and themselves.

In Canada, first responders and other stakeholders have been working towards the goal of a reliable, modern, nationwide and interoperable public safety broadband network (PSBN). A PSBN is a network that can be used by emergency responders and public safety personnel to communicate with each other, share and access information during day-to-day operations, weather-related incidents and natural disasters, emergencies and major events.

The benefits of a PSBN are far reaching and include enhancing emergency prevention and response; improving community safety; addressing the growing need for data transmission particularly in the context of Next Generation 9-1-1; providing a solution for current interoperability challenges; complementing Canada's National Public Alerting System; and broader socioeconomic impacts. The delivery of PSBN services also supports Priority 4 of the *Emergency Management Strategy for Canada: Toward a Resilient 2030*, which seeks to enhance disaster response capacity and coordination and foster the development of new capabilities.

In May 2018, Federal-Provincial-Territorial (FPT) Ministers Responsible for Emergency Management collectively acknowledged the benefits of a PSBN in Canada and endorsed the establishment of a Temporary National Coordination Office (TNCO). Since its establishment in July 2018, members of the TNCO have collaborated to consult with stakeholders and gather their views, conduct research and analysis, and propose a way forward to improve emergency communications in the public safety domain. In June 2020, the TNCO concluded its two-year mandate to develop a national approach to advance a potential Canadian PSBN, and presents this report to FPT governments for consideration. The report outlines a number of recommendations regarding a governance approach, guiding principles, service delivery, approaches to achieving robust coverage and capacity, and suggests next steps for advancing a PSBN.

PSBN Principles

The development and implementation of a nationwide PSBN that will meet the needs and interests of stakeholders is no simple endeavor. Building on the work accomplished for the publication of its progress report in June 2019,[1] the TNCO has refined the PSBN Principles based on feedback received from stakeholders. Further, "Equitable Service" has been added as an additional principle to ensure the quality of experience is equitable across PSBN users. The following principles are meant to guide the deployment, operation and evolution of a PSBN as fundamental norms, rules and values.

Interoperability: The PSBN enables PSBN users to communicate and share information, as authorized, anytime and from anywhere it is accessible.

Equitable Service: The PSBN must deliver an equitable service to the entire community of PSBN users.

Affordability: The PSBN must be affordable to the entire community of potential PSBN users.

Sustainability: The PSBN must be realistically achievable and meet the needs of its first generation of stakeholders without compromising its ability to meet the needs of future stakeholders.

Coverage: The PSBN will, at a minimum, have equivalent to existing commercial mobile wireless broadband coverage and should establish and/or enhance coverage in underserved urban, rural, and remote areas and Indigenous communities.

Deliver Mission Critical Services: The PSBN will enable the delivery of network-hosted mission critical services (MCS) to public safety users.

Network Access Always: Whether in their daily routine, or during major events or emergencies, PSBN users must always have immediate and uninterrupted access to the PSBN where it exists. This includes, in instances where a PSBN is carried across commercial cellular networks, ensuring first responders are unaffected by network congestions caused by user density or event driven commercial carrier surges in use.

[1] To read the progress report, please consult https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/2019-prprt-npsbn/index-en.aspx

Security: The PSBN must incorporate security mechanisms meeting the trust requirements of the organizations of PSBN users and those accessing and exchanging data through it.

Resiliency and Robustness: The PSBN must be resilient and robust to meet network access requirements.

Use of Spectrum: The PSBN will efficiently and effectively use spectrum.

The TNCO recommends that the development, deployment, operation and monitoring of a PSBN satisfy the ten PSBN Principles.

Governance Approach

With a mandate to develop and propose options for the governance of a PSBN in Canada, the TNCO has taken the steps to consider the possible structures and processes that could be designed to ensure overall responsibility, decision making, and participation in an accountable, transparent, inclusive, and responsive manner. Guided by the PSBN Principles, the governance approach should be flexible, sustainable, forward-looking, and comprised of the following components:

1. **Spectrum Licensing Framework**: An essential element of the PSBN led by Innovation, Science and Economic Development (ISED) that will establish the Band 14 Conditions of License and award the spectrum license(s) while considering the contents of this report.
2. **Centralized Governance Functions**: A centralized structure supporting national coordination and interoperability with guidance functions and potential coordination functions.
3. **Distributed Governance Functions**: Regional or distributed structures to address local operational challenges and requirements.

While ISED has decided that the spectrum will not be auctioned, a licensing framework will still be developed to ensure the licensee(s) meet the policy objectives of the allocated 20 MHz of spectrum in the 700 MHz public safety broadband spectrum. However, the licensing framework on its own is not sufficient to ensure the achievement of the PSBN Principles and should therefore be supported by additional governance and enabling mechanisms at both centralized and distributed levels.

There is an expectation among stakeholders for national leadership and guidance to ensure the success of a network of this scale, complexity and disparity of users. At a minimum, the following roles and responsibilities should be centralized:

- Respecting, promoting, and serving as a guardian of the PSBN Principles
- Establishing and promoting national common standards that support nationwide interoperability
- Providing advice to ISED on eligibility and suitability of potential Band 14 licensees
- Consulting with federal, provincial, territorial, municipal, Indigenous, and local public safety entities and authorities, as well as other relevant stakeholders and expertise in order to inform decision-making processes

The service delivery approach will determine the extent of the centralized structure's functions beyond the basic functions identified above. The mandate could therefore vary in size and scope depending on the amount and complexity of additional roles and responsibilities that are accounted for at a centralized level.[2]

Those functions which are not accounted for at the centralized level but are considered as necessary for the building, deployment and/or operations of the network would become distributed governance functions. These roles and responsibilities are best delivered on a regional or distributed basis to reflect and respond to regional needs and operational requirements. These functions could include (but are not limited to):

- Seeking and promoting investment for local network expansion and/or improvement

[2] Annex B proposes two potential variations where additional responsibilities could be added as centralized governance functions where a more active role of coordination is played.

- Determining eligibility for priority and pre-emption (if applicable)
- Identifying and enhancing regional coverage within their jurisdiction, including to rural and remote communities, through the development of coverage requirements and strategies
- Working with the centralized structure on regulatory and policy compliance
- Developing user requirements, technology requirements (for the network and for devices), and application requirements to support the PSBN
- Procuring broadband and PSBN related services from vendors
- Delivering user training
- Conducting exercises
- PSBN promotion and onboarding
- Serving as a point of contact for user concerns and issues

As a legal entity, a centralized structure could take the form of either a for-profit or not-for-profit (NFP) entity, each with its own benefits and considerations. A for-profit entity's fiduciary duty to shareholders could put it in conflict with its mandate to respect, promote, and serve as a guardian of the PSBN Principles.

Recognizing that emergency management is a shared responsibility between the different levels of government in Canada, coordination among all levels of government and the public safety community is essential to implement a PSBN. Therefore, **the TNCO recommends a governance approach that includes representation from a diverse range of stakeholders and establishes and monitors adherence to national common standards through a not-for-profit structure that supports nationwide interoperability.**

Spectrum Utilization Model

Based on extensive analysis found in its progress report, the TNCO acknowledges that a network that supports both public safety and commercial usage, with priority access and pre-emption rights for public safety use during emergencies and other times of need best delivers on the PSBN Principles while ensuring an efficient use of the allocated Band 14 spectrum. **The TNCO recommends that the PSBN be implemented using a Shared Network approach.**

Service Delivery Model

There are different ways to deliver a PSBN in Canada. A future acquisition process should encourage innovative solutions that will meet and exceed the needs of public safety. It must not be limited by any particular solution nor to any specific offeror, but rather should be open to all entities, whether wireless incumbents or new entrants, provided all the PSBN Principles are satisfied. In its progress report, the TNCO considered four service delivery models and compared them against their ability to fulfill the PSBN Principles.[3] TNCO's analysis found that service delivery models A and D are best positioned to satisfy the principles of the PSBN (Annex C). Both of these models support the broader **recommendation that the PSBN be delivered to function as a single nationwide network**. However, it is important to note that the choice of a deployment strategy and service delivery model rests with those ultimately implementing the nationwide PSBN.

Approaches to Achieve Robust Coverage and Capacity

As part of its mandate, the TNCO also considered innovative solutions to address coverage gaps and capacity challenges, which are at the forefront of the PSBN conversation. The TNCO identified the following five potential approaches:

1. Conditions of License and Contracting;
2. Targeted Stakeholder Investment;
3. Government Policy and Initiative Synergies;
4. Strategic Partnerships; and
5. PSBN Deployable Systems.

While no single approach constitutes a complete solution, taken together, these approaches should deliver a PSBN that has sufficient robustness in coverage and capacity to address both coverage requirements and the need for reliable, always-available network service. The Band 14 spectrum asset will be key in facilitating the deployment of a national PSBN in Canada. It is important, however, to ensure that a sufficient degree of flexibility is afforded to the delivery of the PSBN to support the network's evolution and its long-term sustainability. This will likely include the need to

[3] The service delivery model options and their implications on delivering mobile broadband services to emergency responders using Long Term Evolution (LTE) were developed by Defence Research and Development Canada's Centre for Security Science.

employ a broader range of spectrum assets where economically or technologically appropriate and advantageous. **The TNCO recommends that stakeholders consider multiple approaches to addressing both coverage and capacity gaps to support the delivery of a PSBN in Canada.**

Next steps

An interoperable nationwide PSBN in Canada will allow the public safety community to leverage technology in new ways, helping keep Canadians safe in times of need. As new life-saving technologies are created, a PSBN will provide the mechanism to ensure the public safety community has the ability to work together in protecting Canadians.

Across all levels of government, the public safety community and the private sector, interest in pursuing a Canadian PSBN has remained high for the past several years. Continued interest has underlined the significance of this undertaking while making it increasingly clear that a network of this scale and complexity cannot be established overnight. While timeliness of deployment is at the forefront of the conversation, continued collaboration among governments, industry and end users must remain a priority to develop and implement a network that meets the diverse expectations and interests of stakeholders.

In addition, a number of important activities need to be undertaken to deliver a PSBN, including (but not limited to):

- Financial modelling to support governance structure
- Detailed design and approval of governance structure
- Funding and establishment of centralized and distributed governance functions
- Identification and development of national standards
- Evaluation of deployment strategy and development of go-to-market strategy
- Procurement and implementation of PSBN
- Individual jurisdictional procurement of PSBN services
- Individual jurisdictional procurement and implementation of enhancements such as additional coverage, hardened infrastructure.

Introduction

The Temporary National Coordination Office (TNCO)[4] is pleased to present this report regarding the deployment of a future Public Safety Broadband Network (PSBN) in Canada. Since its establishment in July 2018, members of the TNCO have collaborated to consult with stakeholders and gather their views, conduct research and analysis, and propose a way forward to improve emergency communications in the public safety domain. The purpose of this report is to highlight the TNCO's findings on options and recommendations for a Canadian PSBN while also presenting a consolidated view resulting from discussions and activities with stakeholders, technical and operational experts, and the user community.

In June 2019, the TNCO released its *Progress Report on a National Public Safety Broadband Network* which can be found on the Public Safety Canada website.[5] The progress report was an important checkpoint that outlined some of the advantages of using a mobile wireless broadband network in the context of public safety and explained how it could be used to improve the effectiveness of coordination and response efforts during day-to-day operations, weather-related incidents and natural disasters, emergencies and major events. Furthermore, the progress report laid the groundwork for the TNCO to continue pursuing meaningful engagement with stakeholders, expand on the PSBN principles, explore innovative solutions to address coverage and capacity gaps, and solidify its recommendations on a national governance approach, all of which will be discussed in this report.

Stakeholder engagement has been a crucial component of the TNCO's work during its two-year mandate. Consultations and engagement have occurred with a broad range of stakeholders including but not limited to federal government departments, provincial and territorial jurisdictions and municipalities, the information and communications technology (ICT) sector, Indigenous organizations, critical infrastructure operators and utilities, public works, the Canadian Association of Fire Chiefs (CAFC), Canadian

[4] For more information on the Temporary National Coordination Office, its mandate and representation, please visit https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/tnco-en.aspx.
[5] To read the progress report, please consult https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/2019-prprt-npsbn/index-en.aspx

Association of Chiefs of Police (CACP), Paramedic Chiefs of Canada (PCC) and their memberships, experts and researchers, and international stakeholders. The TNCO also reviewed existing analysis and ongoing research pertaining to the deployment of broadband networks and services in Canada.

The TNCO heard from a wide range of stakeholders across the country that there is demand for a mobile wireless broadband network designed to meet the needs of the public safety community. With these views in mind, this report is presented to Federal-Provincial-Territorial (FPT) governments for consideration. The report outlines a number of recommendations regarding a governance approach, guiding principles, service delivery, approaches to achieving robust coverage and capacity, and suggests next steps for advancing a PSBN. It also aims to inform future consultations by Innovation, Science and Economic Development (ISED) on the licensing framework for the 700 MHz public safety broadband spectrum.

State of Public Safety Communications

When responding to routine and emergency incidents, every second counts and every piece of information is crucial for first responders and public safety personnel. First responders and public safety personnel need to have the equipment and capabilities necessary to effectively do their jobs and keep Canadians and themselves safe. Not only do they need as much information as possible to effectively plan their response, they also need that information to be accurate and transmitted as soon as possible. In addition to day-to-day use, effective response to major disasters, emergencies and planned events require reliable, interoperable voice and data communication capabilities across jurisdictions and public safety disciplines.

Today, disasters are increasing in frequency and severity across Canada and represent a growing threat to the safety and economic stability of Canadian communities.[6] In many cases, disasters and emergency incidents cross borders, jurisdictions and/or frontiers, and can require support from international partners, civil society organizations and volunteers. No single agency at any level of government in Canada has the authority and capacity to act unilaterally and therefore significant coordination is required to

[6] Public Safety Canada. (2019). Emergency Management Strategy for Canada: Toward a Resilient 2030. https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/mrgncy-mngmnt-strtgy/index-en.aspx

respond to these incidents.[7] There is public expectation that this coordination is achieved with all governments and the public safety community working together to ensure the safety of Canadians and the protection of property. A whole-of-society approach is therefore required to enhance collaboration in all sectors of society to improve emergency communications.

First responders and the public safety community currently use a combination of land mobile radio (LMR) networks for voice communications and commercial cellular networks to exchange data. LMR systems have evolved over time at the municipal, provincial, and regional levels but were deployed without express concern for national interoperability requirements. With some provincial and regional exceptions, the result is considerable fragmentation at various levels in Canada. Considered nationally, and even within the same jurisdictions, public safety agencies using different systems operating in different parts of the radio spectrum are not able to communicate with each other, unless by means of physically sharing devices or through network gateways, which provide a degree of interoperability between networks. This effectively creates communication silos that make coordination a significant challenge. These challenges are a common theme in exercises and after-action reports, which continue to stress a need for interoperable communications. Cases such as the *Wood Buffalo (Fort McMurray) Wildfires Post-Incident Assessment* report highlight the need for interoperability and coordination between responders who experienced communications challenges during the incident, particularly given the scope and intensity of the disaster. In particular, the report emphasizes the need for further alignment between all levels of government, Indigenous communities, police, fire, paramedics, industry, and service providers.[8]

The current systems in operation in Canada today (largely LMR systems) are principally voice-only technologies. There is a growing requirement to enable more data-centric information to be shared amongst public safety users in a secure and reliable manner. This includes vital situational awareness applications such as interactive mapping, video, and critical data and file sharing. These capabilities would

[7] Public Safety Canada. (2011). Communications Interoperability Strategy for Canada. https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/ntrprblt-strtg/ntrprblt-strtg-eng.pdf
[8] KPMG. (2017). May 2016 Wood Buffalo Wildfire: Post-Incident Assessment Report. Pg. 75, recommendation 11. https://www.alberta.ca/assets/documents/Wildfire-KPMG-Report.pdf

raise the communication capabilities of first responders to match the expectations set by current commercial mobile wireless services. While some responders are using commercial cellular networks, such services do not meet the security requirements nor are they currently approved for mission-critical work by most agencies.

