Defence Research and Development Canada | Recherche et développement pour la défense Canada

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**2017-04-19**

DRDC-RDDC-2017-L121

**Produced for:** Mark Williamson, DG / DRDC CSS

**Scientific Letter**

# Implementation models for a public safety broadband network

## 1. Background

The future Canadian Public Safety Broadband Network (PSBN) will, at the outset, be a fourth generation (4G) broadband cellular network similar to the commercial wireless networks that currently serve the smart devices used by the general public. However, there are many important distinctions between the PSBN and a commercial network. While the commercial networks in Canada operating in the 700 MHz band are licensed in a segmented fashion from province to province and territories, the PSBN is expected to have a licensing footprint that is nationwide—operating under a single Public Land Mobile Network Identifier (PLMN ID) even though it may be implemented by different entities with possibly separate licenses. This is illustrated in Figure 1.

| Service Area | A | B | C | C1 | C2 | D | E | D* | PS BB |
|---|---|---|---|---|---|---|---|---|---|
| | 12 MHz | 12 MHz | 12 MHz | 10 MHz | 10 MHz | 6 MHz | 6 MHz | 10 MHz | 10 MHz |
| Newfoundland & Labrador | Rogers | Rogers | Bell | Bragg | Telus | Bell | Bell | PSBN | PSBN |
| Nova Scotia & PEI | Rogers | Rogers | Bell | Bragg | Telus | Bell | Bell | PSBN | PSBN |
| New Brunswick | Rogers | Rogers | Bell | Bragg | Telus | Bell | Bell | PSBN | PSBN |
| Eastern Québec | Rogers | Rogers | Telus | Vidéotron | Bell | Telus | Telus | PSBN | PSBN |
| Southern Québec | Rogers | Rogers | Telus | Vidéotron | Bell | Telus | Telus | PSBN | PSBN |
| Eastern Ontario & Outaouais | Rogers | Rogers | Telus | Vidéotron | Bell | Telus | Telus | PSBN | PSBN |
| Northern Québec | Bell | Bell | Rogers | Vidéotron | Telus | Bell | Bell | PSBN | PSBN |
| Southern Ontario | Rogers | Rogers | Bell | Vidéotron | Telus | Bell | Bell | PSBN | PSBN |
| Northern Ontario | Bell | Bell | Rogers | Bragg | Telus | Bell | Bell | PSBN | PSBN |
| Manitoba | Telus | Telus | Rogers | MTS | Bell | Telus | Telus | PSBN | PSBN |
| Saskatchewan | Telus | Telus | Rogers | Sasktel | Bell | Telus | Telus | PSBN | PSBN |
| Alberta | Rogers | Rogers | Telus | Vidéotron | Bell | Telus | Telus | PSBN | PSBN |
| British Columbia | Rogers | Rogers | Telus | Vidéotron | Bell | Telus | Telus | PSBN | PSBN |
| Yukon, NWT & Nunavut | Bell | Bell | Telus | ISED | Feenix | Bell | Bell | PSBN | PSBN |

