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Xona Partners Comments on:
“Consultation on a Policy, Licensing and Technical Framework for
Supplemental Mobile Coverage by Satellite”
Canada Gazette, Part I, SMSE-006-24, June, 2024

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Xona Partners (“Xona”) appreciates the opportunity to provide comments in response to the public consultation from Innovation, Science and Economic Development Canada (“ISED”) on a “Policy, Licensing and Technical Framework for Supplemental Mobile Coverage by Satellite.”

Xona is a boutique advisory services firm specializing in the telecom and cloud infrastructure markets. Our founding team comprises technologists and business professionals with extensive experience in developing and deploying telecom and cloud infrastructure solutions. We work with service providers, equipment vendors, and financial investors to leverage technological innovations and create new revenue streams.

We appreciate the initiative by ISED to enable direct-to-device (D2D) satellite communications under the Supplemental Mobile Coverage by Satellite (SMCS) framework. The integration of satellite, or non-terrestrial networks (NTN), with terrestrial mobile networks represents a significant advancement in telecommunications. While mobile satellite services (MSS) currently operate with separate subscriptions and specialized user devices, the incorporation of 3GPP technologies into satellite communications will greatly enhance the accessibility of these services, especially for emergency situations. This integration is particularly advantageous for users in remote regions where deploying terrestrial networks is not economically viable.

Our response focuses on the sections of the proposed SMCS framework related to emergency management and network reliability. These areas are of growing importance to telecommunications regulators like ISED and the CRTC. Satellite communications play a vital role in complementing terrestrial networks, especially in areas without coverage or during outages. In our report to the CRTC on the assessment of Rogers network for resiliency and

reliability following the July 2022 outage¹, we recommended that mobile network operators leverage emerging non-geostationary satellite constellations and explore D2D satellite technologies for emergency 9-1-1 services.

To lay the groundwork for our response, we note that D2D satellite networks possess unique capabilities and limitations compared to terrestrial mobile networks. Primarily operating as non-geostationary satellite networks (NGSOs) in low Earth orbit², these constellations exhibit distinct characteristics. These differences should be carefully considered when setting the requirements for the SMCS framework:

1. **D2D satellite networks generally offer less capacity compared to terrestrial mobile networks.** A single LEO satellite covers a large geographic area but can support only a limited number of registered subscribers³—potentially in the thousands—and even fewer active subscribers, possibly in the hundreds.

When considering the ability of satellite networks to back up terrestrial networks during emergency roaming situations, two factors must be considered: 1) the capacity of the satellite network, and 2) the coverage area and the number of potential subscribers needing service. A catastrophic outage of a terrestrial network could affect millions of subscribers, especially in densely populated areas. In such scenarios, it would be challenging for a satellite network to provide emergency roaming services to all affected users.

2. **The throughput of D2D satellite networks is lower than that of terrestrial mobile networks.**

The distance between a LEO satellite and a mobile device, such as a smartphone, spans several hundred kilometers, leading to significant propagation path loss, which in turn limits throughput. Satellite networks have fewer options compared to terrestrial networks for increasing system gain and compensating for link budget losses⁴. The primary method to mitigate these losses in satellite networks is the use of high-gain antennas on the satellites, including beamforming technologies. Despite these efforts, throughput remains lower in satellite networks, particularly on the uplink, which is typically the weaker path⁵.

This limitation has a significant impact on symmetric communications like voice calls, which are a critical component of 9-1-1 emergency services. Therefore, we advocate for a staged implementation of SMCS, with the initial phase focused on providing 9-1-1 emergency wireless voice and text access. This approach should precede the broader deployment of

¹ See: *Assessment of Rogers Networks for Resiliency and Reliability Following the 8 July 2022 Outage – Executive Summary*, A report by Xona Partners Inc., July 2024, available at:

<https://crtc.gc.ca/eng/publications/reports/xona2024.htm>

² Typically, commercial D2D satellite constellations are planned at altitude between 400 – 1,500 km.

³ Registered subscribers are mobile users in the coverage area of the satellite, who are registered on the base station serving that area. Registered subscribers could be active or idle.

⁴ For example, terrestrial networks implement multiple input multiple output antenna systems to improve system gain and throughput. Satellite communications use single antenna systems.