Canadians are also changing their methods of communication. The prevalence of mobile devices and new applications has led to a shift in Canadians' expectations, including how they access emergency services. Following a Canadian Radio-television and Telecommunications Commission's (CRTC) decision, Canada is on the cusp of implementing Next-Generation 9-1-1 (NG 9-1-1) networks and services, which will allow Canadians to send data to first responders.[9] For example, Canadians could stream video from an emergency incident, send photos of accident damage or a fleeing suspect, or send personal medical information, which could greatly aid emergency response. A mechanism is needed in order to access and transfer this information from public safety answering points (PSAPs) to the front line in a reliable, secure manner and to complement the modernization in emergency communication services.

The pending arrival of fifth generation (5G) cellular also presents a progressive evolution of mobile wireless broadband technology for public safety communications. Faster, lower latency 5G wireless networks will support new and enhanced public safety applications and capabilities. An established and cohesive approach to mobile wireless broadband services in the public safety realm will serve to increase the sector's influence in the establishment of relevant 5G standards.

The benefits of equipping the public safety community with modern technologies and new capabilities have been recognized as significant. In response to these findings, the Government of Canada (GoC) committed funds in Budget 2015 "to take initial steps to establish a PSBN". In 2017, an additional 5+5 MHz block of 700 MHz spectrum was allocated for public safety broadband use, resulting in a total spectrum allocation of 10+10 MHz.[10] While the availability of spectrum is an important aspect of the PSBN

[9] Canadian Radio-television Telecommunications Commission. (2019). Next-generation 9-1-1 (NG 9-1-1). https://crtc.gc.ca/eng/phone/911/gen.htm

[10] Innovation, Science and Economic Development Canada. (2017). Decisions on Policy, Technical and Licensing Framework for Use of the Public Safety Broadband Spectrum in the Bands 758-763 MHz and 788-793 MHz (D Block) and 763-768 MHz and 793-798 MHz (PSBB Block). https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11289.html

endeavor, the establishment of a PSBN involves various other elements and technologies that will interact to successfully deliver PSBN services in Canada.

Scope of the Public Safety Broadband Network

What is a PBSN?

A PSBN is a secure, high-speed, mobile wireless communications network that, much like a commercial cellular network, is the pipe that gets user voice and data from point A to point B during communications sessions. A PSBN can be used by first responders and public safety personnel to communicate with each other, access and share information during day-to-day operations, weather-related incidents and natural disasters, emergencies and major events. A PSBN will offer users an experience which resembles their current handheld and vehicular commercial cellular offerings, but it will provide enhanced functionality, security, reliability and guaranteed access.

The PSBN will enable a range of mobile communications capabilities to enhance situational awareness, including but not limited to speech, text messaging, real-time monitoring, video communication and streaming, and file sharing. It holds the potential to enhance the ability to anticipate, respond and recover from disasters, emergencies and events while improving the safety of first responders, the public safety community and the communities they serve and limiting property damage and loss. It will further allow them to benefit from up-to-date telecommunications products and services. A PSBN will be a piece of Canada's critical infrastructure and, as per the Interoperability principle, it will closely align with the United States national PSBN (FirstNet) to enable cross-border interoperability and leverage the common market.

Who will use a PSBN?

PSBN users are defined as "people, entities/agencies and their devices/machines with a role in or responsibility for the health, safety and security of the public and its property." This definition is meant to be broader than the first responder community and is inclusive of other agencies supporting public safety such as critical infrastructure operators, transportation (air, rail and road), corrections, border services, military, intelligence, search and rescue, public works, environmental agencies and the voluntary

sector.[11] It also includes a variety of machines, handheld devices, sensors and monitor networks. The definition of PSBN users does not include commercial users who remain outside the PSBN security envelope but who may consume PSBN spectrum capacity while it is unencumbered by PSBN users.

Why a PSBN?

A PSBN will enable users to communicate, access, and share information when and where they need it, with the assurance of a secure and reliable public safety-grade network. PSBN users will benefit from network prioritization and pre-emption solutions that will ensure an uninterrupted network experience during day-to-day operations, planned events or emergencies. The enhanced level of security and reliability offered by a PSBN will enable improved agency and user confidence; mission critical and nationwide interoperable communications; advanced technical operational capabilities; improved preparedness and response to planned and unplanned events; reduced risk and hazard exposure through improved situational awareness; and will ultimately save lives and property while improving the safety and security of front line responders.

The case for a PSBN in Canada is supported by the need to address a range of existing communications challenges faced by the public safety community and their partners. The benefits of such a solution are becoming increasingly clear, particularly in respect to interoperability, the ever-expanding demand for time-sensitive and robust data, an expanding list of use cases highlighted by the potential user community, and the opportunity for positive impacts on socioeconomic, budgetary and fiscal management outcomes. Furthermore, technological advancements in public safety communications, including current PSBN proof-of-concepts have taken considerable strides forward both domestically and internationally, making this an ideal time to develop and deploy a PSBN in Canada.

Importantly, a PSBN will help expedite the response to emergencies which will help ensure the life, health and safety of Canadians impacted by emergencies. Effective and sustainable public safety communications systems are essential in ensuring that citizens are able to get the assistance they need. This capability would greatly enhance

[11] This is not an exhaustive list of potential PSBN users.

emergency response, ultimately benefitting community safety. A PSBN would serve to underpin NG 9-1-1 by enabling first responders in the field to access critical information transmitted by Canadians to PSAPs. NG 9-1-1 and PSBN, though distinct, will gain advantage from enhanced coverage, reliability and security, thereby benefiting Canadians. Canada's National Public Alerting System (NPAS) could also benefit from anticipated increases in broadband mobile coverage to deliver alerts to the public.

The delivery of PSBN services is aligned with the *Emergency Management Strategy for Canada: Toward a Resilient 2030* by enhancing preparedness and response capabilities, establishing interoperable emergency management systems and fostering the development of capabilities through innovation, science and technology.[12] To achieve this, federal, provincial, territorial and municipal governments are encouraged to work with their respective emergency management partners to develop interoperable public safety communications solutions.

The TNCO has been keeping abreast of both domestic and international PSBN pilots, tests and evaluation initiatives to provide evidence-based analysis and informed recommendations. The experience, expertise and body of research available enable lessons to be drawn in the context of governance, service delivery, economics, and available and emerging technologies. A Defence Research and Development Canada's Centre for Security Science (DRDC CSS) report published in 2018 highlights a number of the Canadian and international pilots and trials exploring interoperable mobile wireless public safety broadband networks.[13] Through special ISED authorization for use of 700 MHz spectrum, the CAUSE series,[14] [15] [16] [17] as well as other Canadian trials and exercises, have contributed a range of perspectives on governance, technical

[12] Public Safety Canada. (2019). *Emergency Management Strategy for Canada: Toward a Resilient 2030*. https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/mrgncy-mngmnt-strtgy/index-en.aspx
[13] Defence Research and Development Canada. (2018). Lessons learned from deployments and trials of Public Safety Broadband Networks. DRDC-RDDC-2018-D047. https://cradpdf.drdc-rddc.gc.ca/PDFS/unc313/p806956_A1b.pdf
[14] Canada-US Enhanced Resiliency Experiment Series are part of the 2011 Beyond the Border Action Plan. CAUSE III, IV and V all used PSBN technology to enhance cross border communication.
[15] Defence Research and Development Canada's Centre for Security Science (2016). Canada-US Enhanced Resiliency Experiment (CAUSE III). DRDC-RDDC-2016-R047.
[16] Department of Homeland Security and Defence Research and Development Canada's Centre for Security Science. (2016). Canada-US Enhanced Resiliency Experiment (CAUSE IV).
[17] Defence Research and Development Canada's Centre for Security Science. (2018). Canada-US Enhanced Resiliency Experiment V. DRDC-RDDC-2018-R239.

considerations and financial models and have provided the TNCO with valuable information.

DRDC CSS produced a detailed use-case on wildland-urban interface fire.[18] Following this, they led a use-case exercise that identified the capability needs and requirements of potential PSBN users.[19] This comprehensive report received extensive and invaluable feedback from the police, fire, paramedics, and emergency management communities over a twelve month period. Ultimately, this exercise provided concrete examples of the operational capabilities that could be enabled by a PSBN and could inform potential PSBN users in a variety of incidents such as wildland-urban fire, hostage incident, hazardous materials response, and monitoring and control of critical infrastructure. Stakeholder groups such as the Paramedic Chiefs of Canada (PCC) have used the use cases to conduct targeted engagement with their membership and determine the top priorities of the paramedic community.[20] The result of this exercise identified five common themes as paramedic requirements for the PSBN and further confirmed that the paramedic community is very interested in having tools that will allow them to provide time-critical emergency medical care, regardless of whether they operate in a rural or urban setting (Annex E). These exercises will ultimately help inform the development and successful implementation of a nationwide interoperable mobile broadband network in Canada.

These case studies ultimately helped demonstrate that a PSBN in Canada should be a nationwide and interoperable network enabling public safety communications across the country, which is why any path forward should consider how existing PSBN trials and early adopters can become part of the nationwide network.

What does a national PSBN mean for Canadians?

A PSBN will improve the safety of first responders in Canada, help protect and save lives, limit property damage and loss, and enhance community safety and resilience. Canada's PSBN will be the key enabler to the country's next generation of public

[18] Defence Research and Development Canada's Centre for Security Science. (2017). Public safety broadband network use-case – wildland-urban interface fire. DRDC-RDDC-2017-R116.
[19] Defence Research and Development Canada's Centre for Security Science. (In press). Public Safety Broadband Network Use-Cases and User Requirements. DRDC-RDDC-2019-Rxxx.
[20] Paramedic Chiefs of Canada. (2020). Public Safety Broadband Network Paramedic Priority Capability Needs

safety communications. It would also fuel innovation, support technologies and services, foster new business ventures and promote job creation for Canada. A PSBN provides the opportunity for device, application, infrastructure and service providers to develop and provide a range of innovative public safety communications and information sharing solutions that could be recognized on the world stage, whether at the hardware (devices, machines, sensors, networks, etc.), software (applications, programs, network solutions, etc.) or service (data management, analytics, support, etc.) level.

The Government of Canada committed to connect every Canadian to affordable, high-speed Internet no matter where they live, and to improve mobile cellular access from coast to coast to coast.[21] In addition to broadband programs and initiatives being launched, Budget 2019 announced new investments to deliver universal high-speed internet in rural and remote communities. Furthermore, the House of Commons Standing Committee on Indigenous and Northern Affairs heard through testimonies that connectivity to cellular and broadband networks in First Nations communities is an ongoing issue. Recognizing the growing importance of broadband and cellular telecommunications infrastructure in delivering emergency response measures, the Committee recommended that the deployment of infrastructure in Indigenous communities be accelerated in an effort to bridge the existing gap.[22] Provinces, territories and individual communities are also making significant investments in broadband. Considering that broadband coverage in rural, remote and northern parts of the country is an important consideration in the delivery of a PSBN, these announcements and initiatives could ultimately enhance the positioning of mobile wireless public safety broadband. The connection, therefore, between universal broadband access initiatives and public safety broadband provides many opportunities for use of common, existing assets, resulting in a smaller environmental footprint and coordinated infrastructure investments in the future.

In addition to improving emergency communications capabilities and response, a PSBN presents opportunities to create productivity benefits, enhance emergency response and confer wider socioeconomic benefits. A 2013 London School of Economics study

[21] Innovation, Science and Economic Development Canada. (2019) High-Speed Access for All: Canada's Connectivity Strategy. https://www.ic.gc.ca/eic/site/139.nsf/eng/h_00002.html
[22] Ibid, p. 80

identified potential socioeconomic benefits across four core categories: safety, efficiency, service availability, and gross domestic product.[23] For example, the use of mobile broadband by public safety agencies could result in increased user and agency productivity, successful interventions, and operational efficiency where fewer resources are required. The report also identifies better outcomes for victims of violent crimes, serious injuries or medical conditions.

PSBN Principles

PSBN Principles flow from user requirements identified through the analysis of PSBN use cases gathered through consultation with potential PSBN users, domestic pilots and trials, as well as Canadian and international case studies. The PSBN Principles, initially introduced in the TNCO's progress report, have been refined based on feedback from stakeholders. The Principles outlined below are consistent with those of international jurisdictions that are moving forward with domestic PSBNs, including (but not limited to) the United States, United Kingdom, Australia, France, Finland, Qatar and the Republic of Korea.

These Principles are intended to reflect fundamental norms, rules, and values meant to guide the deployment, operation and evolution of a PSBN in Canada. They are more basic than policy objectives – they are meant to both govern and inform the community as a whole. The purpose of the realization indicators for each principle is to enhance the description narrative with high level, tangible indicators that demonstrate the principle has been met.

The following are proposed principles of a Canadian PSBN:

[23] Grous, Dr. Alexander. (2013) Centre for Economic Performance. London School of Economics and Political Science. *Socioeconomic Value of Mission Critical Mobile Applications for Public Safety in the UK: 2x10 MHz in 700 MHz*.

Interoperability

The PSBN enables PSBN users to communicate, access, and share information as authorized, anytime and from anywhere it is accessible.

Description

The principle of interoperability requires that network services and agreements exist to ensure that PSBN users can access PSBN services and other users from any point within the PSBN at any time. It is foundational to the vision for a PSBN that it enables information access and sharing. For example, users on commercial Long-Term Evolution (LTE) networks are inherently able to communicate with each other anytime and anywhere there is accessible coverage in their home network or a visited network.

Subject to agreement with FirstNet, additional network services and agreements are necessary to ensure PSBN users and FirstNet users can access services and other users as needed for them to perform their duties, from any point within either the PSBN or FirstNet at any time, irrespective of what service delivery model is applied to the PSBN. Communications interoperability between a Canadian PSBN authority and FirstNet are integral to sharing strategic and technical information across the border.

The PSBN must adopt common standards to ensure applications adopted in any region of Canada will function properly in the other regions of Canada and to ensure mission critical applications are fully interoperable.

The access to, or sharing of, information may be initiated or completed in the wireless environment of a PSBN but takes place through interaction between the applications, data and servers of the initiator and recipient. Existing statutes, regulations, policies and agreements will influence the availability of such

transactions and may require well considered change to facilitate them. The PSBN will require access and sharing rules.