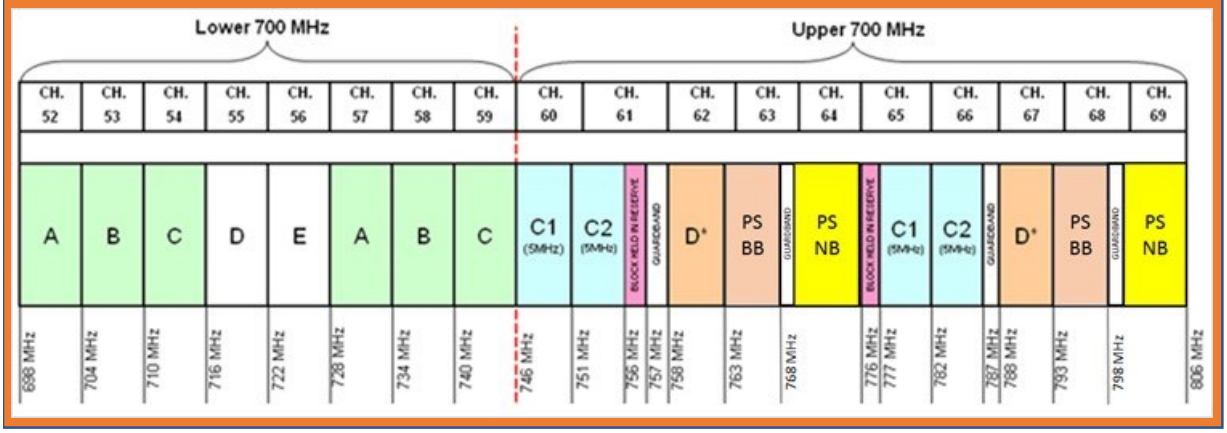


***Figure 1:*** *700 MHz spectrum assignments for Canada.*

The network will make use of 20 MHz of spectrum in the valuable 700 MHz band[1] and will allow first responders and other public safety users to communicate and share content-rich information with one another during their day-to-day operations and during major incidents. It will be a nationwide mobile network based on the Third Generation Partnership Project's (3GPP) Long Term Evolution (LTE) technology, which is the technology predominantly used in commercial cellular networks today. In establishing the PSBN, certain key tenets are imperative to consider: such as the efficient use of spectrum, availability, security, interoperability, affordability and sustainability. While keeping these in mind, there are many possible ways of implementing such a network, and the approach to how it can be implemented can vary significantly. This report describes three implementation models to be considered for the establishment of the PSBN that is consistent with current focus of the Canadian public safety community.

## 2. PSBN implementation models

There are three broad categories of implementation approaches that are considered in this report for the PSBN. One is a dedicated public safety broadband network that is used exclusively by first responders and other designated public safety users, with no commercial traffic permitted on the network. The second approach is to allow the 20 MHz of spectrum, awarded by auction to

[1] The PSBN would occupy 758–768 MHz and 788–798 MHz.

a commercial mobile network operator (MNO), to be used with certain conditions for prioritized use by public safety users when the spectrum becomes congested. The third one is a hybrid of the dedicated and commercial approaches wherein the public safety spectrum is licensed to one or more public safety entities, and there is a sharing arrangement for the spectrum and the infrastructure between the public safety MNOs and the commercial MNOs. This approach will be referred to as "hybrid-shared" in this document.

The different approaches imply different ownership and operating responsibilities between public safety and the commercial MNOs with regards to the spectrum license, the core network, the access network and customer care. In the dedicated model, public safety is responsible for all four dimensions, even though the actual operation of the PSBN may be sub-contracted to one or more commercial entities. With the commercial model, public safety users are subscribed to a commercial wireless service with preferential access conditions as may be stipulated in a service level agreement between the parties. With the hybrid-shared approach the spectrum is licensed to one or more public safety operating entities but commercial users may leverage the public safety spectrum as well; the core network is jointly operated by one or more public safety entities and/or one or more commercial MNOs; the access network is operated by the commercial partners; and customer care for the public safety users is the responsibility of the public safety entities. This is illustrated in Table 1. Each model is examined in greater detail in this report.

The following assumptions apply to all three models:

a) The PSBN would be implemented by leveraging commercial MNOs' physical infrastructure, such as cell sites, to the greatest extent possible. Some facilities may require additional hardening to public safety's requirements.
b) The network operations functions of the PSBN would be undertaken by the commercial MNOs either as their responsibility or under contract to one or more public safety entities. The staff performing these functions may require an additional level of security screening.
c) Band Class-14 (BC-14) spectrum, as a minimum, is used in all the models.

***Table 1:*** *Responsibility matrix for operating the PSBN.*

| | Dedicated | Commercial | Hybrid/Shared |
|---|---|---|---|
| Band-14 Licensing | | | |
| PS Core Network operations | | | |
| Access Network operations | | | |
| Customer care | | | |

Public safety responsibility
Commercial responsibility

## 2.1 Dedicated model

The key assumption for this implementation model is that the PSBN is used exclusively by public safety users. Unlike the other two models that are examined in this report, the BC-14 spectrum is not shared with commercial users. Among other aspects, this means that congestion management policies need not consider the complexities that are engendered by trying to determine if calls by the general public can be pre-empted. For example, it is possible to prevent 9-1-1 calls from being pre-empted. But, it is not possible for the PSBN to know if a non-emergency-dialed number is used for an emergency such as a conversation between two people that could prevent a tragedy. Since the PSBN cannot distinguish on the basis of the nature of the conversation, that call can be pre-empted.

