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CRTC INTERCONNECTION STEERING COMMITTEE (CISC)

REPORT to the CRTC

by

Emergency Services Working Group (ESWG)

Consensus Report for

Task: ESTF0069 – Wireless Location Accuracy

Handset-based Location Implementation in Canada

10 September 2020

Version: 1.0 (Final)

1. Executive Summary

This report identifies advancements that have been made in the availability of handset-based location and how this can be used to improve existing E9-1-1 Phase II based locates in Canada.

The Commission established a wireless 9-1-1 location accuracy monitoring process to better understand the accuracy of location information so that improvements can continue for wireless location accuracy in Canada. The Commission also requested that the ESWG continue to monitor and report on technical and standards developments in the wireless industry that could lead to improved location accuracy results.

The introduction of Phase II location functionality in 2010 was a major advancement in providing accurate locations for wireless emergency calls in Canada. In addition, location accuracy monitoring has helped to understand that the majority of accurate locates are based on GPS functionality. Though network calculations (trilateration) sometimes provide accurate locates, a significant number of wireless emergency calls do not have accurate locates because they are made in locations where these functions are not available i.e. indoors.

In Europe, Phase II was not introduced and over time the need for accurate locations resulted in the creation of Advanced Mobile Location (AML) that could use handset-based location from Google ELS (Emergency Location Service) for Android devices and Apple HELO (Hybridized Emergency Location) for iOS devices. EENA issues an annual report card which provides information on the AML deployments. The added value of Google ELS and Apple HELO is that they use available Wi-Fi data to assist in providing locations where GPS is not available i.e. indoors.

AML and the availability of handset-based location data from Android (Google) and iOS (Apple) has progressed significantly since 2018 and is the sole focus of this report.

Proof of concept testing has shown that both ELS (Google) and HELO (Apple) provide significant improvements in providing accurate locations in environments where GPS is not available i.e. indoors.

This report concludes (Section 6) that E9-1-1 location can be enhanced based on the following:

1. Android ELS (Google) is calculated at the handset using GPS, cellular, and Wi-Fi sensors. The availability of Wi-Fi provides more accurate locations, especially indoors.

2. Since Android ELS (Google) is calculated at the handset, the ELS program must be pre-configured to push the handset location information to pre-defined Aggregation points; thereafter the WSP can perform a validation check, evaluate the best location[1], and forward the result to the PSAP using the existing Phase II configuration.

3. iOS HELO (Apple) is calculated at the handset using GPS, cellular, and Wi-Fi sensors. The availability of Wi-Fi provides more accurate locations, especially indoors.

[1] *Is the most likely location of the caller based on the device processing the call and calculations done at the handset and/or network. This new process is a further improvement to the location determination methods already described in the definition of 'best location' in ESRE0086b – Dispatchable Location.*

4. Since iOS HELO (Apple) is calculated at the handset, the best location information can be pulled in response to a WSP initiated NILR (Network Initiated Location Request) query; thereafter the WSP can perform a validation check and forward the result to the PSAP using the existing Phase II configuration.

During our work on handset-based location for E9-1-1 PSAPs, the opportunity arose for us to explore interim measures to provide unvalidated wireless location information to B9-1-1 PSAPs who do not currently get any location data (Section 5.3). Further investigation is required as detailed in Section 8 – Matters for Further Consideration at Item 2, to determine the logistics to implement this in parallel with the proposed handset-based location schedule.

It is also important to note that this report does not cover the potential future use of handset-based location for the geo-routing of calls. This opportunity will be investigated and reported on in a newly proposed TIF starting in early 2021.

Based on these findings, ESWG is requesting the Section 7 – Recommendations and the Section 8 – Matters for Further Consideration be approved by the CRTC in order to confirm the implementation of handset-based location across Canada on 1 March 2022.

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2. Task Activity

ESTF0069 – Wireless Location Accuracy has been an ongoing activity since June of 2011. Since starting, task participants have issued several reports related to monitoring and reporting on location accuracy which have resulted in ongoing direction from the CRTC. The most current findings and directions were provided in Telecom Decision 2019-120 issued 26 April 2019. The following excerpts are provided from this decision to provide context for this report:

1. *Effective access to emergency services is critical to the health and safety of citizens, and is an important part of ensuring that Canadians have access to a world-class communication system. In Telecom Regulatory Policy 2014-342, the Commission set out its 9-1-1 action plan, which included key initiatives aimed at enhancing Canadians' access to existing 9-1-1 services.*

2. *Through a series of decisions, the Commission established a wireless 9-1-1 location accuracy (location accuracy) monitoring process. The objective of this process is to better understand the accuracy of the location information that wireless service providers (WSPs) send to public safety answering points (PSAPs) during a 9-1-1 call, so that improvements can be made to wireless location accuracy in the future.*

8. *The Commission is continually looking for ways in which emergency telecommunications services can be improved …*

13. *… the Commission …*
    - *requests that the ESWG continue to (i) annually assess WSPs' location accuracy results, and (ii) report to the Commission if and when it deems any adjustment to the thresholds to be appropriate; and*
    - *requests that the ESWG continue to monitor and report on technical and standards developments in the wireless industry that could lead to improved location accuracy results.*

The same request detailed in items 8 and 13 above were also made in previous related commission decisions in 2017 and earlier. Based on this direction, this task group has been monitoring and working on two major ongoing developments in wireless location accuracy:

- Advanced Mobile Location (AML), *and*
- Z-Axis coordinate i.e. height coordinate *(aka altitude)*

Advanced Mobile Location (AML) and the availability of handset-based location data from Android (Google) and iOS (Apple) has progressed significantly since 2018 and is the sole focus of this report. The Z-Axis developments are still in progress and will be part of a future report when a Canadian solution is available.

3. Introduction / Background

As noted in Section 2 – Task Activity, ESWG participants to Task Identification Form (TIF) 69 – Wireless Location Accuracy are continually monitoring location improvements around the world and filing reports with recommendations for Canada-wide solutions for all Enhanced (E)9-1-1 Public Safety Answering Points (PSAPs).

In addition, TIF69 participants undertake an annual review process of actual location data accuracy performance, with the goal to work with industry stakeholders to continually improve the results delivered with E9-1-1 calls to PSAPs.