Realization Indicators

- Increasing subscribership to the PSBN – proportion of eligible users
- Seamless nationwide network connectivity
- Network-hosted application and service interoperability nationwide
- Increased day-to-day and incident/event driven coordination and cooperation amongst PSBN users

Equitable Service

The PSBN must deliver an equitable service to the entire community of PSBN users.

Description

Equitable service on the PSBN ensures the nationwide universality of its service and user experience. It is the assurance that all PSBN users in Canada ultimately have equitable access to the PSBN and the applications and services that it enables, while adhering to all other principles.

Realization Indicators

- All PSBN users have access to equitable service
- Minimal impact to coverage and affordability in delivering equitable service
- Equitable service offering and user experience in all areas served by the PSBN
- Acceptable delivery of user applications and services are delivered to users in a consistent, persistent manner

Affordability

The PSBN must be affordable to the entire community of potential PSBN users.

Description

Affordability is measured by cost relative to the amount a purchaser can pay. However, other principles cannot be sacrificed in the name of affordability. Affordability will compete with other PSBN priorities for scarce funding. The cost of acquiring PSBN services should not be prohibitive for any PSBN subscribers. This may require subsidization of user fees through a variety of means.

Realization Indicators

- Pricing structure is competitive and optimized to deliver a compelling, high-quality, and affordable broadband service to Canada's public safety community
- Proportion of users adopting the PSBN
- All communities see responders collaborating on a PSBN, no matter their size

Sustainability

The PSBN must be realistically achievable, and meet the needs of its first generation of stakeholders without compromising its ability to meet the needs of future stakeholders.

Description

The three pillars of sustainability are environmental, economic and social. The PSBN must be delivered in a manner that is operationally and financially sustainable. It must also be delivered by means that ensure ecological integrity is maintained, resources required to maintain its future integrity are available and the future needs of stakeholders are attainable, served and respected. Intrinsic in this are the needs for ongoing maintenance and innovation to evolve and stay current with changing technology and standards to maintain relevance, and the need for suppliers of goods and services to the PSBN to be sustainable well into the future.

Realization Indicators

- The business model of the PSBN has long term viability, scalability, regional flexibility and survivability
- The technologies in the design and implementation of the PSBN are based on industry standards
- The technologies in the design and implementation of the PSBN are forward compatible, to the extent possible, and will accommodate differing rates of adoption/implementation between jurisdictions

Coverage

The PSBN will, at a minimum, have coverage that is equivalent to existing commercial mobile wireless broadband coverage and should establish and/or enhance coverage in underserved urban, rural and remote areas, and Indigenous communities.

Description

The day-to-day, major events and emergency incidents that PSBN users respond to know no geographical or durational boundaries, and often occur unplanned in rural, remote, northern and Indigenous communities and within buildings where the current business case for commercial coverage is thin. Sufficient coverage must exist where the business of PSBN users frequently/normally takes place and must be supplemented by deployable coverage elsewhere. Coverage can be no less than what is available to mobile wireless broadband commercial users and should, over time, be greater with specific and substantial rural coverage milestones.

Realization Indicators

- Coverage aligned with public safety end-user priorities and all-hazards risks
- Greater than commercial coverage over time
- Timely delivery, installation and operation of deployable systems where required

Deliver Mission Critical Services

The PSBN will enable the delivery of network-hosted mission critical services to public safety users.

Description

It is widely accepted that failure or disruption of public safety push-to-talk voice communication, at any time, will result in the severe degradation of its operations. It is an essential communication and safety element of public safety operations. As the PSBN develops and is embraced, open standards such as Mission Critical Push to Talk (MCPTT), Mission Critical Data (MCData) and Mission Critical Video (MCVideo), collectively referred to as Mission Critical Services (MCS), will become basic and essential communication and safety elements. These network-hosted mission critical services, as opposed to applications chosen by individual user agencies, will be integral parts of the PSBN, enhancing nationwide interoperability.

Realization Indicators

- All PSBN users have full MCS interoperability throughout the PSBN
- PSBN users are confident relying on the services most critical to their ability to serve the public and stay safe
- MCS interoperability with public safety users outside of the PSBN is fully achieved, or maximized

Network Access Always

Whether in their daily routine or during major events or emergencies, PSBN users must always have immediate and uninterrupted access to the PSBN where it exists. This includes in instances where a PSBN is carried across commercial cellular networks, ensuring first responders are unaffected by network congestion caused by user density or event driven commercial carrier surges in use.

Description

Quality of Service (QoS), Priority, and Pre-emption (QPP) enabling mechanisms within the PSBN are required to ensure uninterrupted, persistent network access to PSBN users. PSBN users must always have priority over commercial users and may pre-empt them under specific circumstances. Within the PSBN, there must be a means of establishing priority but there must be enough control of PSBN resources to provide the local command hierarchy with the capability to dynamically change the QPP of users and applications where their role in an event is sufficiently important.

Users roaming from one means of service delivery to another – one PSBN mobile network operator (MNO) to another, fixed site to deployable – must not experience interruption in sessions (service continuity) and must experience the same QPP regardless of how they are connected to the PSBN. Furthermore, sessions between the PSBN and FirstNet should not be interrupted. Inter-network service continuity avoids having to re-start applications, re-initialize an authentication session and re-dial a phone number. The ability to realize this capability requires a level of integration between PSBN operators that is not typical.

Realization Indicators

- Continuous network connectivity at all times, as required
- No degradation of applications and services during disasters, emergencies and planned events; additional capacity is available and brought to bear in a timely manner
- Session persistence and service continuity throughout PSBN and with FirstNet (the U.S. PSBN)

Security

The PSBN must incorporate and enable security mechanisms meeting the trust requirements of the organizations of PSBN users and those accessing and exchanging data through it.

Description

Risk assessments evaluate the probability and impact of potential threats to the PSBN. They must be identified, evaluated and mitigated by a standards-based security posture sufficiently strong to ensure continued network access, and earn the trust of PSBN users and those willing to access and exchange data through it.[24] Security is built in layers to mitigate the impact of potential threats. Drawing on appropriate expertise, protective measures will need to be applied end-to-end to help ensure the security of the PSBN and the information exchanged through it.

Realization Indicators

- High level of confidence in the security of the PSBN
- Minimal impact of PSBN security mechanisms on interoperability
- Security posture meets or exceeds industry standards and best practices

[24] The security framework of public mobile networks is predominantly based on the International Telecommunication Union's (ITU) Recommendation X.805 "Security architecture for systems providing end-to-end communications."

Resiliency and Robustness

The PSBN must be resilient and robust to meet network access requirements.

Description

The services provided by the PSBN to its users, especially those deemed mission critical, are important in day-to-day operations but particularly critical during major events and emergencies, when services are most likely to be stressed by the conditions of their environment or come under attack. The PSBN must be capable of performing without failure under a wide range of conditions, be able to recover from setbacks and adapt well to change. Radio Access Network (RAN) sites may require hardening to a greater degree than commercial sites, particularly with respect to power and site access, in order to survive worst case scenarios.[25]

Realization Indicators

- Redundant network core(s) and backbone established throughout PSBN, to minimize single points of failure
- Elevated site security and hardening at key RAN sites – including backup power
- Network status is transparent to users
- Hardening addresses the unique environmental and/or security considerations for areas or regions across the country
- PSBN system restoration meets established parameters

[25] For an example of hardening guidelines, please see the 2014 NPSTC Public Safety Communications Report, Defining Public Safety Grade Systems and Facilities.
http://www.npstc.org/download.jsp?tableId=37&column=217&id=3066&file=Public_Safety_Grade_Report_140522.pdf

Use of Spectrum

The PSBN will efficiently and effectively use spectrum.

Description

Whether through the support of PSBN users in their daily work and during major events or emergencies, or to generate revenue in support of other PSBN Principles, PSBN spectrum must be used as efficiently and effectively as possible. The primary spectrum of the PSBN is Band 14, but it could include other bands where capacity is available and it is economically desirable.

Notwithstanding the possible commercial use of the Band 14 asset, all PSBN spectrum, Band 14 or otherwise, must always be available to PSBN users, who must have priority over and the ability to pre-empt commercial users if and when needed. Though PSBN users' needs may at times exhaust the capacity provided by the spectrum, at most times, it is expected that PSBN allocated spectrum will have significant surplus capacity.

Leveraging unused spectrum through commercial use, outside of the PSBN network envelope, holds the promise of offsetting the costs of the PSBN.

Realization Indicators

- Where deployed, Band 14 spectrum is optimized by PSBN users and/or commercial users
- Band 14 spectrum usage is maximized – to the extent economically desirable
- Band 14 is being used as intended: to increase the PSBN coverage footprint; to improve the cost model for the PSBN, and to support future generations of PSBN users
- PSBN users contribute to the efficient use of non-Band 14 spectrum

Recommendation 1: The TNCO recommends that the development, deployment, operation and monitoring of a PSBN satisfy the ten PSBN Principles.

Governance Approach

With a mandate to develop and propose options for the governance of a PSBN in Canada, the TNCO has taken the steps to consider the possible structures and processes that could be designed to ensure overall responsibility, decision making, and participation in an accountable, transparent, inclusive, and responsive manner. The analysis of governance options is not intended to pre-empt, but rather to inform jurisdictional decisions.

In addition, the TNCO recognizes that new challenges and considerations will continue to be shared by stakeholders and made evident across pilots and trials as the public safety communications ecosystem and technological capabilities evolve. Governance decisions should allow flexibility for such developments.

Governance Considerations

In developing governance recommendations for a PSBN in Canada that best delivers on the PSBN Principles it is important to balance the diverse interests of stakeholders. In an effort to achieve this goal, the TNCO has established a set of considerations that have emerged as fundamental to any future governance mechanisms of the PSBN. In partnership with the PSBN Principles, they provide a foundation upon which a PSBN in Canada may best deliver an equitable user experience to the entire public safety community.

The governance approach for a nationwide PSBN should be guided by the PSBN Principles in a manner that is representative of Canada's federated structure, cross-jurisdictional public safety community, and diverse population. The governance approach should consider and reflect on Canada's constitutional landscape, distribution of legislative powers, demographics, physical geography, and telecommunications ecosystem in order to exercise national leadership while encouraging regional and municipal participation and autonomy. In this way, it should work to serve the public interest, harness user input and advice, and support the safety and security of Canadians.

Flexibility should be central to the governance approach to allow for broad-based participation, collaboration, and cooperation among stakeholders. This may include the support of a range of expertise, including but not limited to expertise in the fields of emergency management, public safety, telecommunications, wireless technology, emergency communications networks, as well as business and legal expertise.

Any governance approach must be financially self sustaining. Moreover, the governance approach should be sustainable and forward-looking in order to respond to innovation, evolving needs and support deployment(s) on different timelines across various jurisdictions. It should empower users to best leverage existing and future synergies in order to realize greatest benefit from the development of a nationwide PSBN. This includes being responsive to technological advancements in wireless broadband technology, including the arrival of 5G and beyond.

Governance Context

Emergency management in Canada is a shared responsibility between the different levels of government. While the federal government exercises leadership at the national and international levels relating to public safety and emergency preparedness, provincial, territorial, Indigenous, and municipal governments have 'front-line' responsibility for emergency management within their respective jurisdictions as most emergencies in Canada occur locally. Altogether, the different levels of government are supported by a range of front-line expertise, including police, paramedic, and firefighting services.

No single agency at any level of government in Canada has the authority and capacity to act unilaterally and therefore significant coordination is required to respond to incidents that cross jurisdictions and disciplines. There is public expectation that this coordination is achieved with all governments and the public safety community working together to ensure the safety of Canadians and the protection of property. The establishment of a PSBN creates an opportunity to coordinate and align policies, requirements, and standards in order to enable innovation, create economies of scale, improve standard operating procedures, and ensure that public safety users' communication requirements are met. This includes addressing current interoperability challenges within the public safety community.

Many PSBN stakeholders have recommended that national-level leadership be taken in the form of national oversight and/or the establishment of a national coordination function in order to ensure the success of a network of this scale, complexity and disparity of users. The TNCO has also heard from stakeholders that there is concern over liability within a system in which there may be multiple operators and shared accountabilities.

In response to these recommendations, the TNCO proposes a national governance approach which is comprised of the following components:

1. **PSBN Spectrum Licensing Framework (ISED)**
2. **Centralized Governance Functions**
3. **Distributed Governance Functions**

Each governance component represents a distinct set of possible responsibilities and mechanisms which, operating in concert, should offer a comprehensive approach that satisfies the spirit of the guiding considerations for governance as well as the PSBN Principles. The governance framework is expected to be feasible regardless of the service delivery model(s) (Annex C) employed to deliver a nationwide PSBN.

PSBN Spectrum Licensing Framework

Spectrum is "a finite resource" and is "the only resource that can support practical wireless communications in everyday situations."[26] As a result, spectrum is also highly valuable.[27] ISED is the sole authority responsible for spectrum management in Canada, which includes developing national policies and goals for spectrum resource use and ensuring effective management of the radio frequency spectrum resource. In 2017, ISED decided that 20 MHz of 700 MHz spectrum (known as "Band 14") would not be

[26] Innovation, Science and Economic Development Canada. (2007). Spectrum Policy Framework for Canada. https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08776.html

[27] Example for illustrative purpose only: Innovation, Science and Economic Development Canada. (2019). Auction of Spectrum Licences in the 600 MHz Band. http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf11331.html

auctioned and that licenses for that spectrum would be issued directly to a single or to multiple public safety network entities.[28]

As an essential element in the delivery of a PSBN, the spectrum licensing framework is an important mechanism through which the Government of Canada contributes to the overall nationwide PSBN governance framework. ISED will undertake a public consultation process in advance of establishing the Band 14 Conditions of License (CoL) and awarding the spectrum license. While spectrum will be an important component of the PSBN, it is only one of many aspects to be considered. As a result, ISED's authority over spectrum management is not on its own sufficient to ensure the achievement of the PSBN Principles and should be supported by additional governance and enabling mechanisms at both centralized and distributed levels.

Centralized Governance Functions

After extensive consultation and dialogue between federal, provincial, territorial and municipal governments as well as representatives from police, paramedic, and firefighting services, the TNCO acknowledges an expectation among the PSBN stakeholder community of the need for national leadership and guidance in support of nationwide interoperability and adherence to all PSBN Principles.

To ensure an interoperable and nationwide PSBN, the TNCO supports the establishment and role of a centralized structure. A centralized mechanism would be expected to complement the PSBN's spectrum licensing framework by carrying out certain minimum functions required to ensure the success of a network of this scale, complexity and disparity of users. A centralized structure would represent the principal governance mechanism of the overall PSBN and be uniquely responsible for facilitating the successful establishment, development, and operations of the PSBN. In this role it may be accountable for a range of responsibilities and functions, including certain operational functions, in the interest of ensuring the success of the PSBN.

This structure would need to operate in the interest of the PSBN and its users and demonstrate the ability to uphold certain characteristics and competencies, including

[28] Innovation, Science and Economic Development Canada. (2017). Decisions on Policy, Technical and Licensing Framework for Use of the Public Safety Broadband Spectrum in the Bands 758-763 MHz and 788-793 MHz (D Block) and 763-768 MHz and 793-798 MHz (PSBB Block). https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11289.html

the guiding considerations of governance and PSBN Principles. As a component of accountability, this structure would also exercise a level of transparency deemed appropriate by the public safety community, which could include annual public reporting.