⁵ The mobile handset features a low gain antenna of about 0 dB gain in most of the bands specified in the SMCS framework and a 23 dBm power class.

general emergency roaming services, which will include a wider range of voice, text, and data services in addition to 9-1-1 emergency services.

3. **Several architectures exist for D2D satellite networks, each impacting the performance of emergency roaming differently.** Currently, four distinct architectures are in different stages of planning⁶:

- a. Architecture 1: Both the mobile core and Radio Access Network (RAN) are located on the satellite, commonly known as a "network-in-a-box." Constellations using this architecture typically feature lower-gain antennas with a larger coverage footprint to better manage subscriber access to the satellite-borne network, as subscribers need to register onto the core network as the satellite moves in space. We are aware of at least one planned constellation using this architecture, though the name cannot be disclosed due to confidentiality agreements.
- b. Architecture 2: The core network is on the ground, and the baseband engines of the RAN are also on the ground, as depicted in Figure 1. This is commonly known as a "bent-pipe" or "transparent" architecture, as referred to by the 3GPP. The 3GPP has focused its standardization efforts on this architecture in Releases 17 and 18, both of which have been finalized.

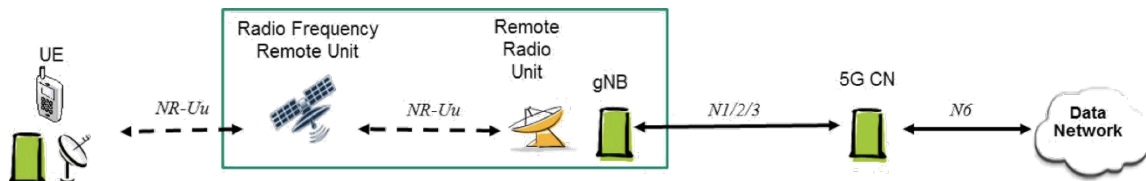


Figure 1 Transparent architecture. [Source: 3GPP TR 38.821]

- c. Architecture 3: The core network is on the ground, while the RAN is located on the satellite, as shown in Figure 2. This is commonly referred to as a "regenerative" architecture by the 3GPP. Standardization of this implementation is expected in Release 19, which is currently under development.

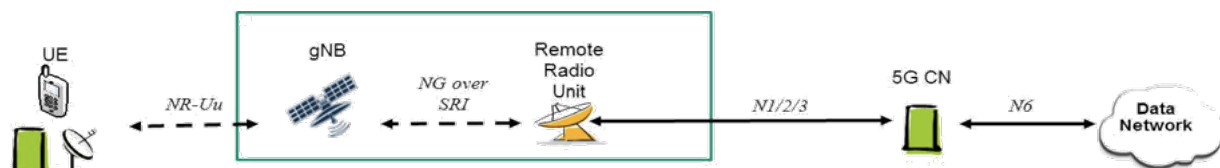


Figure 2 Regenerative architecture. [Source: 3GPP TR 38.821]

⁶ 3GPP focuses on standardizing 5G NR NTN for smartphones, while LTE NTN is being developed for IoT devices. Current commercial NTN networks primarily aim to provide LTE coverage and capture market share, and as a result, they often have independent implementations that may differ from the 3GPP standards.

- d. Architecture 4: The core network is on the ground, with the RAN baseband functions divided between the ground segment and the satellite. A form of this architecture is shown in Figure 3. We are aware of one constellation utilizing this architecture, though the name cannot be disclosed due to confidentiality agreements.

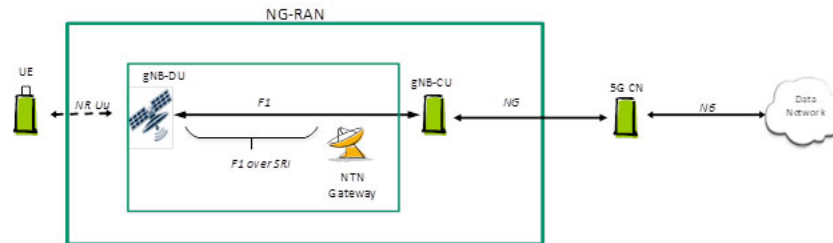


Figure 3 Illustrative diagram of a form of a hybrid or a split architecture. [Source: 3GPP TR 38.821]

D2D satellite constellations based on these architectures could interconnect with terrestrial networks in various ways, as outlined below in item 4. The combined architecture and integration with terrestrial networks impacts the performance and behavior of emergency roaming. Additionally, the spectrum access model and type of service area, which are yet to be defined, will also influence emergency roaming. Furthermore, we must consider the commercial agreements between satellite operators and terrestrial mobile network operators. Therefore, we anticipate that any requirements for emergency roaming will need to account for different NTN architectures and their interconnection with terrestrial networks, as addressed in item 4 below.