In 2018, CRTC staff requested TIF69 undertake a new activity to formally look at enhanced handset-based location options for Canada. This process has evolved over the last 2 years with numerous contributions, as detailed in Appendix 'A'.

We have followed the development of handset-based location around the world, noting the following different types of implementations:

a. Europe and the United Kingdom: They have led the way out of necessity since they were not able to implement Phase II GNSS *(aka GPS in North America)* location, this is the only source of accurate location available to the majority of PSAPs *(see Appendices C and D for further details).*
b. United States: Due to the very large number of PSAPs and the initial lack of cooperation from WSPs, RapidSOS developed an aggregation process for handset-based location data which is queried by numerous PSAPs in order for the Telecommunicator to compare against the Phase II location provided by the WSP. The manual comparison of location data has raised some operational concerns in the US.
c. New Zealand: They have a unique configuration where all the location data is delivered to a single national aggregator to calculate the best location *(using a locally developed algorithm that compares handset-based and network-based locations)* to be sent to the applicable PSAP.

In Canada, ESWG continues to work with the wireless service providers to determine the best way to implement enhanced handset-based location. As well, we are continually focused on ways to improve location technology as detailed in Appendix 'E'.

ESWG has been asked to file a report with the recommended Canadian E9-1-1 architecture to support current in-line delivery of handset-based location *(aka Advanced Mobile Location – AML per Section 4 details; next)* to Wireless Service Providers (WSPs) for the calculation and delivery of best location data using the existing Phase II location delivery mechanism to E9-1-1 PSAPs in Canada.

4. What is Handset-based Location (aka AML)

Handset-based Location is sometimes referred to as AML (Advanced Mobile Location).
AML started in Europe and is strongly supported by EENA (European Emergency Number Association).

Europe did not deploy Phase II location capability, so wireless emergency calls did not have accurate locations. Some countries tried mobile phone Apps to capture the handset location but downloads and set up were susceptible to user errors.

EENA provides a very high-level description of AML and where it is deployed. It also includes links to a report card on deployment and most importantly AML specifications and requirements and technical specification ETSI TS 103 625 V1.1.1 (2019-12). The report card provides details on the current AML deployments around the world *(see Appendices 'C' and 'D' for this information)*.

Accurate caller location in case of an emergency is one of the most significant pieces of information a 9-1-1 system and emergency call-taker/Responders can use. Accurate Caller location can used in many ways, including informing the decision on which emergency centre receives the initial call, which resource are dispatched, identifying the quickest route to get to the incident the dispatched resource can use, and so on.

Acquiring accurate caller location for fixed line phones was relatively easy as it usually used the civic address of the building the phone was installed at, but with the advent of cellular phones determining their accurate location became significantly more difficult, especially if the cellular phone was in motion and thus its location was continually changing.

Initially, Wireless Carriers determined cellular phone location used Wireless Network information such as cellular tower location and trilateration between towers to locate and track 9-1-1 callers. However, the advent of Smartphones offered the opportunity to significantly change how a cellular phone's location could be determined and increase the accuracy of the location.

Smartphones began the era of Handset-based-Location, initially the handset (Cellular Smartphone) relied on receiving GPS signals to determine its location, but the GPS signals could be blocked by weather conditions and buildings. Smartphones utilizing Android (Google) or iOS (Apple) operating systems began to use not only GPS location information but also cellular towers, Wi-Fi hotspots and Bluetooth Beacons that the phone could detect and use to determine and continually update its location.

Google and Apple continuously map cellular towers and identifiable Wi-Fi Hotspots and provide this data to the Smartphone on an ongoing basis. The Smartphone applies mathematical calculations that use the location data on cellular towers/Wi-Fi Hotspots to determine its location. The initial users of this Smartphone location data were Smartphone applications such as Uber, WAZE, etc., where subscribers opt-in. The issue now becomes how to get that accurate location information from the Smartphone to a 9-1-1 centre? Also, as Smartphone users can turn off device location services, how can it be turned back on when the Smartphone is making a 3-digit emergency number call? There are several ways of addressing the two questions just raised, one answer is the standard for Advanced Mobile Location (AML) for emergency calls. AML is not implemented using an App; rather it is a technology built into the Smartphone's operating system (i.e. it is a native feature). In the event of an emergency call, an AML-enabled Smartphone can automatically send the accurate location information it calculated

using location sensors e.g. GPS, cellular, and Wi-Fi to the PSAP. Since AML is not an App, it does not require any action from the caller. If the caller has turned their Smartphone location services off, AML will automatically turn those services back on once the Smartphone detects the caller is placing an emergency call. The AML standard provides for two means to transport the location data to a PSAP. In the case of AML, the two methods are SMS and a HTTPS post. AML defines the message structure for each of the two transport methods. An advantage of AML is that a Smartphone is location aware, so when 9-1-1 is being dialed and connected it sends (i.e. pushes) the calculated caller location at a pre-set time frame to the designated Aggregation point(s). This results in the caller location being available in a shorter time than if a PSAP had to query the Smartphone for its location.

Smartphone handset-based location determination is a significant enhancement in addition to the other means of determining a cellular device's location. The AML standard is one way for PSAPs to access more accurate location information directly from handset, especially where GPS line of sight is obstructed, and Wi-Fi location is available.

ESWG has undertaken extensive research and collaboration to provide the information that follows and the recommendations on how to deploy handset-based location in Canada.

5. Initial Analysis and Findings

For Android devices, the AML standard requires that the handset's operating system (Google Android OS) capture its location and send it to an aggregator(s) who will then facilitate delivery to the PSAP. The Google program (Android OS) will capture the location upon dialing of the emergency number, then send it via SMS to a designated aggregator. An SMS standard has been developed for this AML transmission. The data may also be transmitted using HTTPS, but this requires the user to have data service. Since SMS is not guaranteed and HTTPS may not always be available, sending the location using both methods of transport will increase the likelihood of successful delivery of the handset-based location information.

For Apple devices, the location is calculated by the Apple OS (aka iOS) and is transported through the NILR (Network Initiated Location Request) query method; ***or*** for networks that do not support NILR then an alternate data path can be established using Enhanced Emergency Data (EED) through a designated Aggregation point(s).