Minimum Guidance

The TNCO has considered a range of roles and responsibilities that could be centralized. At a minimum, the centralized structure should be responsible for the following:

- Respecting, promoting, and serving as a guardian of the PSBN Principles
    - A centralized structure should set and promote the guiding PSBN Principles for reference by relevant PSBN users and service delivery partners
- Establishing and promoting national common standards that support nationwide interoperability
    - A centralized structure should establish, promote, and evolve common network standards (ex. Security, QoS, approved devices, etc.) in order to guide uniform PSBN implementation and operations across the country as public safety needs expand and new capabilities and technologies become available
- Providing advice to ISED on eligibility and suitability of potential Band 14 licensees
    - A centralized structure should establish criteria for license eligibility (ex. demonstrated ability to fulfill PSBN Principles) and advise ISED on suitability of license applicants based on these criteria
- Consulting with federal, provincial, territorial, municipal, Indigenous, and local public safety entities and authorities, as well as other relevant stakeholders and expertise in order to inform decision-making processes
    - A centralized structure should regularly consult with stakeholders in order to ensure its decisions are reflective of the needs of the user and service delivery community

Form and Authorities

In order to achieve its primary responsibilities, a centralized structure could also be accountable for a range of additional roles and responsibilities. There is also an opportunity to evolve the centralized functions over time, as it may be favorable to have a more substantial centralized structure that goes beyond the basic functions outlined

above. The mandate could therefore vary in size and scope depending on the number of additional roles and responsibilities that are accounted for at a centralized level. *Table 1* (Annex B) proposes two potential variations. Those functions which are not accounted for at the centralized level but are considered as necessary for the building, deployment, and/or operations of the network would become distributed governance functions.

As discussed, there is currently no national-level organization (or combination thereof) with clear regulatory authority for public safety telecommunications networks in Canada. As the principle governance mechanism of the PSBN, a centralized structure could therefore take various forms and explore a number of approaches in order to fulfill its established roles and responsibilities and derive its authority. This structure could operate under agreed upon processes or mechanisms and would not be required to be a legal entity. For example, it may derive its authority through reference in Band 14 Conditions of License, which could underscore its role as an overarching point of reference for fundamental nationwide standards. Another way in which it could derive its authority is through a decision by FPT ministers, who could endorse its role and mandate.

A more substantial centralized structure with a broader scope of functions and responsibilities could similarly operate under agreed upon processes or mechanisms without necessarily operating as a legal entity. However, due to its larger mandate, it may take the steps to establish itself as a legal entity in order to gain authorities which could only be granted through contractual processes. As a legal entity, it could take the form of either a for-profit or not-for-profit (NFP) entity, each with its own benefits and considerations. A for-profit entity's fiduciary duty to shareholders could put it in conflict with its mandate to respect, promote, and serve as a guardian of the PSBN Principles.

An NFP could either be a government entity or sit outside of government. As a government entity it would be met with a host of available resources upon establishment. However, it would be bound by particular rules and regulations, including restrictions on Board representation, procurement processes, and budgetary cycles. In addition, a single minister would serve as the single point of authority. Alternatively, an NFP that sits outside of government would operate with a high degree of autonomy in respect to direct government oversight. In this space, it could serve as

an effective intermediary between government, who establishes the Conditions of License, and private sector entities, which may partner to design, deploy and operate the PSBN.

By taking on additional responsibilities, an NFP would require a Board and could be supported by an Advisory Committee or Committees. The Board would be comprised of members with relevant expertise, including but not limited to those with experience in public safety (e.g., paramedics, fire, police), emergency management, network technology, and finance. Sub-committees could also be formed according to relevant organizational needs. An Advisory Committee should also be comprised of an appropriate balance of stakeholders who would be responsible for identifying and promoting the interests of the PSBN stakeholder and user communities by reporting to the Board for input into decision-making processes. This committee would serve as an important link between the diverse stakeholder communities it serves and the operations of a centralized NFP. It is the view of the TNCO that an NFP, outside of government, has a higher potential of harnessing the input of stakeholders in order to best align itself with the mission of ensuring the successful implementation and operations of a PSBN.

While the exact composition of a Board and/or Advisory Committee are yet to be determined, it is necessary to note the importance of such bodies being representative of the diverse communities they serve. Involving diverse stakeholders in decision-making processes fosters greater understanding and support for recovery efforts, results in a higher quality of life for Canadians, and supports innovation and growth. Furthermore, increasing diversity in leadership roles (this includes the representation of Indigenous people, women, visible minorities and persons with disabilities) is critical for decisions to be made in the interest of all Canadians and has demonstrated positive impacts on organizational performance.[29] Recognizing that emergency management is currently a male-dominated field, it is therefore recommended that future governance mechanisms of a PSBN account for diversity in leadership and decision-making teams

[29] The Canadian Board Diversity Council's 2018 Annual Report argues that "Critical Mass" (the threshold for increasing organizational innovation) includes having three or more female directors sitting on the board. If boards do not acknowledge a lack of female representation and achieve Critical Mass, profitability, growth, and innovation can be expected to suffer.

in order to best reflect the diversity of their user base and communities they serve as well as support overall financial performance and innovation.

Guidance and Coordination

Over time it may be optimal to have a more substantial centralized structure that goes beyond the basic functions outlined above. As the mandate increases (moving from narrow to broader in scope), a centralized structure is able to shift from a hands-off oversight role to more involved leadership. Consequently, there would be a need for more resources to support these additional functions and an increased need to work with stakeholders across Canada. This larger resource pool would facilitate greater involvement with, and accountability to, stakeholders and help ensure the successful provision of a PSBN.

A more substantial structure would take on additional responsibilities, which could include (but are not limited to):[30]

- Developing deployment strategies, including rural and remote coverage milestones
- Ensuring ongoing compliance review and monitoring of the management and operations of the PSBN in alignment with the PSBN Principles
- Supporting/advising on procurement of services and devices
- Managing and overseeing the implementation and execution of contracts or agreements to build, operate, and maintain the network
- Providing guidance and advice related to equipment and applications which may be connected to/used over the PSBN (e.g. certification of devices or applications)
- Leading the development of user requirements, technology requirements (for the network and for devices), and application requirements to support the PSBN

With a broader mandate, the structure would provide a higher level of support to ISED, particularly by ensuring ongoing compliance review and monitoring of the management and operations of the PSBN in alignment with the PSBN Principles. It would also have

[30] Defence Research and Development Canada's Centre for Security Science. (2017). Implications of Service Delivery Model Options on Interoperability and Operational Efficiency in a PSBN. DRDC-RDDC-2017-R038.

greater influence in enabling effective and efficient procurement and would deliver greater value to stakeholders.

Distributed Governance Functions

Given that Canada is a large, diverse country and that the vast majority of emergency events are local in nature, no one is better positioned than local communities to understand the specific operational challenges and requirements of regional communities and jurisdictions. The TNCO has heard from stakeholders that certain governance functions should therefore serve as complementary to centralized and national-level functions. As such, it is envisioned that a centralized structure would provide value to distributed agencies and/or mechanisms, who would be able to draw on its overarching standards and support.

Distributed governance functions could be carried out by individual provincial/territorial government entities, municipal/local government entities, non-government entities, or collectives/group representation of these entities, and would play an essential role for operational end users of a PSBN. The following roles and responsibilities are best delivered on a regional or distributed basis in order to reflect and respond to regional needs and operational requirements:

- Seeking and promoting investment for local network expansion and/or improvement,
- Determining eligibility for priority and pre-emption (if applicable),
- Identifying and enhancing regional coverage within their jurisdiction, including to rural and remote communities, through the development of coverage requirements and strategies,
- Working with the centralized structure on regulatory and policy compliance,
- Developing user requirements, technology requirements (for the network and for devices), and application requirements to support the PSBN,
- Procuring broadband and PSBN related services from vendors,
- Delivering user training,
- Conducting exercises,
- PSBN promotion and onboarding, and
- Serving as a point of contact for user concerns and issues.

Outstanding Governance Considerations

Stakeholders have reached strong consensus regarding many elements of a future PSBN. They support the development of a PSBN but are at varying states of readiness in terms of implementation (capacity to invest/readiness to adopt). The decision by ISED to set aside Band 14 for public safety broadband use presents a unique opportunity to advance an interoperable nationwide PSBN. Stakeholders have collectively acknowledged this opportunity and the need for all levels of government to continue to work together.

With this in mind, it is important to note that the governance options presented within this report have been developed without any commitment of potential resources from the national police, fire and paramedic associations or federal, provincial, territorial and municipal governments. Stakeholders' level of commitment (from a human resources and financial perspective) is therefore an outstanding consideration that should be taken into account.

In carrying out the duties and responsibilities for which it is accountable, a centralized structure should be financially self-sustaining and be required to re-invest funds toward the overall delivery and operations of the network. It may achieve its financial and operational sustainability through any number of revenue mechanisms. It is, however, ultimately beyond the mandate of the TNCO to determine how this sustainability may be ensured.

Recommendation 2: The TNCO recommends a governance approach that includes representation from a diverse range of stakeholders and establishes and monitors adherence to national common standards through a not-for-profit structure that support nationwide interoperability.

Spectrum Utilization Model

As discussed earlier in this document, ISED has allocated 20 MHz of 700 MHz spectrum (known as "Band 14") for issuance of spectrum licenses to one or more public safety network entities.[31] The 700 MHz Band is an important swath of spectrum available for both commercial wireless and public safety communications. The location of the 700 MHz Band – just above the remaining TV broadcast channels – gives it excellent propagation characteristics. This allows the 700 MHz signals to penetrate buildings and walls more easily and to cover larger geographic areas with less infrastructure (relative to frequencies in higher bands).[32] In its progress report, the TNCO considered three broad models of spectrum utilization for the implementation of a PSBN in Canada:

1. **Public Safety Exclusive Dedicated Network**: A dedicated public safety network used exclusively by public safety users (using 700 MHz Public Safety Broadband).
2. **Shared Public Safety-Commercial Network**: A network that supports both public safety and commercial usage (with distinct public safety and commercial cores), with priority access and pre-emption rights for public safety use during emergencies and other times of need.
3. **Commercial Network**: The public safety community obtains services from one or multiple commercial carriers using that carrier's existing network spectrum and/or acquired Band 14 spectrum.

Although three distinct models were presented for consideration, it should be noted that given ISED's *Decision on Policy, technical and Licensing Framework for the Use of Public Safety Broadband Spectrum*,[33] Model Three – commercial network – is no longer viable for consideration. While it is technically feasible to implement a PSBN

[31] Innovation, Science and Economic Development Canada. (2017). Decisions on Policy, Technical and Licensing Framework for Use of the Public Safety Broadband Spectrum in the Bands 758-763 MHz and 788-793 MHz (D Block) and 763-768 MHz and 793-798 MHz (PSBB Block). https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11289.html

[32] Federal Communications Commission. (2018). 700 MHz Public Safety Spectrum. https://www.fcc.gov/700-mhz-public-safety-narrowband-spectrum

[33] Innovation, Science and Economic Development Canada. (2017). Decisions on Policy, Technical and Licensing Framework for Use of the Public Safety Broadband Spectrum in the Bands 758-763 MHz and 788-793 MHz (D Block) and 763-768 MHz and 793-798 MHz (PSBB Block). https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11289.html

under a Dedicated or Shared approach, comparative analysis demonstrates significantly different risks and opportunities associated with each model.

A Dedicated Network is not preferred due to the low likelihood of satisfying the principles of coverage, sustainability, affordability, and efficient use of spectrum. A Dedicated Network would require a combination of significant new capital and ongoing operational expenditures and would depend solely on user fees from PSBN users and likely heavy investments from all levels of government, which would not be complemented by a significant base of commercial user fees. Furthermore, there would likely be a need to roll out Band 14 more extensively and rapidly than in the case of a Shared Network. As public safety organizations will not be obligated to adopt the PSBN, costs to public safety organizations would likely be high and could require subsidization of user fees to migrate users from existing networks. Low PSBN uptake would ultimately hinder interoperability, the primary objective of a future PSBN. Moreover, a Dedicated Network would have the least efficient use of spectrum with 90-95% of the spectrum unused daily outside of major emergencies and events.[34]

Based on comparative analysis, a Shared Network has the highest likelihood of satisfying the fundamental PSBN Principles, largely due to its ability to leverage the value of Band 14 spectrum. This value could support investments in coverage and resiliency/robustness, while maintaining or improving affordability and sustainability of the network over time. Additionally, a Shared Network model will be best able to ensure the efficient use of spectrum by making best commercial use of Band 14 while ensuring priority and pre-emption for public safety users when and where required. Other advantages include: increasing resiliency of commercial networks that support PSBN; improving public access to wireless in underserved areas; increasing the reach of the NPAS and access to 911; cost savings by avoiding unnecessary duplication of infrastructure; a faster deployment timeline; and public safety access to other spectrum assets.

Recommendation 3: The TNCO recommends that the PSBN be implemented using a Shared Network approach.

[34] Defence Research and Development Canada. (2017). Bandwidth Requirements for Day-to-Day Operations on Canada's 700 MHz Public Safety Broadband. P. 7. http://cradpdf.drdc-rddc.gc.ca/PDFS/unc273/p805324_A1b.pdf

Service Delivery Models

There are different ways to deliver a PSBN in Canada. In its progress report, the TNCO considered four service delivery models and compared them against their ability to fulfill the PSBN Principles.[35] TNCO's analysis found that service delivery models A and D are best positioned to satisfy the principles of the PSBN (Annex C). Both of these models support the broader recommendation that the PSBN be delivered to function as a single nationwide network. Comparative analysis demonstrates that Models B and C will not be able to achieve the PSBN Principles. The structure of multiple networks with little or no national coordination and facilitation structures poses a risk to national interoperability and the ability to support federal users. Additionally, the more complex structure presents extra costs for those stakeholders involved. It is important to note that the choice of a deployment strategy and service delivery model rests with those ultimately implementing the nationwide PSBN.

The TNCO does not recommend dictating the deployment strategy or the manner in which parties may or may not seek to align themselves through partnerships, joint ventures, or other vehicles to produce proposals for a nationwide PSBN offering. Rather, in considering various service delivery approaches (Annex C) the TNCO evaluated a set of possibilities against the Principles that must be met. A future acquisition process should encourage innovative solutions that will meet and exceed the needs of public safety. It must not be limited by any particular solution nor to any specific offeror, but rather should be open to all entities, whether wireless incumbents or new entrants, provided all the PSBN Principles are satisfied.

Ultimately, the PSBN will need to achieve financial sustainability through public funding, user fees, and agreements with partners that will leverage the value of excess network capacity. In undertaking this task, there is a need to leverage – to the extent economically desirable – existing infrastructure, obtain optimal value for excess network capacity, and optimize its pricing structure to deliver a high-quality, affordable broadband network and services to Canada's public safety community.

[35] Options for service delivery models and their implications for the delivery of mobile broadband services to emergency responders using long-term evolution technology (LTE) were developed by Defence Research and Development Canada's Centre for Security Science.