While this model is for dedicated, exclusive use by public safety, a portion of the physical infrastructure is shared between public safety and the commercial MNOs as illustrated in Figure 2. Public safety would own the spectrum (under license from the Government of Canada), the user devices, radio equipment that is exclusive to BC-14, a virtual tunnel in the backhaul, and the core network. For other components, public safety could leverage the existing physical infrastructure of commercial MNOs. With this arrangement, the public safety traffic is kept isolated from the commercial traffic in such a way as to impart certain protections for privacy and confidentiality. Given that some public safety user groups have certain requirements for cyber-security, the dedicated model allows those needs to be addressed independently of the service delivered to commercial users. There is no need for the commercial networks to adopt the cyber-security requirements of the PSBN for the services they provide to the general public.

Since public safety owns the portions of the infrastructure that are for the exclusive use by public safety, it has the authority to select the vendors for the PSBN infrastructure that meet its requirements, which include cyber-security provisions to facilitate FirstNet subscribers to operate on the PSBN and vice-versa. While the public safety MNOs can select the vendors of the PSBN independently of the commercial MNOs, there may be cost saving benefits to aligning with the commercial MNOs that are being leveraged.

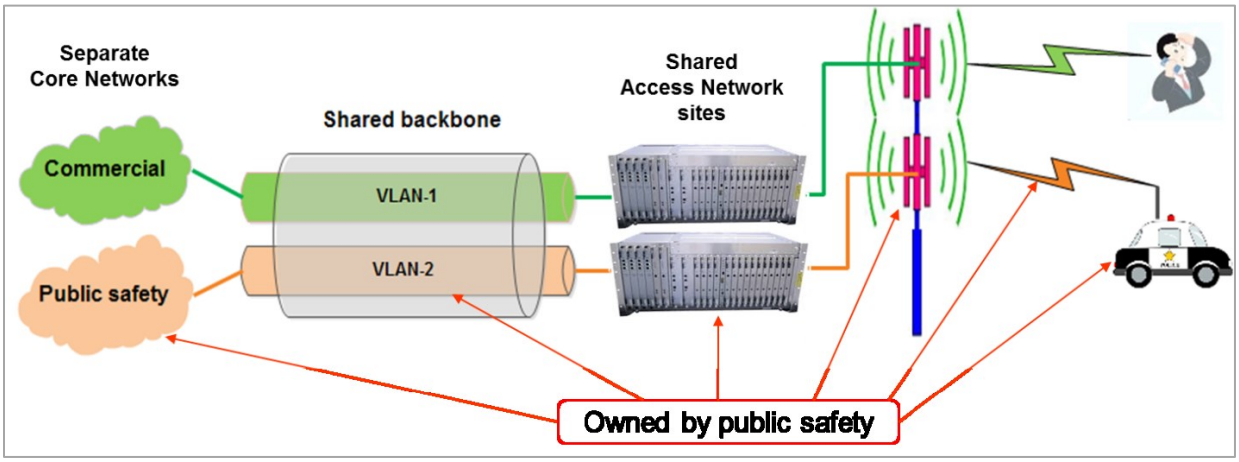


***Figure 2:*** *Sharing arrangement of the physical infrastructure in the dedicated implementation model.*

Since the coverage of the PSBN would follow the commercial footprint to a large extent, leveraging the physical infrastructure of the commercial MNOs is de facto. However, as the dedicated network would be purpose-built to suit the needs of public safety, a number of sites would be upgraded to a higher level of hardening than would otherwise be required for commercial services. It is expected that public safety would rate and rank the criticality of cell sites in order to decide where and how much to invest in order to protect them against certain natural and man-made threats. Some commercial MNOs may be able to leverage the increased reliability as a competitive advantage. The extent to which the hardening is mutually beneficial would determine how the cost of those measures would be shared, if at all.