In both cases, the program capturing the location information is set up in advance with parameters determining when the first location should be sent, where, how many additional locates should be sent and how far apart without depleting the user's battery. The set up is a one-way push system so the Service provider does not control the program.

For deployments where the handset result is sent as a separate data stream to a PSAP *(as is the case in the US)*, best practices are recommended in Annex C of the ETSI specification noting the responsibility on the PSAP to compare the handset result with the Service provider Phase I network location result and decide which to use.

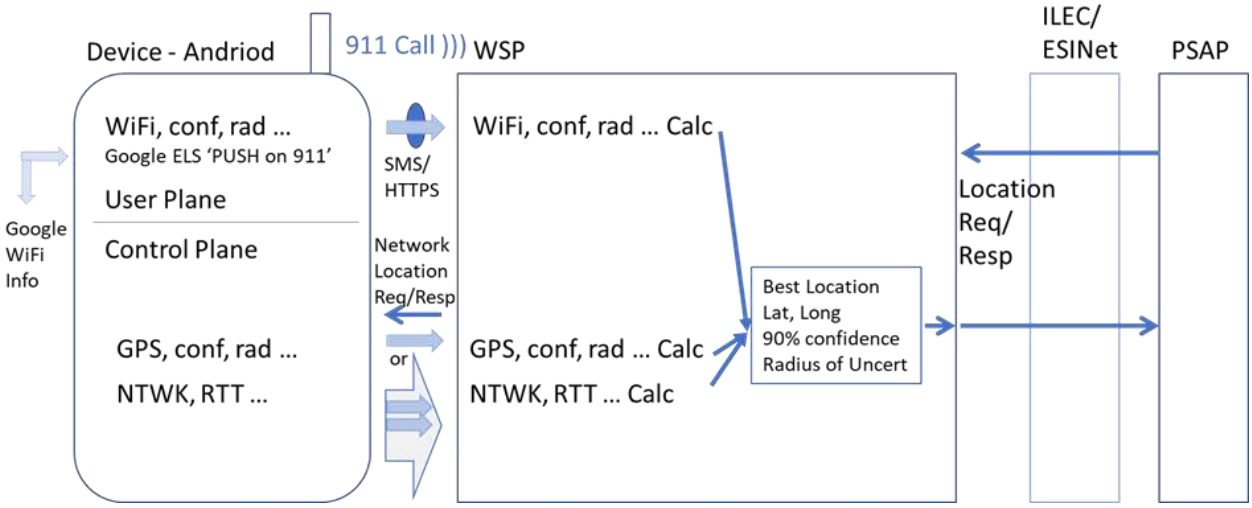
The following section describes potential Canadian solutions taking into account that Canada has delivered wireless Phase II location capability since 2010.

5.1 Android (Google) Location Data

Android Emergency Location Service (ELS) is a supplemental service that sends enhanced location directly from the Android handsets to PSAPs when an emergency call is placed. Google has provided ongoing guidance to ESWG regarding the options available to provide handset-based location data delivery using up to four (4) designated AML Aggregation points for deployment across Canada. In summary, Google offers two modes for reporting ELS location data:

- Sampling mode: location is sent at predefined intervals starting from the time the emergency call is initiated, e.g. 10 secs and 25 secs into the call (*maximum is 35 secs*). It is also possible to request that ELS send a location as soon as it can be determined ("first available fix"). Sampling mode ends *35 seconds into the call* or after *the last specified interval has expired* (if that is <35 seconds).
- Tracking mode: this is an optional parameter. If requested by the Partner, ELS will report location every X seconds until the call ends. If both sampling and tracking modes are selected, tracking mode will only be used once sampling mode is completed. Tracking mode will terminate when the call ends (and will only operate when the phone call is active).

Android devices provide GNSS accurate locations through the control plane[2] network supporting Phase II, however they do NOT provide Wi-Fi location data through the control plane. Google has captured location data including Wi-Fi location in their operating system in the user plane and provides it, supporting the AML solution noted above. The following figure illustrates location requests for Android devices.



Location requests for Android devices

- Android device responds to a network location request with GPS location info (when available).
- Android device does not provide Wi-Fi location info in response to a network location request, instead Google ELS is used to send Wi-Fi location info (when available).
- Google ELS pushes the location result, which includes the Wi-Fi information, to the WSP (Bell, Rogers, TELUS, or a 4th aggregator) with predetermined parameters e.g. timing, location updates, etc.
- Smaller WSPs will need to have result routed through a single aggregator. *(NOTE: this is a Google requirement that could be handled by an ILEC, existing vendor, WSP, or a third party.)*
- The WSP will perform validity check calculations on results, including *(but not limited to)* ensuring the ELS result is within GPS or Network radius of uncertainty, and then calculating the Best Location (i.e. ELS *or* Phase II) to forward to the PSAP.
- For In Call Location Updates (ICLU), the network location request will be used to respond. The Google ELS Wi-Fi data will be used/validated if an update is available keeping in mind ELS is not aware of ICLU requests. See section 5.1.4 for further recommendations on ELS program configuration.

Most AML deployments, to date, have provided handset location data directly to PSAPs. This separate method of delivery requires PSAPs calltakers to compare handset-based location with WSP provided location data and determine the best location to use. The configuration depicted above requires the handset result to be sent to the WSP so they can process and compare all location information then deliver the best location to the PSAP using the existing Phase II interconnection.

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[2] *The 'Control Plane' is the secure signaling between the network provider and the handset for managing communication during a session i.e. how they work together; the 'User Plane' is specific to the handset operating system i.e. the data that it sends and receives from the handset.*

5.1.1 Canadian Aggregator Options (Google)

A. Google – direct connection to major WSPs i.e. Bell Mobility, Rogers Wireless, and TELUS Mobility, plus a fourth Aggregation point for all other facilities based WSPs *(i.e. Eastlink Wireless, Freedom Mobile, ICE Wireless, SaskTel Mobility, TBayTel Mobility, Videotron Mobile, and xplore mobile)*

Pros:

- WSPs can work directly with Google to get unique configurations and ongoing support required by Bell Mobility, Rogers Wireless, and TELUS Mobility
- WSPs can work directly with Google to establish known costs for implementation, ongoing support, and future upgrades
- More ability to maintain compliance and enforcement mechanisms for data handling, storage, and privacy

Cons:

- Google will only establish a single AML Aggregation point (fourth in Canada) to facilitate the aggregation requirements for all the small facilities based WSPs *(Eastlink Wireless, Freedom Mobile, ICE Wireless, SaskTel Mobility, TBayTel Mobility, Videotron Mobile, and xplore mobile)*, which may be a hardship for these WSPs; and could result in an exception to the ability to maintain compliance and enforcement mechanisms for data handling, storage, and privacy.