In weighing the speed of deployments, services, functionality, cost, and implementation and operational risks and benefits for a nationwide solution versus a more disaggregated network solutions some of the factors that should be considered include:

- The economies of scale and scope, including the synergy value and speed of deployment associated with leveraging existing commercial mobile provider infrastructure;
- The value of excess network capacity (ultimately for public safety's benefit) on a national scale or on a market or region-by-region basis;
- The advantages and disadvantages, including with regard to execution risk and redundancy, of having a single party or several parties responsible for implementation and operation of the network;
- The technical, operational, cost, and speed of deployment considerations related to integrating disparate RANs with multiple vendor technologies and varying standards compliance;
- The technical, operational, cost, and timing considerations related to contracting for, gaining access to, and using a variety of public and private sites and other infrastructure with different owners, lessors, requirements, and equipment;
- Providing certainty to potential offerors in any procurement process in order to get the best value for public safety; and
- The duration of the spectrum license, compliance with licensing conditions, and other legislative and regulatory considerations.

Recommendation 4: The TNCO recommends that the PSBN be delivered to function as a single network.

Approaches to Achieving Robust Coverage and Capacity

One of the TNCO's key responsibilities was to develop and recommend innovative solutions to address coverage gaps and capacity challenges. A key consideration when designing and deploying a PSBN in Canada will be the geographic coverage and network capacity available to PSBN users. While the same can be said for commercial cellular networks, this topic has even greater importance when considering the requirements that may be placed on the PSBN in times of emergencies and during daily operations. Stakeholders have consistently highlighted the importance of these aspects of a PSBN.

Coverage and access to broadband infrastructure remain at the forefront of the PSBN conversation. As highlighted by the Broadcasting and Telecommunications Legislative Review Panel,[36] this is particularly true in the case of remote, rural and Indigenous areas of the country, where even commercial broadband network coverage remains a significant challenge. While coverage is an issue that manifests most clearly in rural and remote regions, the challenge of access and availability are also frequently experienced in urban, densely populated regions. In these areas, competition for scarce network resources are more likely to occur. However, rural and remote regions may still experience capacity issues if the underlying network infrastructure is not adequately designed, sized and deployed.

This section will review potential approaches to addressing both coverage and capacity gaps in the design and delivery of PSBN services nationwide. To address these, the balance of this section will explore five approaches that could be employed to address the coverage and capacity requirements. These five approaches are:

1. Conditions of License and Contracting;
2. Targeted Stakeholder Investment;
3. Government Policy and Initiative Synergies;
4. Strategic Partnerships; and

[36] Broadcasting and Telecommunications Legislative Review. (2019). What We Heard Report. https://www.ic.gc.ca/eic/site/110.nsf/vwapj/What_we_Heard_eng_final_07-17-19.pdf/$file/What_we_Heard_eng_final_07-17-19.pdf

5. PSBN Deployable Systems.

As these approaches are explored, it becomes clear that no single approach will constitute a complete solution. Taken together in combination, however, these approaches should support the delivery of a PSBN that has sufficient robustness in coverage and capacity to address both coverage requirements and the need for reliable, always-available network service.

1. Conditions of License and Contracting

One of the principal mechanisms for addressing the question of coverage of a national PSBN is tied to the creation of appropriate Conditions of License (CoL), which is the tool by which a network entity is granted radio frequency spectrum (hereafter referred to as spectrum) to deploy services.

ISED is the federal department tasked with the full life cycle of spectrum management in Canada. As per ISED's mandate related to spectrum licensing, coverage objectives will be included in the CoL for Band 14 spectrum. Coverage conditions for spectrum licenses are currently a standard feature, although the specifics of these conditions vary according to a given spectrum band.[37] [38] Under these conditions of license, ISED can exercise a range of options by which to define coverage obligations. Two common coverage criteria used by ISED are coverage of a given percentage of the population and coverage of given percentage of land area in a region. In this context, ISED's primary role is to ensure that spectrum, a scarce public resource, is used efficiently. The creation of the CoL for Band 14 is ISED's responsibility and will be the subject of a public consultation. In this consultation, ISED will propose an approach and all stakeholders, public and private, will be invited to comment.

While any coverage objectives outlined in the 700MHz Band 14 CoL will only apply to Band 14 usage, it is worth clarifying that Band 14 spectrum should not be the only spectrum used to deploy a PSBN in Canada. To those ends, in addition to conditions of

[37] Innovation, Science and Economic Development Canada. (2013). Licensing Framework for Mobile Broadband Services (MBS) – 700 MHz Band. https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10581.html#p6
[38] Innovation, Science and Economic Development Canada. (2018). Technical, Policy and Licensing Framework for Spectrum in the 600 MHz Band. https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11374.html#s9

license, any entities with the responsibility to physically build and operate a national PSBN could be subject to further coverage objectives and compliance mechanisms through the negotiation of contracted arrangements. These objectives and mechanisms would be derived from the Principles of the PSBN that have been previously articulated.

In summary, while the CoL offer a mechanism for ensuring the compliance and expansion of 700MHz Band 14 spectrum usage, a PSBN coverage strategy will need to be articulated through additional mechanisms which can ensure compliance, and which may leverage additional spectrum assets, even if only temporarily. Effectively, through contractual arrangements with the entities deploying and operating the PSBN, these entities may make use of existing network infrastructure operating on spectrum bands other than Band 14 where capacity is already available. In this respect, while the Band 14 coverage targets in a CoL must be met, more comprehensive coverage targets may be established by a centralized structure for an entity to meet contractually, thereby improving and accelerating overall PSBN coverage. This approach could alleviate pressure on MNOs to build out Band 14 where there is an abundance of spectrum. It could also contribute to the deployment of PSBN in a more efficient, timely and cost-effective manner.

2. Targeted Stakeholder Investment

From a commercial perspective, private sector investment is ongoing in the telecommunications market, as competition compels firms to innovate and expand their offerings, including addressing coverage gaps and increasing overall capacity. In that respect, there is an expectation that any PSBN MNO(s) would have a vested commercial interest in expanding coverage to serve its customers (both PSBN users and other customers). This expectation could be reinforced through the CoL and/or contractual obligations.

As with any service, direct investments in infrastructure would contribute to broader coverage. In order to create a strong business case, entities deploying the physical PSBN could leverage partial commercialization of the 700MHz Band 14 spectrum,[39] as

[39] In the ISED decision paper (https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11289.html), it has been noted that commercialization of underutilized/idle spectrum in Band 14 is permissible, which would lead to a revenue stream for the PSBN operator (See D-4 in above link)

well as service fees from PSBN users. Apart from these funding sources, direct investments could be targeted specifically for activities such as introducing infrastructure for underserved or unserved areas, as well as densification of service in high-volume areas.

From a public perspective, federal, provincial, territorial and municipal governments determine their own investment priorities as they pertain to broadband connectivity, including both wireline and wireless technologies, in order to address the needs of their constituents. These will include both private citizens and users from all levels of government. Due to the nature of a PSBN, there will be naturally overlapping investment priorities from both private and public viewpoints. All stakeholders should ensure accordingly that funds are directed efficiently while identifying potential gaps and opportunities as they become known. In this way, market forces may address some gaps, whereas public investment may be needed to address others.

3. Government Policy and Initiatives Synergies

The desire to increase wireless network coverage is applicable not only to a PSBN in Canada, but also to improving coverage for the public. The societal benefits of broadband connectivity have been explored and affirmed by numerous bodies, including the United Nations.[40] In Canada, federal, provincial, territorial, and municipal governments have each identified broadband access as a key component of economic prosperity.

The Minister of Innovation, Science and Industry's mandate letter sets a target to deliver high-speed Internet to 100 per cent of Canadian homes and businesses by 2030.[41] Several government initiatives have been launched to increase the availability of broadband services in all parts of Canada, including ISED's Connect to Innovate program[42] and the Canadian Radio-Television and Telecommunication Commission's

[40] One example of this is the creation of the *Broadband Commission for Digital Development,* which was established in May 2010 with the aim of boosting the importance of broadband on the international policy agenda, and expanding broadband access in every country as key to accelerating progress towards national and international development targets. Following adoption of the UN's Sustainable Development Goals in September 2015, the Commission was re-launched as the *Broadband Commission for Sustainable Development* to showcase and document the power of ICT and broadband-based technologies for sustainable development. More information on this group can be found here: https://broadbandcommission.org/

[41] Government of Canada. (2019). Minister of Innovation, Science and Industry Mandate Letter. https://pm.gc.ca/en/mandate-letters/minister-innovation-science-and-industry-mandate-letter

[42] Government of Canada. (2019). Connect to Innovate. https://www.ic.gc.ca/eic/site/119.nsf/eng/home

Broadband Fund. [43] Much of the funding will be targeted to improve the access in rural and remote areas, as evidenced by Canada's recent investments in technologies such as low-earth orbit satellites,[44] which can provide faster, lower cost, and more reliable satellite Internet services than previous satellite technologies.

Provincial budgets across the country have also singled out the need to invest more in connectivity to underserved, remote, rural and Indigenous communities. Much of this investment is targeting both backhaul infrastructure and last-mile connections – both of which currently present considerable economic barriers to commercial expansion into underserved communities. Some municipalities are also actively investing, often as partners with federal and provincial governments, in broadband infrastructure that addresses both coverage and capacities gaps. Alleviating these economic barriers reduces the cost burden and improves opportunities to leverage new projects to expand PSBN infrastructure.

In order to benefit from these opportunities, all levels of government should work in partnership where such programs and investments are concerned. In many programs, there are specific application processes where various criteria are examined and evaluated to determine funding eligibility. There may be an opportunity to propose the inclusion of criteria specific to furthering the goals of the PSBN. For example, criteria could be included to determine whether an applicant's proposal takes into account authorization for the PSBN to make use of any new infrastructure, including backhaul, which is a critical connectivity requirement.

In addition to funding programs, various levels of government may also have a role to play in ensuring that coverage can be enhanced efficiently and affordably. These roles could include modifying statutes, regulations and policies in such a way that allows for deployment of PSBN equipment on existing infrastructure. These types of policies already exist in the commercial space, such as federally mandated requirements around tower sharing, and municipally to allow equipment to be attached to utility poles. For example, the access and use of municipal rights-of-way for PSBN purposes would

[43] Canadian Radio-television and Telecommunications Commission. (2019). Broadband Fund. https://crtc.gc.ca/eng/internet/internet.htm
[44] Blatchford, A. (2019). Canada to invest in satellite technology to connect rural, remote areas. *CBC.* https://www.cbc.ca/news/polistics/satellite-high-speed-internet-1.5222655

require significant consultation with affected municipal stakeholders, including the Federation of Canadian Municipalities (FCM). To ensure these arrangements exist and are favourable to a PSBN deployment, governments may need to change existing rules.

4. Strategic Partnerships

While cellular technology is ubiquitous in Canada with LTE access reaching roughly 99% of the total population in 2017,[45] geographically there are large areas of the country that remain unserved or underserved. These areas (primarily rural, remote and Indigenous communities) present a range of network infrastructure deployment challenges for existing commercial service providers due to considerable distances and very low (or non-existent) population densities. A principal concern for these providers is the level of investment required to expand network coverage to areas where economic barriers undermine the business case. From a PSBN perspective, however, emergencies can and do happen anywhere. In fact, the 2013 Auditor General of Canada's report[46] found that emergencies occur more frequently in Indigenous communities as a result of factors including geographic location and isolation (rural, remote, and Northern). Vulnerable populations could benefit considerably from a faster, more effective and coordinated response when their lives or property are threatened.

With the above in mind, decisions regarding where permanent infrastructure should be located will need to be made. This could include a decision to have permanent network coverage near all rights of way (e.g. roads, railways, shipping lanes, etc.). While these regions may not have permanent residents, there may very well be other entities with an interest in having network coverage. This could include critical infrastructure owners, public works, railway operators, national parks, etc. An example could be a remote hydro dam where workers travel to/from a facility but currently have no commercial cellular coverage, or a stretch of railway where there is infrastructure and a need to coordinate movements of multiple trains sharing the tracks.

Many rural and remote areas also support significant tourism activities. While there may not be many permanent residents or businesses in these regions, tourists travel

[45] Canadian Radio-television and Telecommunications Commission. (2018). Communications Monitoring Report 2018. https://crtc.gc.ca/eng/publications/reports/policymonitoring/2018/cmr3d.htm
[46] Office of the Auditor General of Canada. (2013). 2013 Fall Report of the Auditor General of Canada. https://www.oag-bvg.gc.ca/internet/English/parl_oag_201311_06_e_38800.html

extensively either in groups or individually within these areas. Additionally, seasonal populations can significantly increase in regions and this needs to be recognized as part of a PSBN.

Strategic partnerships with infrastructure owners, whether public or private, who operate in these regions may present an opportunity for cost-effective and sustainable network expansion. Many entities in private industry, including mineral and gas exploration, transportation, and utilities firms, possess considerable infrastructure to support their operations, often located in harsh environments. These entities, like the public safety community, require reliable and robust communications solutions for their operations. Some have identified synergies with a PSBN and have expressed interest in leveraging Band 14 spectrum to support their mission critical communications requirements. Under mutually beneficial agreements, infrastructure owners could choose to share some of their infrastructure for installation of new equipment for the PSBN or could become a regional PSBN operator in their own right, depending on the circumstance.

Strategic partnerships among MNOs is another possibility to expand coverage. Subject to relevant policy and regulatory decisions, a mobile virtual network operator-like approach (MVNO),[47] in whole or in part, to delivering PSBN in Canada is not precluded as long as it fulfills the PSBN Principles. Network operators involved in the deployment of the PSBN should leverage their own existing infrastructure to the greatest extent possible. If and where those firms lack infrastructure, they may also benefit from mutual agreements over infrastructure sharing, and may enter into such agreements using their own internal mechanisms. Tower sharing, for example, avoids duplication of construction and maintenance efforts, resulting in potential cost savings and a reduction in environmental impact.

5. PSBN Deployable Systems

While permanent, fixed infrastructure is optimal, there is currently no economically viable option to blanket the entirety of the Canadian geography with such equipment.

[47] A mobile virtual network operator (MVNO) is a wireless communications services provider that does not own any or all of the wireless network infrastructure, as the case may be, but rather leases wireless capacity from a third-party mobile network operator (MNO) by entering into a business agreement. In the cellular world, MVNOs offer alternatives to costumers and often more flexible and less expensive mobile plans.

For several years now, commercial mobile network operators and other communications providers have had options available to them to deploy temporary coverage and augment capacity where and when it is needed. These types of equipment are often referred to as 'deployable systems' or, more casually, 'deployables'.

Deployable systems refer to mobile network resources which can be deployed (often rapidly) to an area in response to a disaster or emergency, a planned event or to support day-to-day operations in areas where network coverage is either unreliable or non-existent, or where capacity needs to be augmented. Common examples include cell on wheels (COWs), system on wheels (SOWs), and cell on light trucks (COLTs). These systems are designed to be incidental and temporary in nature, and help to support operations by providing connectivity where operations do not normally occur, where network connectivity is unreliable due to challenges of economic feasibility or geography, where the network is congested, or where existing infrastructure has been rendered inoperable by natural or man-made events. Deployable systems could, however, be used in a more permanent manner where warranted and desired.