4. **Satellite network operators (SNOs) can interconnect and interwork with mobile networks in various ways, each impacting the performance of emergency services differently.** One option is for the satellite radio access network to share the same core network as the terrestrial mobile network, as illustrated in Figure 4, resulting in a more integrated system. Alternatively, the satellite network could maintain its own independent core network, as shown in Figure 5, creating a roaming arrangement between the two operators.

The reliability and resiliency of emergency services depend on how these networks are interconnected. For example, in a shared-core setup, a failure in the core network would cause outages in both the satellite and mobile networks. ISED, along with the CRTC, which oversees emergency services regulations, should consider the different architectures and interconnection arrangements when defining the requirements for emergency services.

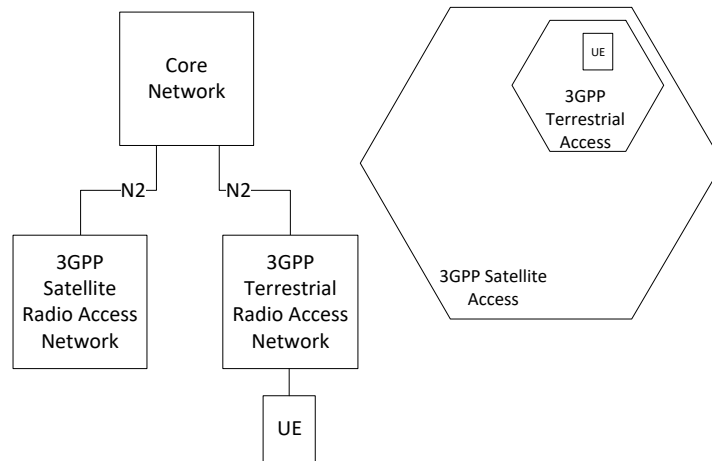


Figure 4 Satellite and terrestrial 3GPP access networks within a mobile network. [Source: 3GPP TR 23.737]

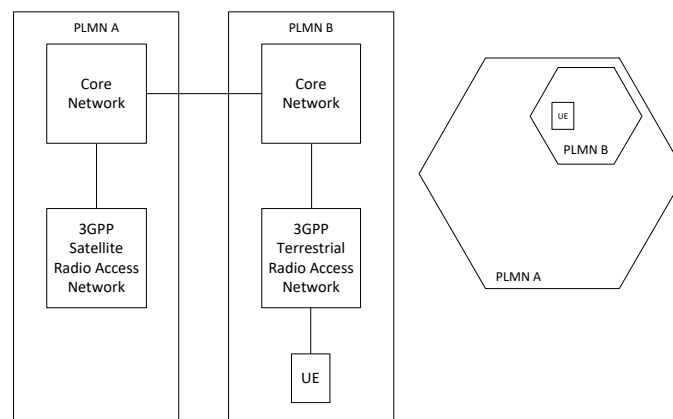


Figure 5 Roaming and mobility architecture between satellite and mobile networks. [Source: 3GPP TR 23.737]

5. **Satellite network operators may not be able to provide the same 9-1-1 services as mobile network operators.** In satellite networks, location services typically rely on the mobile device relaying its position using GPS or assisted GPS techniques. This reliance is necessary because determining the location of a mobile device based solely on 3GPP-native technologies is challenging⁷. The 3GPP began exploring NTN-based positioning in Release 18, the latest completed release, aiming to verify mobile device locations with an accuracy of within 10 km without depending on device-reported GNSS data⁸.