B. RapidSOS – single Canadian Aggregator solution with each facilities based WSP

Pros:

- Single source for all carriers with flexibility for individual configurations
- Eliminates the limited aggregation options that exist with other providers
- Ability to determine when location data is unencrypted (HTTPS only)

Cons:

- WSPs are not able to establish the same known cost for implementation, ongoing support, and future upgrades
- Third party company with no guarantees of longevity
- Limited ability to establish compliance and enforcement mechanisms for data handling, storage, and privacy
- Potential future implications in terms of call processing latency which may impact geo-routing calls

C. Comtech – delivery to existing WSP customers

Pros:

- Some WSPs can work directly with their existing vendor (Comtech) to implement unique configurations and ongoing support
- Applicable WSPs can establish known costs for implementation, ongoing support, and future upgrades
- Ability to maintain compliance and enforcement mechanisms for data handling, storage, and privacy
- Goal is to deliver the best result to PSAPs using the existing Phase II delivery mechanism (no change)
- They may only have to be the aggregator for the smaller wireless service providers since Google will be sending the ELS location directly to the major providers.

Cons:

- Can only be aggregators for existing WSP customers which may result in the inability to propose a national configuration
- Will result in a network location and a handset location being delivered to the WSP, which will require a new algorithm to determine best result (not hybridized); more development required

D. Intrado – delivery to existing WSP customers

Pros:

- Some WSPs can work directly with their existing vendor (Intrado) to implement unique configurations and ongoing support
- Applicable WSPs can establish known costs for implementation, ongoing support, and future upgrades
- Ability to maintain compliance and enforcement mechanisms for data handling, storage, and privacy
- Able to deliver the best result based on a calculation that looks at available location data from the network and handset to determine a single location (hybridized)

Cons:

- Can only be aggregators for existing WSP customers which may result in the inability to propose a national configuration

E. List of Considered Aggregator Options for Android (Google)

Based on the initial feedback from Google, we undertook an analysis (as detailed above in items ‘A’ to ‘D’) of the Pros and Cons for several options. Since this initial analysis, and based on extensive follow-up, the list has been updated to show the Aggregator options being considered:

1. One of the Tier 1 WSPs i.e. Bell, Rogers, or TELUS agrees to be the National Aggregator for the Tier 2 and 3 WSPs
2. One of the ILECs i.e. Bell, SaskTel, or TELUS agrees to be the National Aggregator for the Tier 2 and 3 WSPs
3. The NG9-1-1 network providers i.e. Bell, SaskTel, and TELUS agree to be Aggregators for all WSPs in Canada
4. One of the Tier 2 or 3 WSPs agrees to be the National Aggregator on behalf of the smaller WSPs
5. RapidSOS contracts to be the National Aggregator for Tier 2 and 3 WSPs
6. Comtech partners with Bell, Rogers, or TELUS to be the National Aggregator for Tier 2 and 3 WSPs

F. Android (Google) Aggregation Decision and Next Steps

After consultation and follow-up on all of the options listed above, ESWG has confirmed the following modified Option 3 Aggregation arrangement for moving forward:

i) NG9-1-1 network providers Bell and TELUS have committed to being the aggregators for all WSPs in Canada

ii) NG9-1-1 network provider SaskTel has committed to determining the technical and support model requirements for them to consider being a third aggregator for all WSPs in Canada

iii) WSPs will work with the NG9-1-1 network providers to determine the requirements for

interconnection. *[NOTE: Once finalized, these requirements will be added to the applicable Network to Network Interface (NNI) documents.]*

The modified Option 3 aggregation model is very beneficial because it starts the foundation for interconnection required to facilitate the future expansion of additional data about the call, the caller, and the location; so, it is definitely forward looking. In addition, it provides enhanced redundancy and resiliency for the end to end processing of additional data.

During this process ESWG identified the following matters for further consideration that require additional work and resolution in order to confirm this modified Option 3 aggregation arrangement for Canada:

- Work with Google (Android) to confirm a single aggregation implementation for Canada that simultaneously sends the ELS location data to the designated NG9-1-1 network providers (Bell and TELUS confirmed, SaskTel decision is pending)
- Confirm the process and interconnection required to push the ELS location results delivered from Google to the applicable WSP
- Determine if additional processing is required to handle MOCN (Multi-Operator Core Network) arrangements between two WSPs
- Confirm how licencing with Google, encryption/decryption, and the privacy of ELS location data will be addressed with this arrangement
- Determine the implications of this arrangement (i.e. enhancements required to existing platforms) for TSPs, as well as the pending NG9-1-1 tariffs

All of these steps will be undertaken as part of the process detailed in the Section 8 – Matters for Further Consideration at Item 1.

5.1.2 Options for Delivery of Android Location Data

G. Control Plane – not available from Google in Canada

H. Data SMS using Advanced Mobile Location (AML) Protocol

Pros:

- Data SMS service is widely available
- This protocol works with 99% of Android handsets (OS 4.0 or higher)
- Google can include country specific configurations with operating system updates
- Data SMS works for roaming situations

Cons:

- Need an SMS plan (unless this is waived by the WSPs i.e. like some in the US have done)
- WSPs may have to provision new Data SMS end point(s)
- The location data provided has less details than what's available in the complete ELS data set
- Data SMS location delivery is slower than HTTPS location delivery
- Data SMS is not encrypted

I. HTTPS using Emergency Location Service (ELS)

Pros:

- Uses all the location tools available on a handset to calculate location
- Provides significantly more information than Data SMS i.e. additional handset and carrier-based data is available
- Is future proof in terms of providing additional data (when available)
- This protocol works with most Android handsets (not all)
- Google can include country specific configurations with operating system updates
- HTTPS is encrypted

Cons:

- Good data coverage is required
- A subscriber data plan **may** be required for this to work
- Availability may be limited in certain roaming situations e.g. international

J. Data SMS and HTTPS

Pros:

- Google supports and recommends this configuration i.e. send both Data SMS and HTTPS with each call
- Higher likelihood of a successful locate using both Data SMS and HTTPS
- All potential Aggregators i.e. RapidSOS, Comtech, and Intrado can receive Data SMS and HTTPS data sets and combine into a single delivery to WSPs

Cons:

- WSPs will need to test and implement both protocols which will be more complicated
- Must test both delivery methods on all supported handsets

5.1.3 Proof of Concept Trial (Google)

Introduction & Technical Considerations:

TELUS conducted an initial AML Proof of Concept Trial utilizing Google's Android Emergency Location Service (ELS). Goal of testing was to determine the accuracy of ELS location vs Network based location with regards to actual ground truth.