Although certain functions would be the responsibility of the public safety MNOs, such as for this model, the operation of the PSBN, some functions would be nonetheless sub-contracted to the commercial MNOs in order to leverage their experience, facilities and procedures. An example

is the Network Operations Centre (NOC). The staff that would be assigned to the PSBN NOC are subjected to a heightened level of security screening and monitoring by the Security Operations Centre (SOC) because of the criticality of the work they do. The SOC function pertains to public safety and may be out-sourced to a 3rd party managed security service provider or undertaken by an agency or department of the Government of Canada. Another function that could be out-sourced is the maintenance and repair function. The field workforce and asset management procedures for the commercial operations would be leveraged to serve the PSBN. The service level agreements for the maintenance of the PSBN would stipulate that maintaining the availability of PSBN service is of highest priority.

The interaction between the public safety agencies and the commercial operations that support the PSBN is somewhat limited in this model owing to the relatively small degree of sharing. But, an important touch point between them is with the Customer Services function. All the customer support tiers—from first line call takers to technical support, the trouble ticketing processes and issue resolution and close-out procedures would leverage the commercial MNOs' operations as it would prove costly to establish a parallel operation. A service level agreement would require that the calls to customer services from public safety users be prioritized in the automated call distribution system and the issues would receive priority treatment, depending on the severity.

Another service aspect that is visible to the end-users is the quality of experience. Since there is complete separation between the commercial and public safety networks, the PSBN MNOs could apply policies that affect the user experience independently of what the commercial MNOs choose to do. Such policies cover, as a minimum (i) end-to-end quality of service (QoS), (ii) admission and QoS controls for visiting users, (iii) the ability for applications to access RF channel conditions to tune their performance, (iv) sharing BC-14 spectrum with FirstNet along the Canada-U.S. border, and (v) Internet filtering.

In this model, the public safety agencies would procure their devices from the PSBN MNOs. The user devices would contain certain security features that protect the PSBN from malicious or misbehaving user devices, as well as protect the information that is downloaded, stored or captured by the cameras, microphone and other sensors on the devices. This is necessary in order to assure the chain of trust for the information in order for it to be admissible as evidence in a court of law. Since the commercial devices would not operate on BC-14, any compromised device that launches a denial of service attack on the cell site would not affect the PSBN service. The user devices would only be able to use applications that are approved by the PSBN MNOs.

## 2.2 Commercial model

This model assumes that the BC-14 spectrum is assigned by auction to one or more commercial MNOs. The obvious implication is that there is a substantial initial monetary outlay by the successful bidder(s) for the spectrum. Public safety users, through their respective public safety agencies, could procure broadband wireless service from a commercial MNO or they could procure the service from a public safety mobile virtual network operator (MVNO). The former is similar to today's environment with the exception that public safety would be expected to be able to have priority access in case of congestion. There are some commercial carriers currently offering priority access on their networks for a pricing premium[2]. This does not include pre-emption rights. In the case of a public safety MVNO, it could negotiate with the commercial MNOs to offer a service profile for sale to the public safety users. An MVNO does not have a spectrum license. It

[2] AT&T Dynamic Traffic Management; Verizon Private Network Traffic Management; for business and public safety subscribers; available for data services only (no voice) on their LTE networks.

essentially re-sells capacity from MNOs to a segment of the served population, which in this case would be public safety. It may have its own billing system and a database of its subscribers.

If the conditions of license for the BC-14 spectrum stipulated certain security, availability and interoperability obligations, then the commercial MNOs would implement measures that are outside of their current practice. For example, they would implement a separate core network dedicated for public safety using vendors that are approved for processing sensitive user traffic. However, it would be infeasible to restrict the sourcing of radio access network elements with the same security and interoperability conditions as the public safety core network. To enhance availability, the MNO could harden high value cell sites and provide redundant backhaul connections to sites that aggregate traffic from other sites. These measures entail additional cost and, as in the dedicated model, the degree to which costs can be spread among all of the MNO's subscribers depends if the MNO can sell the value of a more reliable network to its commercial users. These security, availability and interoperability obligations in the conditions of license could significantly impact the value of the BC-14 spectrum from the commercial MNOs' perspective.