⁷ In general, determining the location of a device on Earth using communication satellite constellations is challenging. GNSS positioning relies on wide, overlapping beams from multiple satellites to triangulate the position of a receiver on Earth. In contrast, communication satellites typically avoid overlapping coverage areas to reduce interference and increase capacity. This fundamental difference complicates using communication protocols for precise location determination.

⁸ TSG RAN, "Study on requirements and use cases for network verified UE location for Non-Terrestrial-Networks (NTN) in NR," 3GPP TR 38.882, version 18.0.0.

However, there are instances where a mobile device may not have its GPS coordinates. This can happen if the GPS receiver loses its signal lock, if the user disables location services, or if location sharing is not authorized. Additionally, a service provider within the routing chain may lack support for E911 services.

Moreover, satellite cell coverage is extensive and may encompass multiple Public Safety Answering Points (PSAPs). As a result, associating the location of a mobile device with a satellite serving cell may not provide enough certainty to route a 9-1-1 emergency call to the appropriate PSAP. Therefore, there is a need for flexibility in routing emergency 9-1-1 calls, potentially directing them to a PSAP or a call center for further processing as needed.

In light of the above points, we provide comments in response to specific questions in the SMCS consultation.

[Q10] ISED is seeking comments on its proposal that SMCS would not contribute to meeting deployment conditions associated with flexible use licences.

6. We agree with ISED that the coverage provided by SMCS should not contribute toward meeting the conditions of license applied to flexible use licenses. As outlined in items #1 and #2 above, D2D satellite networks will have lower capacity and throughput compared to terrestrial networks. In fact, D2D constellations are considered a last-resort access option in the absence of terrestrial network coverage. D2D satellite coverage is complementary to, rather than a substitute for, terrestrial mobile networks. If SMCS were to count towards meeting deployment conditions associated with flexible use licenses, it could delay or even prevent the establishment of superior terrestrial coverage.

[Q11] Considerations and/or limitations in providing network reliability and resilience using SMCS, based on the requirements in the MOU on Telecommunications Reliability.

And

[Q12] ISED is seeking views on any considerations and/or limitations to providing emergency roaming using SMCS based on the requirements in the MOU on Telecommunications Reliability.

7. The MoU on Telecommunications Reliability (MoU) does not exclude the participation of SNOs. The MoU serves as a framework for collaboration among service providers, relying primarily on their good faith and best efforts. The MoU includes various types of service providers, such as mobile, cable, and satellite network operators; however, no MSS operator is currently a signatory.

We see no barriers preventing a D2D SNO from participating in the MoU. However, for a D2D SNO to effectively implement specific elements of the MoU—particularly those related to emergency roaming—it will require testing across different network failure scenarios, network interconnect architectures, equipment, services, and other performance-impacting elements. Additionally, further definition of the SMCS framework may also be necessary.

8. Further definition of SMCS and Emergency Roaming⁹ behavior is required. The Emergency Roaming Protocol in the MoU states that service providers would enter into bilateral Emergency Roaming agreements. This implies a level of symmetry in capabilities and service offerings between telecom network operators necessary to establish such agreements. However, it is currently unclear how the SMCS framework will operate to address emergency roaming under these bilateral agreements.

To be more specific, we foresee several potential scenarios in which an SNO could operate under the SMCS framework:

- a. The SNO partners with an MNO, utilizing the spectrum assets of the MNO. We agree with ISED that this is the most likely scenario.
- b. The SNO operates independently of any MNO, using spectrum under the Access Licensing (ASL) regime. We understand that ISED wishes to protect ASL licenses, which we interpret as prioritizing terrestrial services for Access Licensing frequency bands.

A third approach involves the SNO operating independently of any MNO, using its own MSS spectrum, as seen in the Globalstar-Apple example. Since SMCS falls under the MSS definition, this raises the question of whether the same rules should apply equally to SMCS and MSS services, which we believe they should.

It is important to note that network outages can occur for various reasons and can affect different parts of the network (e.g., IP network, mobile core network, or radio access network). The effectiveness of emergency roaming will depend on the specific failure scenarios and the characteristics of the networks involved, particularly those of the Responding Party, which in this case would be the D2D SNO providing emergency roaming services. Therefore, it is crucial to consider the capabilities and limitations of satellite networks, as well as the dependencies related to deployment architectures, implementations, and potentially the commercial arrangements between operators.