Testing was done in city of Montreal with Montreal PSAP in December 2019, in the areas of Ajax and Whitby Ontario in January-Feb1ruary 2020 with Durham Regional Police Service and in TELUS test environment in Toronto in February 2020. The ELS Aggregation point was provided by RapidSOS for this testing. Only HTTPS Post End Point was used for this testing.

A variety of scenarios both indoors and outdoors were tested with some popular android OS based devices. A total of 40 test calls were made. Logs from Network and ELS were analyzed and location accuracy of the two methods was measured against the ground truth of actual device location at the time of 911 call. Z-axis analysis was not in scope for this testing. Z-axis information was provided by ELS, but z-axis ground truth was not recorded.

It should be noted that ELS utilizes several location technologies located on an Android phone, including cell, GPS, and Wi-Fi signals, as well as other Smartphone sensors, to estimate a caller's emergency location, both indoors and outdoors. The ELS geolocation information sent

to the designated Aggregation point (i.e. RapidSOS) is determined directly by the Android device and its Android OS.

Results Summary:

The test environment and subsequent results are categorized into three categories.

A. Environment: Wi-Fi Signals available, No GPS signals

Test Environments:
Indoors: office building, elevator, parking garage, underground path, food court, urban store, shopping mall, hotel room, suburban house basement
Outdoors: street level urban canyon

Findings: ELS provided significant improvement to location accuracy. 75% of ELS results were within 50m of ground truth as compared to 25% results within 50m of ground truth for network-based location.

B. Environment: GPS signal available

Test Environments:
Indoors: shopping mall, suburban house
Outdoors: city park, in car, urban street level, parking lot, conservation area

Findings: 100% of network-based location results were within 50m of ground truth as compared to 80% results within 50m of ground truth for ELS. Wi-Fi signals were available for some outdoor calls in urban areas and ELS used it to calculate location.

C. Environment: No GPS, No Wi-Fi Signals available

Test Environment:
TELUS test cell inside a chamber with shielding for blocking GPS and Wi-Fi signals. Cellular data available.

Findings: ELS Location was not received for these test cases except where device already had Wi-Fi based location in cache. Network location was obtained for all calls. More testing is required in real settings as test results are inconclusive.

Observations:
Although our data set is small, we saw that ELS provided threefold increase in the number of calls that have location accuracy within 50m as compared to network-based calculations for scenarios with Wi-Fi signal present but no GPS.

Additional Things to Consider:
Methodology of choosing the best location from ELS and Network location data should be developed. Further analysis of response times and uncertainty radius of the location results is required when this technology is adopted in Canada.

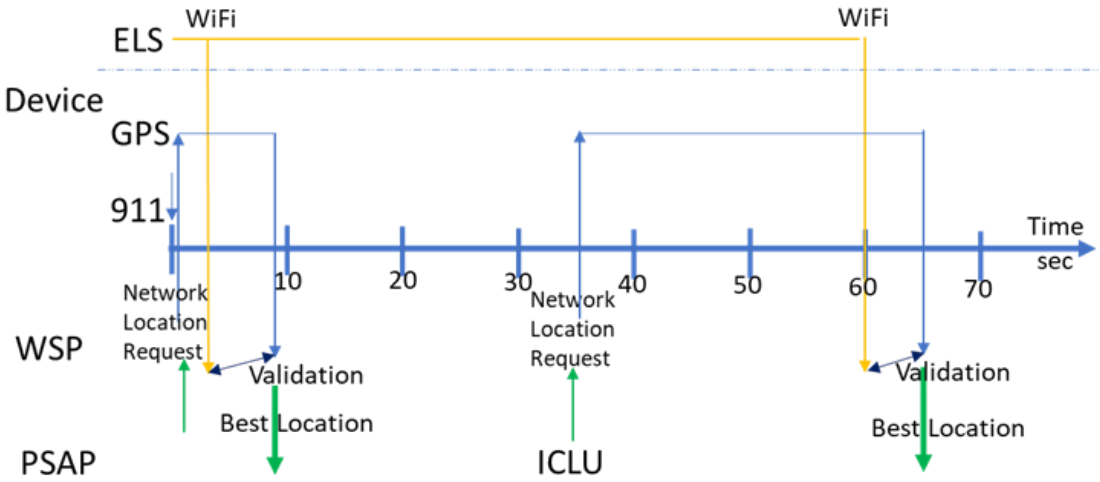
5.1.4 Location Delivery Timing (Google)

Based on the findings detailed above *(in Sections 5.1.1 to 5.1.3)*, and after considering the extensive deployments around the world *(as summarized in Appendix 'D' – Operational Use of AML)*, ESWG is proposing the following specification.