The public safety agencies would enter into a long-term contract in order to secure best possible pricing. The user devices may be procured from various sources in unlocked configurations so that they could accommodate the Universal Integrated Circuit Card (UICC) from the contracted commercial MNO, which may be different from one region to another.

The BC-14 spectrum would be shared by all of the commercial MNOs' subscribers. Since the spectrum and network infrastructure is entirely within the operational domain of the commercial MNOs, they could allow public safety users to share the commercial spectrum as well.

As a share-capital corporation, the commercial MNO is beholden to its share-holders to deliver the highest possible value to them. This drives investment decision-making that maximizes the return of those investments. For a commercial MNO, the key performance indicators for share-holder value are strongly correlated with (i) minimizing churn, (ii) maximizing subscriber take rate, (iii) minimizing subscriber acquisition and retention costs, (iv) maximizing revenue for services delivered, and (v) minimizing cost of operations. These drivers suggest that investments benefitting the largest group of users would deliver the greatest returns. It is also possible that maximizing share-holder value is best realized by selling the company. The degree of foreign ownership is limited by the Telecommunications Act of Canada, but can change as was done in 2012[3].

## 2.3 Hybrid-shared model

The hybrid-shared model is characterized by sharing the spectrum and the infrastructure between the public safety MNO(s) and the commercial MNO(s). It does not point to a specific arrangement, but represents a range of different sharing possibilities. The hybrid-sharing model consists of elements from both the dedicated model and the commercial model. With regards to licensing the BC-14 spectrum, the model is like the dedicated one. That is, the licence is not auctioned but assigned to one or more public safety entities. But, like the commercial model, both BC-14 and commercial spectrum and networks are shared between public safety users and the general public.

The shared model could simply be limited to allowing users of commercial MNO(s) to access the public safety MNO(s) and vice versa. If the sharing arrangement becomes more involved by sharing spectrum and infrastructure, the 3GPP has specified two approaches for sharing infrastructure between MNOs—the Gateway Core Network (GWCN) approach and the Multi-Operator Core

[3] Bill C-38 amended the Telecommunications Act to relax the foreign ownership rules for telecommunications carriers with less than 10% share of the Canadian telecom market.

Network (MOCN) approach [1]. The latter entails a complete separation of the core network functions between the MNOs, while the former requires a higher level of integration between the core networks. Figure 3 illustrates the GWCN sharing approach and Figure 4 illustrates the MOCN sharing approach. The GWCN requires that the public safety MNO(s) and the commercial MNO(s) coordinate the operation of the Mobility Management Entities (MME). This is more conducive to service continuity when users migrate between the coverage of the BC-14 network and commercial networks. In both approaches the radio access network, consisting of the evolved Node-B (eNB) base stations, are shared.