For example, a failure could occur in either the radio or core network of the mobile network. If the core network fails but the radio network remains operational, many mobile devices would not be able to select the satellite network for 9-1-1 emergency services. Older generation devices, in particular, would be unable to complete a 9-1-1 call because the core network, which is experiencing an outage, would not be able to process any traffic. Additionally, if the satellite network shares the same core network, it too would experience an outage.

⁹ Schedule A defines the conditions and characteristics of emergency roaming between a service provider that extends the emergency roaming services (Responding Party) to a second service provider that is experiencing a network outage (Receiving Party) under a reciprocal bilateral emergency roaming agreement. Emergency roaming traffic includes domestic voice, text and data roaming services, and especially 9-1-1 wireless access.

We also emphasize that implementing emergency roaming is complex due to the numerous dependencies and possible scenarios involved. Service providers must test and validate these scenarios to ensure that any emergency roaming services, including 9-1-1 wireless access, are operational under different outage conditions. This may be challenging in the early stages of D2D satellite technology development, leading us to consider a gradual approach.

[Q13] ISED is seeking comment on the technical possibilities and limitations of SMCS for the provision of 9-1-1 access to all handsets from all service providers where there is SMCS satellite coverage.

9. **Enabling satellite emergency 9-1-1 wireless access is a beneficial first step.** This approach aligns with the Emergency Roaming Protocol outlined in the MoU, which mandates that the Responding Party prioritize 9-1-1 wireless access above all other wireless traffic.

However, provisioning 9-1-1 access to *all* handsets from *all* service providers within SMCS satellite coverage will require careful consideration of satellite capacity and throughput limitations, as discussed in points #1 and #2 above. Additionally, it will be necessary to delineate the areas where SMCS service is available to estimate the number of potential 9-1-1 emergency users. While providing 9-1-1 access to all handsets from all service providers may be feasible in certain remote regions, capacity constraints may prevent this in areas with higher subscriber density.

Another critical factor to consider is the interoperability of networks and the commercial agreements governing relationships between MNOs and an SNO within an SMCS coverage area. In terrestrial networks, an outage typically allows customers of the affected network to access emergency services through another MNO, facilitated by the symmetric services MNOs extend to one another. However, the situation is different when it comes to an SNO and MNOs, as the SNO may not have established any commercial relationships with the MNOs in that region.

Furthermore, it would be advantageous to prioritize terrestrial emergency roaming and 9-1-1 wireless access over similar satellite-provided services. Such prioritization would help avoid overloading satellite networks in areas where terrestrial coverage from other MNOs is available.

[Q14] ISED is seeking comments on how SMCS deployments would support the distribution of emergency alerts to mobile devices.

10. **Distribution of emergency alerts for SMCS deployments should be optional.**

Technically, it is possible for D2D satellites to distribute emergency alerts; however, geo-targeting mobile devices presents challenges. The large coverage footprint of satellites could result in alerts being received by mobiles outside the intended target area.

We note that D2D constellations use varying approaches to provide coverage from space. Some employ wide-beam antennas, while others utilize more advanced beamforming technology that may better target mobile subscribers within a smaller area.

Additionally, according to CRTC 2017-91, MSS companies are not required to provide wireless public alerts because their networks cover broad areas and cannot effectively geo-target mobile devices.

Given these factors, it would be reasonable to make the distribution of public emergency alerts optional for SMCS deployments.

[Q15] ISED is seeking comments on whether existing mechanisms will support emergency communications in the absence of a roaming agreement between providers, or whether a new obligation would be appropriate regarding this issue for SMCS.

11. It is risky to assume that existing mechanisms will adequately support emergency communications in the absence of a roaming agreement between providers. This risk arises from the following points outlined in #3, #4, and #7 above:

- a. The varying architectures and implementation models for how satellite networks interwork with mobile networks.
- b. Different types of network outages necessitate testing various scenarios to ensure the proper operation of emergency roaming.
- c. The SMCS framework requires further definition to establish the commercial and legal groundwork for collaboration between satellite and terrestrial operators.
- d. Emergency roaming is inherently complex, with numerous corner cases and interdependencies. Therefore, collaboration among service providers is essential to ensure reliable operation under well-defined outage scenarios.