Proposed Canadian Configuration for Google ELS:

a. The initial ELS result is calculated and delivered at 3-5 seconds to the designated AML Aggregation point(s) using HTTPS and Data SMS *(future consideration)*
b. The subsequent ELS results are calculated and delivered at each 60 second interval, while the call is in progress, to the designated AML Aggregation points using HTTPS and Data SMS *(future)*

The following figure illustrates an example of a configuration option for timers:



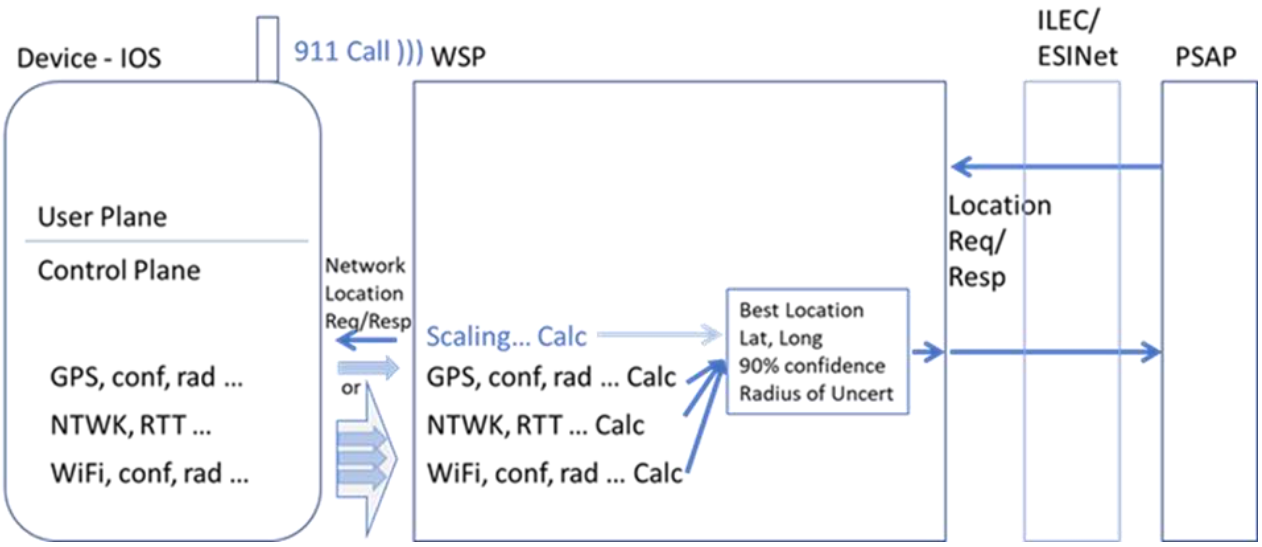
Potential Android Timers Configuration

c. Per the existing Phase II requirements, the WSP will initiate a regular Phase II location query *(either GPS and GNSS; or Network calculated)*
d. If an ELS location is **not** available, the existing Phase II location response will be used
e. If both are available, then the WSP will do a validity check and deliver the best location to the PSAP using the existing Phase II delivery mechanism
f. The WSP will perform **validity check calculations** on results, including *(but not limited to)* ensuring the ELS result is within GPS or Network radius of uncertainty, and then calculating the Best Location (i.e. ELS *or* Phase II) to forward to the PSAP.
g. When a PSAP initiates an In-Call Location Update (ICLU), steps 'c' to 'f' (above) will be repeated, with a result returned within 30 seconds

5.2 iOS (Apple) Location Data

For iOS (Apple) devices, the location is calculated by the Apple OS and is available through the NILR (Network Initiated Location Request) query method; *or* for networks that do not support NILR then an alternate data path can be established using Enhanced Emergency Data (EED) through a designated Aggregation point(s).

In Canada, all facilities-based wireless service providers can support the NILR query method, eliminating the need for a separate EED service. The following figure illustrates location requests for IOS devices.



Location requests for iOS devices

- IOS device provides a location response to the network location request; Apple refers to these as a NILR query. These calculations can include Wi-Fi, GPS, and/or Network location data from the Apple Smartphone.
- WSP will work with Apple to calculate optimal result on the device and send it.
- The WSP will perform a **validity check calculation** on the result by ensuring the NILR location is within the serving cell area, and then forward the handset calculated Best Location (enhanced Phase II location i.e. Wi-Fi *or* existing Phase II) to the PSAP.
- For In Call Location Updates (ICLU), a subsequent network location request(s) will provide updated calculated location data.

Given the fact that iOS NILR location is already available from all facilities based wireless service providers in Canada; and it includes Wi-Fi location data *(when available)* in the response, this means no separate aggregator(s) are required; eliminating the security, privacy, timing concerns that are applicable with the Android solution.

5.2.1 Canadian Aggregator Options (Apple)

A. Apple – direct connection to all WSPs *(NOTE: these arrangements are done directly with Apple under non-disclosure agreements (NDAs) – which limits the information that is available for consideration in these scenarios)*

Pros:

- WSPs can work directly with Apple to get unique configurations and ongoing support required by facilities based WSPs
- WSPs can work directly with Apple to establish known costs for implementation, ongoing support, and future upgrades
- More ability to maintain compliance and enforcement mechanisms for data handling, storage, and privacy

Cons:

- Very little information is available due to the NDAs regarding potential limitations of this direct connection approach

B. RapidSOS – single Canadian Aggregator solution with each facilities based WSP

Pros:

- Single source for all carriers with flexibility for individual configurations
- Eliminates the limited aggregation options that exist with other providers
- Data is delivered using the Enhanced Emergency Data (EED) which is encrypted

Cons:

- WSPs are not able to establish the same known cost for implementation, ongoing support, and future upgrades
- Third party company with no guarantees of longevity
- Limited ability to establish compliance and enforcement mechanisms for data handling, storage, and privacy
- Potential future implications in terms of call processing latency which may impact geo-routing calls

C. Comtech – delivery to existing WSP customers

Pros:

- Some WSPs can work directly with their existing vendor (Comtech) to implement unique configurations and ongoing support
- Applicable WSPs can establish known costs for implementation, ongoing support, and future upgrades
- Ability to maintain compliance and enforcement mechanisms for data handling, storage, and privacy
- Goal is to deliver the best result to PSAPs using the existing Phase II delivery mechanism (no change)

Cons:

- Can only be aggregators for existing WSP customers which may result in the inability to propose a national configuration
- Will result in a network location and a handset location being delivered to the WSP, which will require a new algorithm to determine best result (not hybridized); more development required

D. Intrado – delivery to existing WSP customers

Pros:

- Some WSPs can work directly with their existing vendor (Intrado) to implement unique configurations and ongoing support
- Applicable WSPs can establish known costs for implementation, ongoing support, and future upgrades

- Ability to maintain compliance and enforcement mechanisms for data handling, storage, and privacy
- Able to deliver the best result based on a calculation that looks at available location data from the network and handset to determine a single location (hybridized)