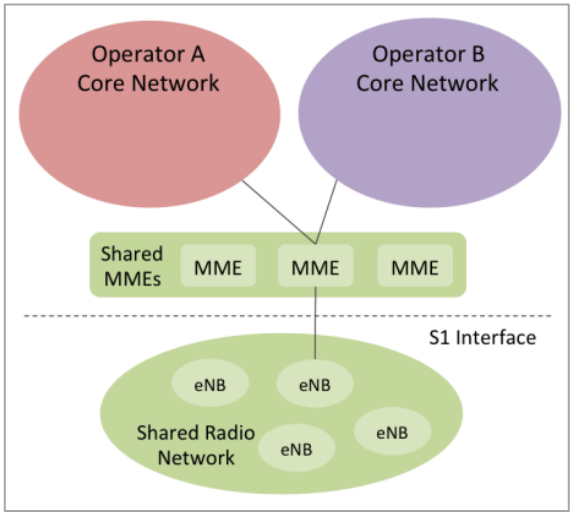


***Figure 3:*** *Gateway Core Network.*

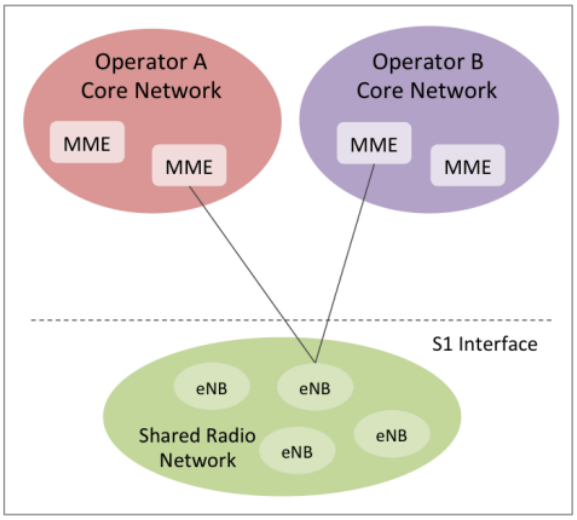


***Figure 4:*** *Multi-Operator Core Network.*

The MNOs in the hybrid-sharing model could agree to deploy BC-14 in dense urban areas where the demand for spectrum is high and the frequency of occurrence of emergencies is also high. In the same way, they could forestall deploying BC-14 in areas that are not taxing the existing commercial networks in terms of demand and that deploying additional capacity in those locations would not be justified. In such a network implementation, public safety users would nevertheless require the same user experience as those on the BC-14 deployment.

## 3. Comparison of PSBN Implementation Models

The implementation models carry different advantages and disadvantages for the PSBN. The key dimensions for comparing the models are examined here and summarized in Table 2.

**3.1 Efficient use of spectrum:** The dedicated model presents the least efficient way to utilize the BC-14 spectrum. Since it is not shared outside of the public safety user groups, the spectrum would be under-utilized especially when first responders are only using the PSBN for day-to-day operations [2]. The commercial and hybrid-shared models maximize the use of the BC-14 spectrum since it is shared with commercial users. Furthermore, those models would also maximize the use of commercial spectrum by allowing public safety users to utilize those bands when the emergencies are of such severity that the BC-14 spectrum is insufficient to serve their needs.

3.2 **Affordability and sustainability:** These attributes are considered together because an affordable service is assumed to be delivered from MNOs with sustainable business models. It implies that the MNO(s) will have found a way to meet their financial goals with a service offering that meets public safety's needs. Without any external injection of funds or subsidies, the dedicated model is likely to be the least affordable due to the small number of users that are served with the BC-14 radio access network. The radio access network is the largest contributor to total cost of ownership (TCO) due the multiplicative effect of the number of sites. If the PSBN operations are subsidized by public funds, its sustainability is at constant risk due to the vagaries of the public purse and policies. Hence, an MNO that relies on public financing to deliver mobile services to public safety is under constant threat of failing commercially.

The commercial model has high up front cost for the spectrum license. The 700 MHz auction in Canada in 2014 resulted in $5.3 billion for 68 MHz of bandwidth. A simple pro-rating for 20 MHz of spectrum four years later would suggest $1.7 billion value for the BC-14. There are some considerations that would need to be factored into the price such as whether priority access for public safety would reduce the value of the spectrum because of the encumbrance for commercial users or increase the value if the MNOs can obtain higher revenues from premium services delivered to a user group with a low churn risk. Combined with regional variations and incident-based fluctuations in the demand for mobile services, it becomes difficult to quantify the value of the spectrum for potential bidders as well as for the Gov't of Canada to establish the strike price.

The commercial model could, however, carry the lowest operating expenses if there is no provision for a dedicated core network for public safety. However, a significant portion of the public safety users may not subscribe to a service that does not provide a minimum level of security. This would be further compounded if the MNOs' investments that benefit the commercial users take precedence over those that benefit public safety.

The hybrid-shared model has the same advantage as the commercial model in that it can share the BC-14 spectrum with commercial users, but must consider the costs of an additional core network dedicated for public safety. Albeit, the cost of the core network is a fraction of the cost of the spectrum license that the commercial model would incur. Those costs would need to be recovered and it is unlikely that it would be spread among commercial users since they risk losing subscribers to their competitors who would not be burdened with these additional costs.