A national PSBN would make use of deployable systems when and where necessary in order to create or supplement access and coverage for the network. Depending on the network configurations and contracting relationships between PSBN actors, such deployable systems could be managed through national, regional or local entities. The maintenance of a national register of deployables could be a centralized function.

It is important to note that the use of deployable systems may pose some unique challenges for a nationwide interoperable PSBN. Whichever entity or combination of entities manage deployable systems will ultimately be responsible to ensure specific software release versions and technical capabilities align with the national, permanent PSBN. This alignment will be the key to ensuring interoperability. Deployable systems should be capable of reasonably quick deployment timelines to best address the operations of PSBN users whenever or wherever they occur. In the United States, for example, FirstNet has 72 FirstNet-dedicated deployable systems stationed in 40 locations across the country available to respond to situations where infrastructure is overloaded or destroyed.[48] In addition, through its partnership with AT&T as the

[48] AT&T. (2018). FirstNet Fleet of Dedicated Deployable Network Assets Now Available to Public Safety Subscribers Nationwide. https://about.att.com/story/2018/firstnet_deploables.html

network operator, additional deployable systems (over 700 non FirstNet-dedicated) and assets may be leveraged, as available in situations where needed.

With respect to the technical requirements and challenges of using and maintaining a fleet of deployable systems, the National Public Safety Telecommunications Council (NPSTC) and DRDC CSS produced a report entitled: *Broadband Deployable Systems in the Nationwide Public Safety Broadband Network*.[49] Among other things, this report explores:

- Operational Uses of Deployable Systems,
- Deployment Considerations,
- International/Cross Border Considerations,
- Operations and Maintenance,
- Deployable Systems Security/Assurance,
- Technical Challenges, and;
- Operational Policy & Governance Considerations.

To summarize, PSBN deployable systems should be considered an essential, albeit primarily situation-specific and temporary, element in addressing coverage and capacity challenges of the PSBN across the country. They are a key mechanism to ensuring a robust PSBN capable of delivering services to PSBN users when and where they are needed.

Recommendation 5: The TNCO recommends that stakeholders consider multiple approaches to addressing both coverage and capacity gaps to support the delivery of a PSBN in Canada.

[49] National Public Safety Telecommunications Council and Defence Research and Development Canada's Centre for Security Science. (2017). Broadband Deployable Systems in the Nationwide Public Safety Broadband Network. http://www.npstc.org/download.jsp?tableId=37&column=217&id=3903&file=NPSTC_CSS_BB_Deployable_Systems_Report_Final_170403.pdf

Way Forward

The Canadian public safety community has considered the benefits and opportunities of a PSBN for nearly a decade. In the absence of a PSBN, responders continue to gather and share information as best they can. In most cases, situational awareness relies on manual processes that leverage different equipment and standards between jurisdictions and agencies. The result is often an incomplete picture of the broader situation and communication silos that can make coordination a significant challenge. Additionally, many emerging technologies, such as real-time high definition video streaming, cannot be fully utilized by responders as the underlying data services they rely on do not meet the mission critical standards required.

As disasters in Canada increase in frequency and severity and as day-to-day operations, emergencies and major events require significant amounts of data, the status quo is not sustainable in the 21st century. From coast to coast to coast, stakeholders across the public safety community have continued to express a need for modern, improved communications capabilities. Moreover, there is public expectation that all levels of governments and the public safety community have the tools and level of coordination necessary to ensure the safety of Canadians and the protection of property.

The transition to a PSBN will be complex and require all levels of government to support its development. Stakeholders are encouraged to examine the recommendations included herein as they consider their future involvement in and/or relationship with the PSBN in Canada.

While considerable work has been undertaken to consolidate the views, interests, and priorities of the public safety community, several key items will need to be addressed:

- Financial modelling to support governance structure
- Detailed design and approval of governance structure
- Funding and establishment of centralized and distributed governance functions
- Identification and development of national standards
- Evaluation of deployment strategy and development of a go-to-market strategy
- Procurement and implementation of PSBN
- Individual jurisdictional procurement of PSBN services

- Individual jurisdictional procurement and implementation of enhancements such as additional coverage, hardened infrastructure

An interoperable nationwide PSBN in Canada will allow the public safety community to leverage technology in new ways, helping keep Canadians safe in times of need. As new life-saving technologies are created, a PSBN will provide the mechanism to ensure the public safety community has the ability to work together in protecting Canadians.

Definitions

Term	Definition
Backbone	The physical part of a communications network between the central backbone and the individual local networks.
Backhaul	The connection between the radio access network (base stations) and the mobile core network.
Band 14	A paired block of 10+10 MHz in the bands 758-763 MHz and 788-793 MHz (Block D) and 763-768 MHz and 793-798 MHz (Block PSBB) spectrum ranges (downlink: 758-768 MHz; uplink: 788-798 MHz).
Commercial users	MNO users with no public safety role.
Conditions of license (CoL)	Conditions ISED imposes on a spectrum licensee in exchange for the use of spectrum.
Coverage	Network coverage can be established by targeting a percentage of the population that resides in the geographic coverage area, or by stating the goal for a land area or road length covered by a network. Mobile network coverage can be extended on a temporary basis by using deployables in a localized incident area and/or by roaming across multiple networks.
Critical infrastructure	Critical infrastructure refers to processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of Canadians and the effective functioning of government. Critical infrastructure can be stand-alone or interconnected and interdependent within and across provinces, territories and national borders. Disruptions of critical infrastructure could result in catastrophic loss of life and adverse economic effects.[50]
Deployable systems	Portable systems that are temporary in nature and provide wireless service with LTE equipment. Several deployable systems can be linked to serve a larger area. Deployable systems may or may not have backhaul. Systems can be small enough to be easily carried by one person up to vehicle towed or mounted systems and even airborne system.
First responders	Individuals employed or formally engaged to carry out the duties of a police officer, firefighter, or paramedic by a Canadian emergency service in Canada.

[50] Public Safety Canada. (2009). National Strategy for Critical Infrastructure. https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/srtg-crtcl-nfrstrctr/index-en.aspx

Term	Definition
Hardening	A collection of tools, techniques, hardware and best practices used to reduce vulnerability to one or more threats.
Interoperability	The ability of emergency personnel to communicate between jurisdictions, disciplines, and levels of government, using a variety of systems, as needed and as authorized. It includes achieving full national operability using common user credentials regardless of the network deployment method used as well as interoperability of PSBN with existing Land Mobile Radio (LMR) services in the near to medium-term. Data interoperability can also be achieved at the application level.
Land mobile radio (LMR)	A wireless communications system commonly used by emergency first responders to support voice and low-speed data communications.
Long-Term Evolution (LTE)	A standard for high-speed wireless communication for mobile devices and data terminals.
Mission Critical Services (MC Services)	Mission Critical Services (MC Services) refers to the standards defined by 3GPP, including Mission Critical Push to Talk (MCPTT), Mission Critical Video (MC Video) and Mission Critical Data (MC Data). Details of these standards and their evolution are outlined in the 3GPP Rel-13, Rel-14, and Rel-15.
Mission critical services	Any activity, device, service or system whose failure or disruption will cause a failure or severe degradation in operations can be described as mission critical. In the context of the public safety community and the PSBN, this would constitute any aspect of the essential communications services upon which a given user depends for their day-to-day operations, during emergencies and planned events.
Mobile network operator (MNO)	A wireless service provider, wireless carrier, cellular company, or mobile network carrier, is a provider of wireless communications services that owns or controls all the elements necessary to sell and deliver services to an end user, wireless network infrastructure, backbone network infrastructure, billing, customer care, provisioning computer systems and marketing and repair organizations.
Mobile virtual network operator (MVNO)	A wireless communications services provider that does not own all of the wireless network infrastructure over which it provides services to its customers, but can own some.
Network access	Ability to have immediate access to a PSBN for mission critical services.

Term	Definition
Network capacity	The maximum amount of data that may be transferred between network locations over a link or network path[51].
Pre-emption	Used together with priority to control use of resources by removing active sessions of lower priority users and allow allocation of resources to higher priority users, when network resources are scarce or fully occupied.
Priority	The means by which users, applications, traffic streams or individual packets take precedence over others in setting up a service session or forwarding packets during periods of congestion in the network.
PSBN users	People, entities/agencies and their devices/machines with a role in or responsibility for the health, safety and security of the public and its property.
Public Land Mobile Network Identification Number (PLMN ID)	3GPP – Globally unique network identification code.[52]
Quality of Service (QoS)	Traffic prioritization and resource control mechanisms used to achieve desired levels of performance for a data flow.
Radio access network (RAN)	A technology that connects individual devices to other parts of the network through radio connections.
Resilience	The ability of the network to provide and maintain an acceptable level of service in the face of various faults and challenges to normal operations. A resilient PSBN infrastructure would be hardened to withstand threats such as power outages, flooding, seismic activity, and terrorism/vandalism and- should failure occur- rapidly restoring communication availability.
Roaming	The ability for a PSBN user to automatically receive service, including home data services, when travelling outside the geographic area of the home network, by means of a visited network.
Service delivery	The approach to delivering mobile broadband services to PSBN users.
Security	The ability to protect and secure physical wireless network infrastructure and to prevent malicious activities such as cyberattacks at the system and application level.

[51] https://www.techopedia.com/definition/18179/capacity-network
[52] https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=558

Term	Definition
Spectrum	Radio frequencies over which wireless data travels. In Canada, the spectrum used in communication is regulated by ISED, who specifies which frequency ranges can be used by whom and for what purpose.
Temporary National Coordination Office (TNCO)	Office established by the Government of Canada to play a leadership role in the advancement of a national and interoperable PSBN for Canada.

Acronyms

Acronym	Definition
3GPP	Third Generation Partnership Project
4G	Fourth generation
5G	Fifth generation
CACP	Canadian Association of Chiefs of Police
CAFC	Canadian Association of Fire Chiefs
CANUS	Canada/United States
CISC	Communications Interoperability Strategy for Canada
CoL	Conditions of license
COLT	Cell on light trucks
COW	Cell on wheels
CRTC	Canadian Radio-television Telecommunications Commission
DRDC CSS	Defence Research and Development Canada Centre for Security Science
ETSI	European Telecommunications Standards Institute
FCM	Federation of Canadian Municipalities
FPT	Federal/Provincial/Territorial
GBA+	Gender-based analysis plus
GoC	Government of Canada
ICT	Information and communications technology
ISED	Innovation, Science and Economic Development Canada

Acronym	Definition
ITU	International Telecommunication Union
IWG	Interoperability Working Group
LMR	Land mobile radio
LTE	Long-Term Evolution
MCC	Mobile Country Code
MCData	Mission-critical data
MCPTT	Mission-critical push-to-talk
MCS	Mission Critical Services
MCVideo	Mission-critical video
MHz	Megahertz
MNC	Mobile Network Code
MNO	Mobile network operator
MOCN	Multi-Operator Core Network
MVNO	Mobile virtual network operator
NFP	Not-for-profit
NG 9-1-1	Next Generation 9-1-1
NPAS	National Public Alerting System
NPSTC	National Public Safety Telecommunications Council
PCC	Paramedic Chiefs of Canada
PLMN ID	Public Land Mobile Network Identification Number

Acronym	Definition
PSAP	Public safety answering point
PSBB	Public safety broadband
PSBN	Public safety broadband network
QoS	Quality of Service
QPP	Quality of Service, Priority & Pre-emption
R&D	Research and development
RAN	Radio access network
SOW	System on wheels
TNCO	Temporary National Coordination Office
VPN	Virtual private network

Annex A: List of Recommendations

TNCO Recommendations

1) The TNCO recommends that the development, deployment, operations and monitoring of a PSBN satisfy the ten PSBN Principles.

2) The TNCO recommends a governance approach that includes representation from a diverse range of stakeholders and establishes and monitors adherence to national common standards through a not-for-profit structure that support nationwide interoperability.

3) The TNCO recommends that the PSBN be implemented using a Shared Network approach.

4) The TNCO recommends that the PSBN be delivered to function as a single network.

5) The TNCO recommends that stakeholders consider multiple approaches to addressing both coverage and capacity gaps to support the delivery of a PSBN in Canada.

Annex B: Table of Centralized Functions

Table 1: Potential Roles & Responsibilities of a Centralized Function

Potential Additional Centralized Roles & Responsibilities	Scope of Functions	
	(A) Centralized Basic Structure: Guidance	(B) Centralized Structure: Guidance & Coordination
1. Respecting, promoting, and serving as a guardian of the PSBN Principles	✓	✓
2. Establishing and promoting national common standards that support nationwide and cross-border interoperability	✓	✓
3. Providing advice to ISED on eligibility and suitability of potential Band 14 licensees	✓	✓
4. Consulting with federal, provincial, territorial, municipal, Indigenous, and local public safety entities and authorities, as well as other relevant stakeholders and expertise in order to inform decision-making processes	✓	✓
5. Supporting/advising on procurement of services and devices		✓
6. Ensuring ongoing compliance review and monitoring of the management and operations of the PSBN in alignment with the PSBN Principles		✓
7. Develop deployment strategies, including rural and remote coverage milestones		✓
8. Managing and overseeing the implementation and execution of contracts or agreements to build, operate, and maintain the network		✓

Annex C: Service Delivery Models

Context

There are many ways to deliver the PSBN, each approach entailing different sets of actors and distribution of functions among them. The TNCO considered four service delivery approaches for a PSBN in Canada, comparing them against their ability to fulfill the PSBN Principles. The following approaches are notional and are not intended to affirm the ultimate service delivery approach or governance framework of the PSBN. The hypothetical models were originally developed by DRDC CSS and have been utilized to represent a wide breadth of possible service delivery options.

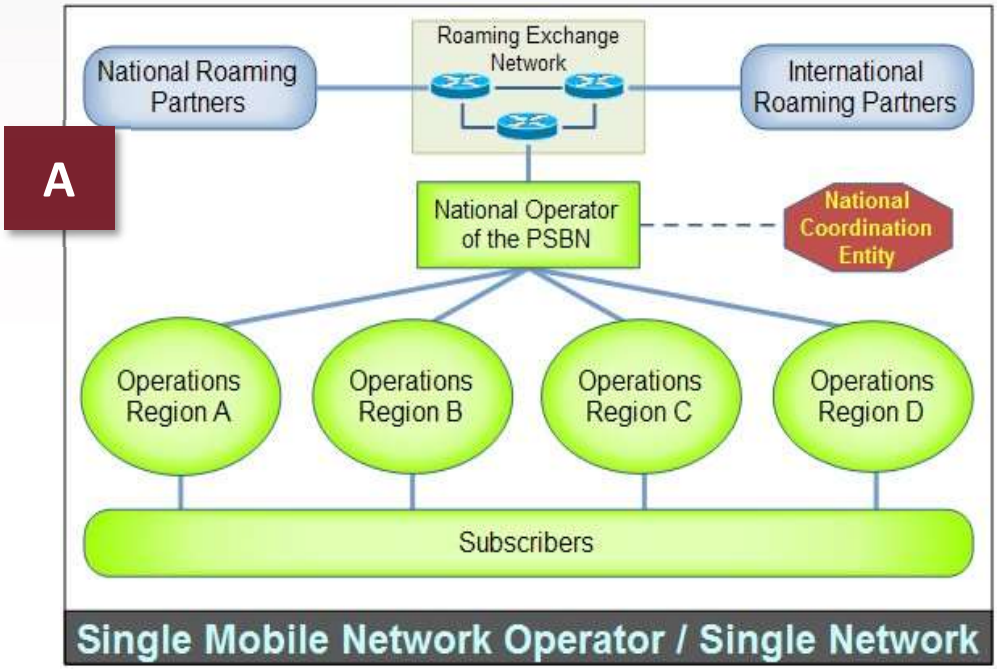
Each model assumes a single national entity and/or several regional entities. For the purposes of this report, network entities perform certain operational network functions and could perform governance functions. Although each model specifies where network functions may reside, it makes no recommendations regarding the composition or structure of any network entities. Furthermore, these entities may perform various network functions in any of the models; this does not restrict their operations from being contracted to third parties.