Cons:

- Can only be aggregators for existing WSP customers which may result in the inability to propose a national configuration

5.2.2 Options for Delivery of Apple Location Data

B. Control Plane

Pros:

- This delivery method is available now using Network Initiated Location Request (NILR), and is available for implementation
- The data is encrypted
- Should readily support ICLU *(need to confirm during Proof of Concept Trial – Stage 1)*
- Best location is calculated at the handset using available location sensors such as Global Navigation Satellite Systems (GNSSs) and Wi-Fi from the device (called HELO [Hybridized Emergency Location])

Cons

- Does not work with all handsets; must be a model 5s or higher running a minimum of iOS 9.0 *(NOTE: Most handsets being used today meet this specification)*
- The current specification is for the US, we do not currently have a confirmed Canadian specification *(NOTE: Confirm during the Section 3 – Stage 1 Proof of Concept Trials)*

C. SMS – not an available transport option directly from Apple in Canada

D. HTTPS – not an available transport option directly from Apple in Canada

E. All three delivery methods – Control plane is the only option currently available in Canada

5.2.3 Proof of Concept Trial (Apple)

Introduction & Technical Considerations:

Bell conducted an initial AML Proof of Concept Trial utilizing the production system Apple configured Network Initiated Location Response (NILR) method. Goal of testing was to determine the accuracy of NILR location vs Network based location with regards to actual ground truth.

Testing was done in city of Mississauga with the Peel Regional PSAP in December 2019.

An Apple iPhone 8, 11, and Apple Watch were tested in the areas of urban, sub-urban and indoor locations with 3G and 4G mobile networks, using the NILR method. The HELO push method to support AML in Europe is not supported in North America.

The NILR method will also be used by Apple for both the initial Phase II and ICLU (aka Re-bid) location calculations.

It should be noted that the location fix type supported is the Mobile Subscriber (MS) Based (device-based location fix) using GNSS and Wi-Fi data.

In approximately 10 percent of the test cases, the location fix was not always a circle shape with uncertainty; the uncertainty is based on the k-value, conversion is required by GMLC using 3GPP standard formula.

Results Summary:

The trial average uncertainty calculation is about 70 to 100 metres if GNSS and Wi-Fi are available; if Wi-Fi or GPS is not available, then NO location fix is provided to the GMLC. The GMLC must use other fallback location calculation mechanisms (ECID or CellID) to calculate the location of the caller.

Devices without a SIM card are also supported if GPS and GNSS are available.

The Apple Watch location fixes used for the trial tests were only supported on the 4G network, not the 3G network.

HELO location fixes are supported during the network handovers from 4G to 3G (SRVCC)

The location calculation time varies with the environment and availability of the GNSS and Wi-Fi networks (5-20 seconds).

Additional Things to Consider:
The testing did not include a comparison between MS based (handset) versus MS assisted (network) calculations, due to the fact that the best location is calculated at the handset only. If the MS based (handset) location is not available, then an MS assisted (network) location is calculated by the GMLC. The NILR method does not include a validation check, this must be done at the GMLC based on a check of the Phase I location.

5.2.4 Location Delivery Timing (Apple)

Proposed Canadian Configuration for Apple using the NILR method:

a. The initial NILR (Network Initiated Location Response) query from the WSP using the control plane is already in place for all facilities-based carriers in Canada based on their current Phase II configuration
b. Per the existing Phase II requirements, the WSP will initiate a regular Phase II location query
c. If a MS based (handset) location response is **not** available, the existing Phase II location response will be sent
d. The WSP will do a **validity check calculation** on the MS based location result using the Phase I location information *(NOTE: currently not implemented or tested)*
e. When a PSAP initiates an In-Call Location Update (ICLU), steps ‘a’ to ‘d’ (above) will be repeated, with a result returned within 30 seconds

5.3 Pre-NG9-1-1 Location Query Tool to Support Basic 9-1-1 PSAPs

There are some areas in Canada, such as Newfoundland and Labrador, the Yukon, and Northwest Territories that only have Basic 9-1-1 (B9-1-1) capabilities and will not be ready to upgrade to NG9-1-1 for several years. Currently, the B9-1-1 PSAPs serving these areas have no location information provided with the delivery of 9-1-1 dialled calls.

ESWG has drafted a new task (ESTF0094) to propose a transition plan from B9-1-1 service to NG9-1-1 service in Canada. Without speculating on the conclusions of this new TIF, the ESWG notes that the framework recommended in this Report around handset-based location offers an opportunity to improve B9-1-1 service while staying within the realm of the NG9-1-1 ecosystem in Canada. In fact, in the event that the Commission approves the recommendations of this Report, the availability of mobile handset-based location Aggregation points in Canada could present an opportunity to make available this location data for wireless 9-1-1 dialled calls to B9-1-1 PSAPs before becoming fully NG9-1-1 compliant.

The actual implementation of this process could utilize existing NENA NG9-1-1 defined Functional Elements and protocols. In NG9-1-1, the location database Functional Element is referred to a Location Information Server (LIS). The mobile handset-based location Aggregation point *(as applicable)*, enhanced with the capability to accept and respond to a location query received from a B9-1-1 PSAP, can be seen as a LIS function. In line with the current regulatory framework for NG9-1-1, the B9-1-1 PSAPs who wish to take advantage of this service must have a secure and dedicated IP interconnection on an ESInet to gain access to this service.

The potential process could be as follows:

1) B9-1-1 PSAPs receives 9-1-1 dialed wireless voice call
2) The PSAP agent determines the caller's Telephone Number (TN) from the calling line ID (CLID)
3) The PSAP agent uses a utility program running on the call taking workstation to enter the caller TN and have the utility query the NG9-1-1 LIS over secured Internet based connections
4) The NG9-1-1 LIS receives the HELD (HTTP-Enabled Location Delivery) query and determines if it has a current location for the TN and responds to the B9-1-1 PSAP with either the location information OR a message that location is not available
5) The B9-1-1 PSAP receives the location or a message that location is not available
6) The B9-1-1 PSAP can issue location update requests by issuing another query using the same utility

The implementation of this process would give B9-1-1 PSAPs access to mobile 9-1-1 caller location and allow B9-1-1 areas served by these PSAP to have a significantly improved level of 9-1-1 service.