3.3 **Interoperability:** User-level interoperability is predicated on network-level inter-working and supporting polices. In general, the complexity and cost of 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. The subject is treated in depth in the DRDC CSS Technical Report on Service Delivery Options [3]. In all the models examined in this report, interoperability is facilitated by central coordination of network operations policies, adherence to nationwide interoperability standards and a robust monitoring and compliance enforcement regimen for those policies and standards.

Interoperability with the U.S. raises an additional consideration to that of coordinating policies and standards. The U.S. Dept. of Commerce has prohibited some vendors from participating in the FirstNet network due to cyber-security concerns. If those vendors are present in the Canadian PSBN, it is not fully known what impact there would be on the ability to host FirstNet users on the PSBN and vice-versa. It is a risk that must be evaluated.

**3.4 Quality of Experience (QoE):** This attribute is affected by the nature of the service that the users' receive, especially during periods of congestion. Public safety users expect that they will receive priority service during emergencies. This includes priority access to radio resources, applications that perform adequately, and pre-emption privileges over lower priority users. In the dedicated model, the congestion management mechanisms are triggered less frequently since there are no commercial users sharing BC-14 spectrum. But, regardless of when the trigger occurs for the congestion management algorithms, as long as public safety users have higher priority than commercial users, and whether it's in the dedicated model or the other two, there would be no perceived difference in the manner by which the PSBN responds for the users and the quality of experience. However, the algorithms are simpler to implement in the dedicated model. Since it is not possible for the network to know the context of a conversation by members of the general public, it is possible that a conversation to de-escalate violence or avoid a tragedy[4] can be pre-empted. Hence, an algorithm that pre-empts commercial traffic would be considerably more complex than if only public safety users were considered.

Another important aspect of QoE is the ability to maintain an active session when a user is in motion and transitions from one MNO's service coverage to another MNO. Inter-network (PLMN) 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 MNOs that is not typical. The GWCN approach in the hybrid-shared model is the most amenable to this.

The dedicated model allows the greatest level of control on policies that impact QoE for the public safety users.

**3.5 Access to information and sharing:** The commercial model presents the greatest barrier to information access and the ability to share it. That is because all traffic is routed to the Internet, which obliges public safety to use virtual private networks (VPN). But, if it implements a core network that is dedicated to public safety, it can connect directly to public safety information networks without having to route all traffic to the Internet. However, it would need to provide assurances that the network is secure. There is no difference in the access and sharing capabilities between the dedicated and hybrid-shared models. The dedicated model would engender a greater degree of comfort with public safety users since the security measures would be implemented to their requirements and any residual security risks would be the result of cost-benefit considerations.

**3.6 Service availability and reliability:** If there is no incentive for the commercial MNOs to harden their network infrastructure or to improve the availability of the backhaul to cell sites, it is not likely to be implemented in either the commercial model or the hybrid-shared model. With the dedicated model the public safety MNO may have some control, but it will highly depend on who will pay for it. It is possible that one-time capital investments or those that depreciate over a relatively long time can have public funding without jeopardizing the sustainability of the service.

If public funds were available for a capital investment to benefit the availability of the network, including extending the reach of BC-14 into areas that commercial MNOs could not serve economically, it is likely that only the dedicated model would present a

[4] This scenario is provided as an example of the type of harm that may be caused to the public if their mobile services were pre-empted.

non-conflictual opportunity. That is, investment of public funds would not appear to be benefitting one commercial enterprise over its competitors.

**3.7 Regional autonomy:** Since all the implementation models examined in this report leverage the commercial MNOs' infrastructure, as a stated assumption (Section 2), it is possible to award contracts to build and/or operate the networks at a regional level. That is the current licensing framework for commercial service in the 700 MHz band. However, for interoperability to be achieved it is necessary that the MNOs coordinate closely, as described in Section 3.3.

It is important to consider the potential for vendor lock-in in the services contracts. Vendor lock-in creates a de facto monopoly and removes the negotiating leverage when contemplating renewing or re-competing the contract. The commercial model presents the highest barrier to re-compete since the spectrum is auctioned and thereby licensed to one or more commercial MNOs. The public safety entities cannot take their spectrum and go shopping for a better deal. The dedicated model also presents the lowest barrier to re-compete because all the PSBN-specific infrastructure would belong to the PSBN MNO(s) and they would own the license to BC-14 spectrum. The hybrid-shared model would present a middle barrier because of the joint ownership of the radio access network. If it uses GWCN, the core networks would be partially integrated.