For a more detailed description of each service delivery model, please see *Figure 1: Service Delivery Model Options* below and/or the Scientific Report *Implications of Service Delivery Model Options on Interoperability and Operational Efficiency in a Public Safety Mobile Broadband Network* developed by DRDC CSS.[53] [54]

[53] Defence Research and Development Canada. (2017). Scientific Report DRDC-RDDC-2017-R038: Implications of Service Delivery Model Options on Interoperability and Operational Efficiency in a PSBN.
[54] Ibid., p 6-8

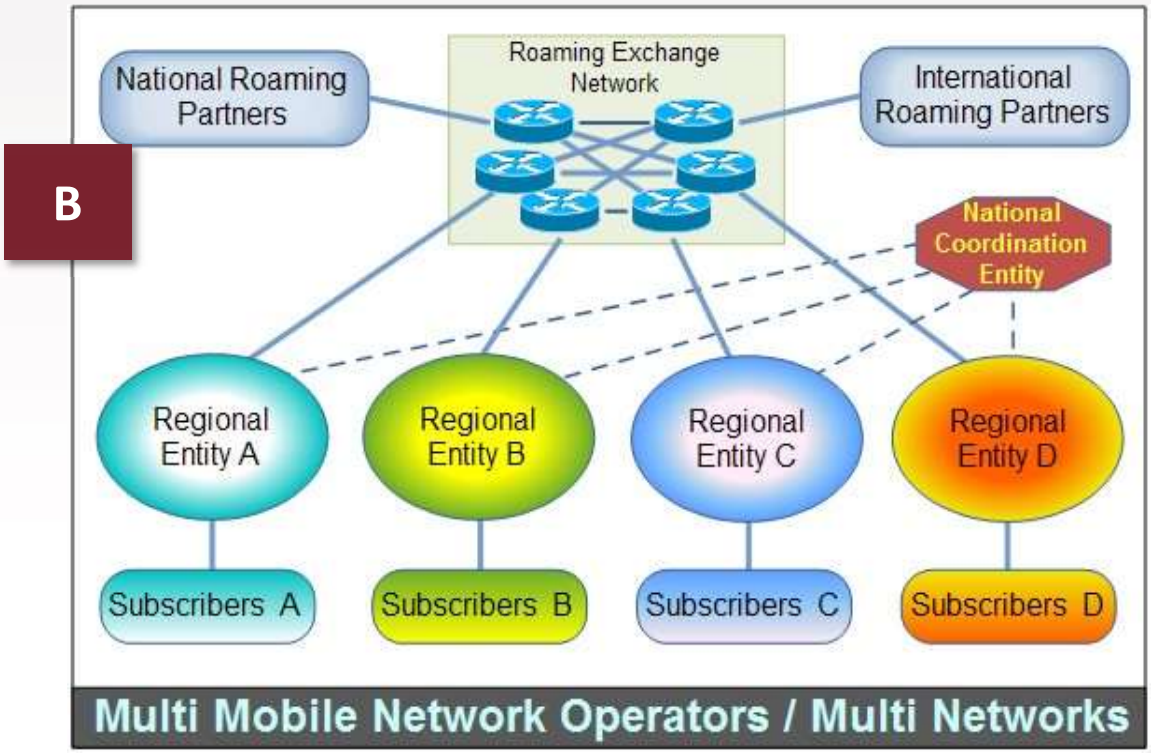
Model A: One Public Safety Network/One National MNO

(Hereinafter referred to as "Model A"): One national network would operate throughout Canada (one Public Land Mobile Network Identification Number (PLMN ID))[55] that would serve all PSBN users. The national operator of the PSBN would include the roles and responsibilities of both the national entity and regional entities in model D. The national MNO could be a single MNO with nationwide coverage, or a single MNO leveraging other MNOs radio access network (RAN) infrastructure to achieve nationwide coverage. The latter would require an agreement on the part of MNOs across the country on how to work together to work as a single network that can provide seamless nationwide coverage. The national network operator would interface with all external networks and roaming partner networks. It would be responsible to comply with ISED Conditions of License (CoL), network standards, and PSBN Principles.

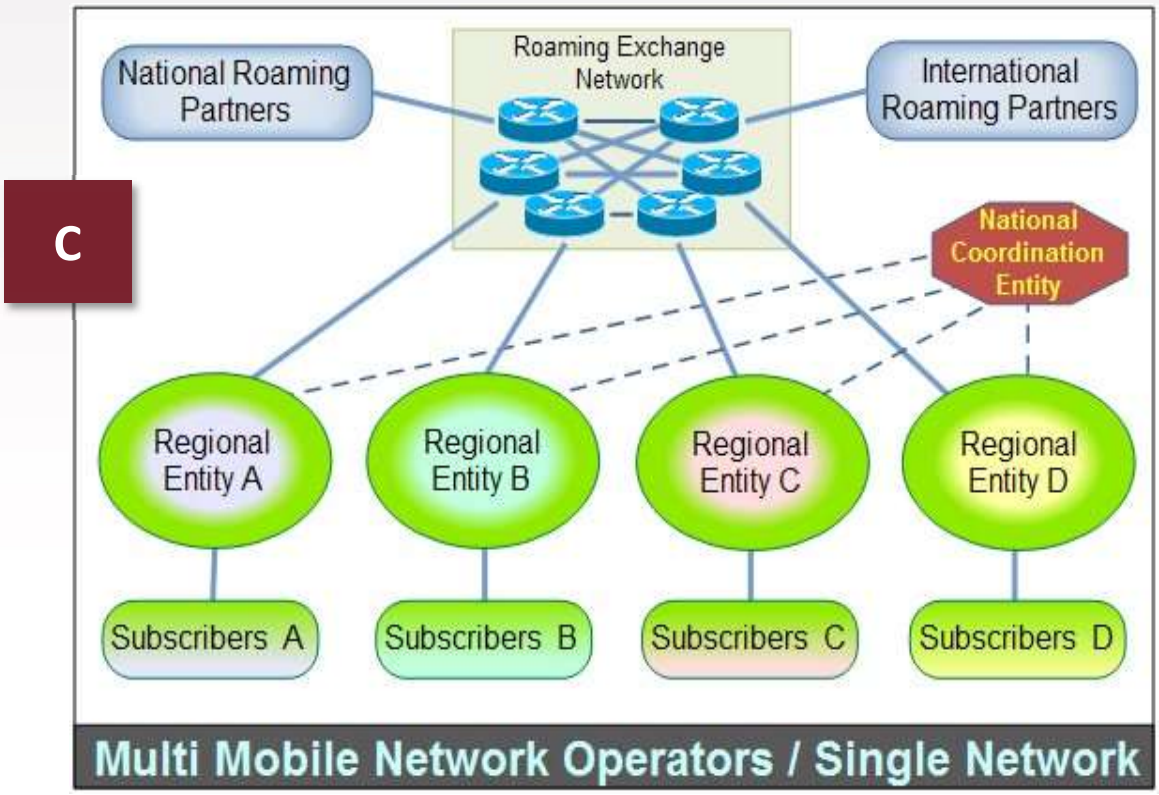


[55] The PLMN ID is a globally unique 6-digit number used to distinguish one public mobile network from any other public mobile network in the world. The PLMN ID comprises a 3-digit Mobile Country Code (MCC) and a 3-digit Mobile Network Code (MNC). In Canada, the MNC is administered by the Canadian Numbering Administrator (CNA) by authority of the CRTC. At the time of writing, it is unknown whether the CNA would issue multiple PLMN IDs to REs. (European Telecommunications Standards Institute (ETSI) Technical Specification 122-101 v15.6.0 (2018 -10)

Model B: Multiple Regional Public Safety Networks/Multiple Regional MNOs *(Hereinafter referred to as "Model B"):* Regional entities would be allocated spectrum in specific geographic boundaries, each with their own PLMN ID. Each regional entity would be responsible for interfacing with external networks, national and international roaming agreements, and complying with CoL. Standards would have to be in place initially but there is no central body to manage them as they evolve or ensure uniform application and compliance. Each regional entity would be required to perform all network functions.

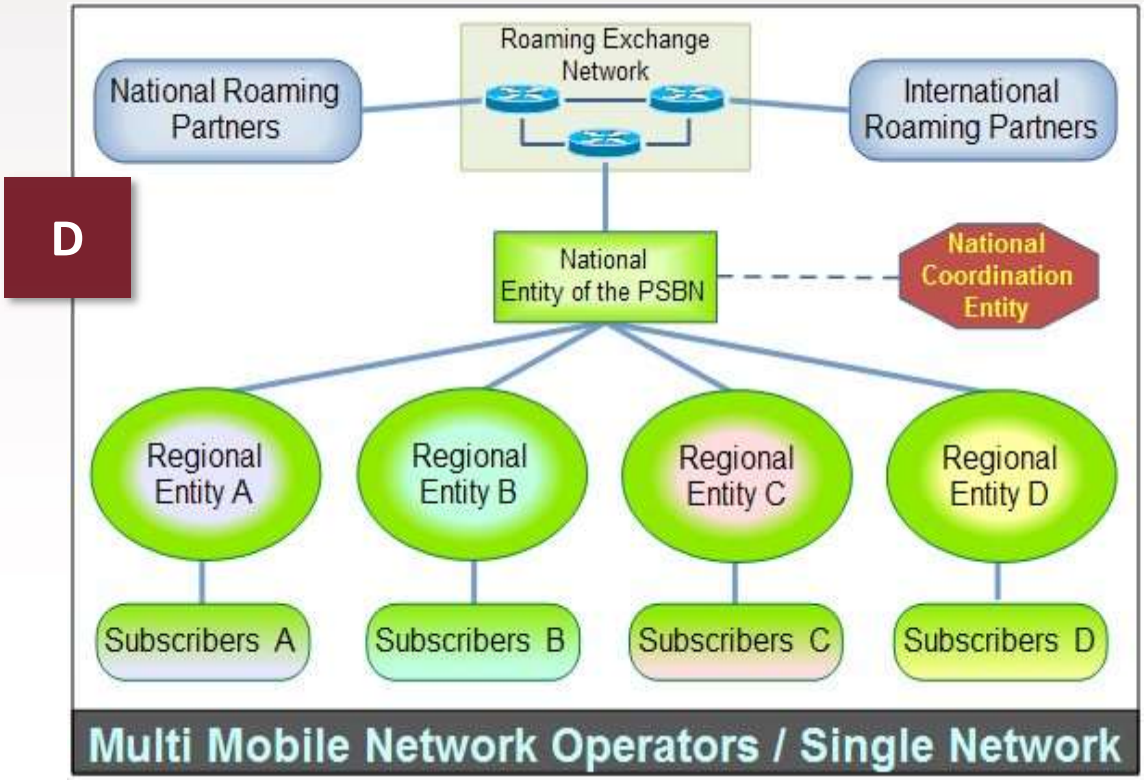


Model C: Single Public Safety Network/Multiple Regional MNOs
(Hereinafter referred to as "Model C"): Each regional entity would be allocated spectrum with one PLMN ID shared among them. A national coordinating entity would be the applicant for the PLMN ID. As in Model B, the regional entities are responsible for interfacing with external networks, roaming agreements, and complying with CoL and network standards. The national coordination entity would need to manage standards as they evolve. Each regional entity would be required to perform most, if not all, network functions.



Model D: Single Public Safety Network/Multiple Regional MNOs (with centralized national functions)

(Hereinafter referred to as "Model D"): A national entity would be responsible for network standards, connections with external networks and roaming agreements and certain operational network functionality. Network functions could be consolidated for efficiency in the national entity. The spectrum could be allocated to the national entity or to the regional entities.



Considerations

Models A to D were developed by DRDC CSS and assessed in their 2017 report,[56] based on the significant distinctions among them. They have been examined in the context of a Shared Network.

Under the Shared Network model, commercial users would be allowed access to the PSBN spectrum but authorized PSBN users would be the only ones on the PSBN. Where the RAN is shared between commercial users and PSBN users, each with their own core, Multi-Operator Core Network (MOCN) architecture can be applied.

Analysis, opportunities and risks

With the above considerations in mind, the TNCO qualitatively assessed the four possible service delivery models against their ability to fulfill the PSBN Principles, using a rating of low, moderate or high likelihood of success.

The opportunities and challenges identified within each model are summarized in *Table 2: Summary of Service Delivery Models Analysis* and examined below.

[56] Defence Research and Development Canada. (2017). Implications of Service Delivery Model Options on Interoperability and Operational Efficiency in a PSBN. DRDC-RDDC-2017-R038

Table 1: Summary of Service Delivery Models Analysis

Legend	The likelihood of success for service delivery models are represented as being high, medium or low for each PSBN principle

Service Delivery Models				
PSBN Principles for Assessment	**Model A** One National MNO / One Network	**Model B** Multiple Regional MNOs / Multiple Regional Networks	**Model C** Multiple Regional MNOs / Single Network *(no National Functions body)*	**Model D** Multiple Regional MNOs/ Single Network *(with National Functions body)*
Interoperability	Medium*	Low	Low	High
Equitable Service	High	Low	Low	Medium
Affordability	Medium*	Low	Low	High
Sustainability	Medium*	Low	Low	High
Coverage	Medium*	High	High	High
Deliver Mission Critical Services	High	Medium	Medium	High
Network Access Always	High	High	High	High
Security	High	Medium	Medium	High
Resiliency/Robustness	Medium*	Medium	Medium	High
Use of Spectrum	High	High	High	High

* The provided rating is based on the assumption that one MNO is contracted to provide nationwide coverage. In the case that the PSBN MNO leverages the RAN of other MNOs where required, moderate ratings would change to high likelihood of success.

While it is feasible to deliver a PSBN under each of the evaluated service delivery models, comparative analysis demonstrates various risks and opportunities associated with each, including satisfying the PSBN Principles. Taking these risks and opportunities into consideration, the TNCO assesses that a future PSBN would be best delivered using either a Model A or Model D approach.