**3.8 Public safety community acceptance:** Assuming the subscription price for public safety users would be the same for all three models, then 'price' is removed from consideration for the public safety community's acceptance of one model versus another. The evaluation of this attribute is based on the public safety user requirements for the PSBN [4] and how each model is able to deliver on their requirements.

The dedicated model is the most familiar to public safety since it resembles the implementation model for their land mobile radio service, which has no economic leveragability as it is a purpose-build system. In the case of public safety broadband, public safety controls how the spectrum is utilized and shared among first responders and between agencies. The network is built to their specifications. Public safety is in control of the service they receive, even if it is sub-contracted to a service provider.

The commercial model is the closest to the type of mobile service that public safety currently buys from commercial MNOs. It is unsecured and as such, public safety agencies rely on VPN tunnels, which inherently limit interoperability. They know the limitations of the service they currently buy and as a consequence, they do not use it for mission-critical communications. In this model, public safety has the least amount of control to (i) provision services for their users, (ii) adapt the user priorities to specific incidents, (iii) direct the investments in improving the service they receive such as implementing mission-critical push-to-talk (MCPTT) services, and (iv) dispatch deployable systems to supplement BC-14 coverage in emergencies.

With the hybrid-shared model public safety can assert the types of controls that they are not able to with the commercial model. But, as this model is unproven in the public safety space, the PSBN MNO(s) will need to build the confidence of the public safety user community that their requirements can be met repeatedly and reliably.

***Table 2:*** *Rating the attributes of the implementation models.*

| | Implementation Model | | |
|---|---|---|---|
| **Attributes** | **Dedicated** | **Commercial** | **Hybrid-Shared** |
| 3.1 Efficient use of spectrum | | | |
| 3.2 Affordability & sustainability | | | |
| 3.3 Interoperability | | | |
| 3.4 Quality of Experience | | | |
| 3.5 Information access and sharing | | | |
| 3.6 Service availability and reliability | | | |
| 3.7 Regional Autonomy | | | |
| 3.8 Public safety acceptance | | | |

## 4. Conclusion

The implementation models that are being considered for Canada's nationwide PSBN have hitherto been talked about or written about at the very highest level. That is (i) the PSBN is implemented as a dedicated mobile network for the exclusive use of public safety, (ii) public safety buys mobile services from a commercial carrier who would own the license for BC-14, or (iii) some other arrangement that fits somewhere in between those two. This report examined each one of those three models to a "next level" in depth. It is not an in-depth examination, but rather the next step in surfacing the major elements at play for each of the models. In all cases, it is assumed that commercial MNOs will play an important role in the implementation of the PSBN—either as the licensed service delivery entity or as a sub-contractor to the PSBN service delivery entity(ies).

The implementation model with the greatest variability is the in-between model, referred to as the 'hybrid-shared' model. The concept of "sharing" that has been proposed covers: (i) sharing spectrum, (ii) sharing infrastructure, and (iii) sharing the service, which includes mobile communication services, customer support services, network operations and maintenance services, and more.

The models are compared against each other for several key attributes. While the evaluation is somewhat subjective, the conclusions are consistent with other work that has been done in the same vein [5] [6]. The advantages and disadvantages that are presented have not been weighted. That means that the colours in Table 2 do not account for whether one attribute is more important than another. It is recommended that this exercise be undertaken as a next step.

**Prepared by:** Joe Fournier (DRDC – Centre for Security Science) and
Claudio Lucente (contractor to DRDC – Centre for Security Science).

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[5] TETRA and Critical Communications Association, “A discussion on the use of commercial and dedicated networks for delivering Mission Critical Mobile Broadband Services”, February 2017.

[6] TETRA and Critical Communications Association, “Mobile Broadband for Critical Communications Users – A review of options for delivering Mission Critical solutions”, December 2013.


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