Interoperability:
Fundamental to interoperability is that users can access the PSBN and, as such, the availability of the network is critical to user adoption. Model A is assessed as having a moderate likelihood of success as no single MNO currently has adequate nationwide coverage therefore a single PSBN MNO would need to extend their own coverage sufficiently to meet PSBN needs. Alternatively a single PSBN MNO could augment PSBN coverage by entering into agreements with other MNOs that have RAN coverage in areas the PSBN MNO does not. With this second approach, there is still a risk that nationwide coverage is not achieved if agreements cannot be reached. Either of those options risks regional public safety organizations remaining with local commercial networks for a host of business reasons, hindering national interoperability as PSBN users would not be able to easily exchange data with responders who remain on commercial networks.

If one or more MNOs cannot collectively provide nationwide coverage, Model D has the highest likelihood of achieving interoperability. The central management of interoperability standards and the ability to align with the MNO in the region that would best meet public safety needs make it more likely that the majority of public safety users are on the same network.

Models B and C present the least likelihood of achieving interoperability. Multiple regional MNO application and service platforms would create network-hosted application and service interoperability challenges if standards are implemented differently, and if networks do not agree to interconnect their core networks. Multiple regional MNOs would also be less able to support federal users across Canada without additional complexity and risks to end-to-end quality and service performance.[57] Models B and C also introduce additional requirements for roaming agreements

[57] Defence Research and Development Canada's Centre for Security Science. (2017). Implications of Service Delivery Model Options on Interoperability and Operational Efficiency in a PSBN. DRDC-RDDC-2017-R038.

domestically and internationally (as an example, up to 210 agreements that must be made and managed, in contrast with up to 36 for Models A and D).[58]

Equitable Service:
A single network and network operator, Model A, represents the best opportunity for equitable service nationwide. Under Model A, a single network operator would have the ability to leverage value from Band 14 to offer equitable services in more areas of the country. In models B, C, and D, as the number of network operator's increase, the value of Band 14 becomes fragmented across the country, increasing the difficulty to provide equitable service nationwide.

Affordability:
Models A and D have a high likelihood of affordability as their more centralized structure will reduce costs that cannot similarly be reduced in Models B and C. As a result, Models B and C are assessed as the least affordable, having high amounts of duplication and complexity that public safety users will ultimately have to pay for.

Sustainability:
In general, the complexity and cost of both establishing and sustaining interoperability over the life of the PSBN is a function of the number of actors in the service delivery fabric and the number of vendors that comprise the PSBN.[59] Model D is assessed as having a high likelihood of success at achieving sustainability due to the flexibility in how it can be implemented. For example, regions could work together to share resources and some network functions could be centralized, where possible, to reduce costs. Roaming cost and complexity could also be reduced by having the regions act as a single network. It is recognized that the market for the PSBN is not uniform nationwide and, as such, independent regional entities may experience varying abilities to be sustainable.

Model A is assessed as having a moderate likelihood of success. There will be a requirement for capital investment to expand coverage where current MNO coverage is

[58] Defence Research and Development Canada's Centre for Security Science. (2017). Implications of Service Delivery Model Options on Interoperability and Operational Efficiency in a PSBN. DRDC-RDDC-2017-R038.
[59] Defence Research and Development Canada. (2017). Scientific Letter DRDC-RDDC-2017-L121: Implementation models for a public safety broadband network.

deficient. However, if multiple MNOs can cooperate to achieve better nationwide coverage, then Model A is more sustainable than Model D.

Models B and C are assessed as the least sustainable way to deliver mobile broadband services. Significant capital and operating expenses would be incurred due to the multiple instances of identical network resources needed to create and sustain multiple different public safety networks. As previously referenced, additional complexity and cost will also be incurred by the need to initiate and sustain exponentially more roaming agreements. Model C also has the added complexity of trying to implement a non-standard roaming agreement which will add extra initial, and potentially on-going, costs. However, some complexity and cost could be reduced if multiple regions work together to act as a single network.

Coverage:
Models B, C and D are assessed as having a high likelihood of achieving maximum possible coverage as the relationship with the MNOs will be at the regional level, which could allow for greater regional flexibility. It could also be easier in Models B, C and D to leverage existing contractual or organizational relationships to access provincial, regional or municipal infrastructure with the aim of expanding PSBN coverage with the MNO.

Model A has a moderate likelihood of success as a single national network will not have the relationships with provincial, regional or municipal organizations to be able to readily leverage their infrastructure and expand network coverage. Additionally, at this time there is no MNO with adequate nationwide coverage - meaning that some areas of the country will not have access to PSBN service unless MNOs cooperate to provide seamless nationwide coverage or new investments are made to fill coverage gaps in areas where the business case has previously been considered weak.

Deliver Mission Critical Services:
Models A and D have a high likelihood of success as the presence of a co-ordinating entity at the national level facilitates evolution of technology to ensure consistent delivery of MC Services. Where multiple networks exist, such as in Models B and C, a greater level of complexity is introduced regarding the coordination of technology and network standards.

Network Access Always:
All models are assessed as having a high likelihood of success as the service delivery model does not affect the ability to access the network.

Security:
Models A and D have the highest likelihood of meeting security standards, as network and security standards can be more easily implemented on a single network.

Models B and C will be more challenged to support federal users or any other users that would operate across different regions. This would particularly apply to mobile Virtual Private Network (VPN) solutions which the multiple networks in models B and C would have great difficulty supporting.

Resiliency/Robustness:
Model D is assessed as having the greatest resiliency/robustness. It requires strong national level coordination to ensure a resilient national backbone while also having regional redundancy to limit the impact of shocks to the network.

Models B and C are assessed as having the least likelihood of achieving national resiliency although their local or regional resiliency could be acceptable. With the lack of national coordination in Models B and C, there is a higher risk of the national backbone not having sufficient resilience when compared to Models A and D. As a single network, Model A is assessed as being less resilient. Shocks to the network could more easily affect the national network and would require investments in redundant capabilities in contrast to Models B, C and D that have some regional redundancy.

Use of Spectrum:
Based on the assumption that the PSBN will employ a Shared spectrum utilization approach, Models A to D all have a high likelihood success in achieving efficient use of spectrum.

Service delivery model approaches
While adhering to the principles put forward, the TNCO recommends that models A and D be considered for implementation.

While it is feasible to deliver a PSBN under each of the evaluated service delivery models, comparative analysis demonstrates various risks and opportunities associated with each, including satisfying the PSBN Principles. Taking these risks and

opportunities into consideration, the TNCO assesses that a future PSBN would be best delivered using either a Model A or Model D approach.

The main weakness of Model A is the lack of an established MNO that has adequate nationwide coverage for PSBN users across the entire country. Addressing coverage gaps will require investment, which will ultimately impact sustainability and affordability. The option of the PSBN MNO acquiring coverage in underserved areas through contracts for access to other MNOs RAN infrastructure is reliant on the willingness of the RAN MNOs to enter into contracts with the PSBN MNO. There is no certainty of this. Model D becomes the best model in the absence of the ability of a collective of MNOs to form a Model A.

Model D is preferred as it allows for the best regional coverage footprint while still operating as a single nation-wide network. This ensures nationwide interoperability and the fulfillment of other PSBN Principles while at the same time being sustainable and affordable.

Comparative analysis demonstrates that Models B and C will not be able to achieve the PSBN Principles. The structure of multiple networks with little or no national coordination and facilitation structures poses a risk to national interoperability and the ability to support federal users. Additionally, the more complex structure presents extra costs for those stakeholders involved.

Assessment of mixed implementation approaches

A mixed implementation of the PSBN presents the following additional risks:

Implementation of PSBN Principles and standards:
It is anticipated that standards will be developed from the PSBN Principles. In the case that there are multiple independent PSBNs without overall coordination or direction, it is likely that standards (either identical or different) would be implemented in various ways across the country. This increases the risk of not satisfying principles such as interoperability or security, and presents significant challenges for users (especially federal users) that may be unable or unwilling to adopt the PSBN as a result.

Interoperability:
Some public safety users will remain with commercial providers either because there is

no PSBN service available, a preference for or obligation to their current service providers or it may be too expensive for them. Competing MNOs may offer PSBN-like services, including priority and pre-emption, for an additional fee in competition to PSBNs in some areas. Voice interoperability would remain at its current state where some areas have voice LMR interoperability. Data interoperability would vary by jurisdiction and/or by discipline (e.g. police, fire, paramedic, critical infrastructure, etc.) depending on whether PSBN services were being offered and which organizations are on PSBN services versus commercial services.

Equitable Service:
It is assumed that PSBN users and organizations will have varying capacities to implement the PSBN in their respective jurisdictions. Some municipalities and/or regional organizations will be willing and able to invest the capital and operational funds to implement a Dedicated or Shared PSBN using Band 14 at the local or regional level. Those jurisdictions who cannot commit the financial resources will find themselves at a disadvantage, thus exacerbating inequities across potential users and beneficiaries of a nationwide PSBN.

Sustainability and Affordability:
The overall sustainability and affordability of the PSBN would be compromised in the case that different islands of the PSBN are implemented across the country. In areas where Band 14 spectrum is highly valued commercially, the PSBN will be more sustainable and could require little or no additional public funding. However, in areas where Band 14 spectrum is not as valuable, sustained public funding could be required. Additionally, a lack of coordination may result in duplication of network infrastructure and the human capital required to operate and govern the network.

Use of Spectrum:
In any Dedicated Network it is estimated that PSBN users will only use up to 10% of the 20MHz of spectrum in day-to-day operations.[60] In a fragmented approach to implementation, spectrum may therefore be used inefficiently in some areas of the country compared to others who support both public safety and commercial use.

[60] Defence Research and Development Canada. (2017). Bandwidth Requirements for Day-to-Day Operations on Canada's 700 MHz Public Safety Broadband. P. 7. http://cradpdf.drdc-rddc.gc.ca/PDFS/unc273/p805324_A1b.pdf

Annex D: Gender-Based Analysis Plus (GBA+) Considerations

Gender-based Analysis Plus (GBA+) is an analytical process used to assess how diverse groups of women, men and non-binary people may experience policies, programs and initiatives in order to close key gaps between those groups. [61] Certain groups of people are more vulnerable to the impacts of disaster or emergency than others, and their unique vulnerabilities are important to recognize in order to effectively prepare for and respond to disasters and emergencies. The Canadian Red Cross has identified ten high-risk groups that are disproportionately vulnerable to disasters: seniors; persons with disability; Indigenous peoples; medically dependent persons; low-income residents; children and youth; persons with low literacy levels; and new immigrants and cultural minorities. The TNCO acknowledges that the policy processes related to the establishment of a PSBN in Canada should take into account the ways in which vulnerable populations could be impacted by the PSBN and consider how the PSBN may be leveraged as a tool to ensure their needs are met during times of emergencies and disasters.

In 2017, prior to the standing-up of the TNCO, Public Safety hosted a workshop at which participants were asked to think about the ways that the PSBN could be viewed through a GBA+ lens.[62] A number of key items and considerations were raised and remain relevant today. It will be important to monitor these factors as they evolve over time in order to ensure that certain groups of Canadians are not unduly impacted as a result of the PSBN.

With this in mind, future governance mechanisms and service delivery partner(s) would be encouraged to take into consideration the following GBA+ opportunities and concerns:

[61] For more information on GBA+ analysis, please visit https://cfc-swc.gc.ca/gba-acs/index-en.html

[62] Gender-based Analysis Plus (GBA+) goes beyond biological (sex) and socio-cultural (gender) differences. For this reason, the process takes into account other identity factors such as race, ethnicity, religion, age, and mental or physical disability. It is essential that GBA+ is applied to government work as all types of public policy and programs have either direct or indirect effects on people.

Deployment: It is anticipated that the deployment, or 'roll-out', of the PSBN will take place in stages and may include potential research and development (R&D) opportunities. As a result, vulnerable populations or those in rural and remote communities may not receive PSBN services at the same time as more urban populations. Moreover, agencies and users of a PSBN may not be able to deploy PSBN services at the same time due to factors including coverage and affordability of the service. It is therefore necessary to consider how services will be rolled out to communities and the impact a staged roll-out may have on public safety users as well as community members. It will also be important to ensure that agencies and users have equitable opportunity to deploy and benefit from the PSBN and associated R&D activities, and that future deployment schedules consider the needs of communities in addition to factors such as cost and ease of execution.

Coverage: Closely linked to deployment, nationwide coverage of a PSBN cannot be immediately guaranteed. Future decision-makers are encouraged to consider the groups that would be most affected by coverage gaps of a PSBN, for example Indigenous communities and peoples living in rural, remote, and underserved areas. These considerations are important to take into account for the PSBN to support meaningful universal connectivity in Canada.

Ongoing Operations: Closely linked to deployment and coverage, it is therefore necessary to consider how ongoing operations of the PSBN will impact and benefit Canadian communities. This includes consideration for the security and confidentiality of information crossing the PSBN, as well as consideration for the range of ways that the PSBN may be leveraged to support first responders and public safety personnel in serving the diverse communities they serve. For example, the PSBN could help to deliver instant translation for assisting individuals facing language barriers.

Tools & devices: While the PSBN is simply the network or ‘pipe’ over which data travels, it is likely to indirectly encourage the development and introduction of new devices, applications and services. For this reason, industry partners should ensure that gender and other diversity factors are taken into account in their design and delivery. For example, ‘wearable’ deployables may be used to enhance coverage in rural and remote areas. While this may be an effective technological solution, such equipment could exacerbate some physical and other accessibility barriers experienced by members of the public safety community. Factors such as this can be easily overlooked, but are important considerations in developing and implementing solutions intended to support and benefit the diverse Canadian population.

Annex E: Paramedic Priority Capability Needs

Executive Summary

As the Federal Government designs the construction of the Public Safety Broadband Network, the Paramedic Chiefs of Canada conducted a paramedic prioritization exercise to help inform what paramedics require to order to complete time critical lifesaving decisions.[63] From 31 use cases a list of 397 user capability needs were further filtered to 95 specific user capability needs thought to align with the paramedic profession. These filtered capability needs were then shared across Canada to engage urban, rural, and remote paramedics requesting them to rank each capability need. The results showed that out of the 95 survey questions there were 30 user capability needs that had a top ranking score. The following top five (5) themes emerged as paramedic requirements needed of the Public Safety Broadband Network.

1. The ability to have 4G or better priority of uninterrupted continuity of communications regardless of the environment.
2. The ability to locate paramedics, ambulances, incident command and other assets.
3. The ability to access databases and receive information such as medical protocols, patient data in order to conduct their missions.
4. Paramedic Leadership needs to be involved in the discussions surrounding the management, and policies surrounding the network to ensure it meets the needs of paramedics.
5. Secure and encrypted, cell and data service resiliency to immediately send information using deployables for poorly covered areas.

[63] To read the entire report, please visit https://www.paramedicchiefs.ca/docs/bcs-tomembers/2020/Paramedic%20Priorities%20for%20the%20PSBN%20Final.pdf

There will be many decisions that will be required as the Public Safety Broadband Network is built. This report includes a breakdown of urban, rural, and combined paramedic requirements. It is interesting to note that there was hardly any difference between urban and rural needs when looking at the overall ranking of top priorities. This is significant information as it shows that regardless of where paramedics are performing mission critical responses, that these paramedic capability needs will be required by the Public Safety Broadband Network in order to deliver the highest medical standards.

Respectfully Submitted,

Chief Doug Socha
Temporary National Coordination Office
Paramedic Chiefs of Canada Representative