In order to confirm that this new location query tool is viable for implementation by 1 March 2022 for B9-1-1 PSAPs in Canada, the proof of concept work detailed in Section 8 – Item 2 must be completed.

6. CONCLUSIONS

6.1 Summary

As identified in Section 2 – Task Activity:

…the Commission established a wireless 9-1-1 location accuracy (location accuracy) monitoring process… to better understand the accuracy of the location information … so that improvements can be made to wireless location accuracy in the future.

The Commission also,

requests that the ESWG continue to monitor and report on technical and standards developments in the wireless industry that could lead to improved location accuracy results.

Advanced Mobile Location (AML) and the availability of handset-based location data from Android (Google) and iOS (Apple) has progressed significantly since 2018 and is the sole focus of this report.

It is important to note that the introduction of Phase II location functionality in 2010 was a major advancement in providing accurate locations for wireless emergency calls in Canada. In addition, location accuracy monitoring has helped to understand that the majority of accurate locates are based on GPS functionality. Though network calculations (trilateration) sometimes provide accurate locates a significant number of wireless emergency calls do not have accurate locates because they are made in locations where these functions are not available i.e. indoors.

In Europe, Phase II was not introduced and over time the need for accurate locations resulted in the creation of AML that could use handset-based location from Google ELS (Emergency Location Service) for Android devices and Apple HELO (Hybridized Emergency Location) for iOS devices. EENA issues an annual report card which provides information on the AML deployments *(see Appendices 'C' and 'D' for details)*. The added value of Google ELS and Apple HELO is that they use available Wi-Fi data to assist in providing locations where GPS is not available i.e. indoors.

Proof of concept testing *(see Sections 5.1.3 and 5.2.3)* has shown that both ELS (Google) and HELO (Apple) provide significant improvements in providing accurate locations in environments where GPS is not available i.e. indoors.

This report concludes that E9-1-1 location can be enhanced based on the following:

1. Android ELS (Google) is calculated at the handset using GPS, cellular, and Wi-Fi sensors. The availability of Wi-Fi provides more accurate locations, especially indoors.

2. Since Android ELS (Google) is calculated at the handset, the ELS program must be pre-configured to push the handset location information to pre-defined Aggregation points; thereafter the WSP can perform a validation check, evaluate the best location, and forward the result to the PSAP using the existing Phase II configuration.

3. iOS HELO (Apple) is calculated at the handset using GPS, cellular, and Wi-Fi sensors. The availability of Wi-Fi provides more accurate locations, especially indoors.

4. Since iOS HELO (Apple) is calculated at the handset, the best location information can be pulled in response to a WSP initiated NILR (Network Initiated Location Request) query; thereafter the WSP can perform a validation check and forward the result to the PSAP using the existing Phase II configuration.

5. There is a potential opportunity to enhance B9-1-1 service by making wireless location information available (albeit somewhat limited) with 9-1-1 calls in areas where only B9-1-1 is available.

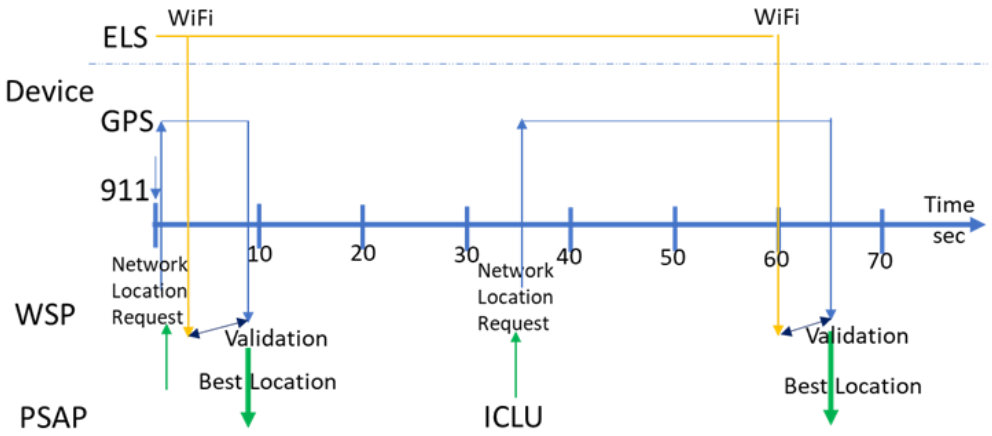
6.2 Proposed Android ELS (Google) Configuration

Based on the analysis in this report, the initial trial results, and input from Google, the following steps are required for the Android ELS implementation:

a. Google will enable the Canadian ELS configurations as follows:
    i. Set the emergency number as 9-1-1
    ii. Set the minimum handset battery percentage threshold at 10 percent *(i.e. Android ELS will not be calculated or delivered below 10 percent)*
    iii. Push the Android ELS location data simultaneously to the designated NG9-1-1 network providers (Bell and TELUS confirmed, SaskTel decision is pending)
    iv. Deliver the Android ELS location using HTTPS to the applicable Aggregation point(s) based on the WSP identifier *(i.e. MCC/MNC)*
    v. Test and confirm Android ELS timers as follows:
        - ✓ Deliver the initial handset first fix location as soon as available
        - ✓ Set the sampling mode timer at 4 seconds *(confirm the optimal value for the best Wi-Fi result during testing e.g. 4, 5, 6, 7, etc.)*
        - ✓ Set the tracking mode timer at every 60 seconds for the duration of the call
    vi. Set the Android ELS location confidence level at 90 percent

b. Once the Canadian Android ELS software load is complete and in-service, WSPs will, for all wireless 9-1-1 calls:
    i. Undertake a validation process to ensure the Android ELS result is within the Phase I serving area or the calculated control plane location
    ii. Compare Phase II location with handset-based location (if available and validated) to determine the most accurate location result and send it to the PSAP using the existing Phase II configuration
    iii. Maintain the current In-Call Location Update (ICLU) process i.e. no Phase II configuration changes are required; however, it may now include Android ELS location data as part of the most accurate location calculation from the WSP
    iv. Configure their networks to deliver 9-1-1 calls from Android ELS enabled handsets that do not have a data plan in order to deliver the location data to the applicable Aggregation point(s)

The following diagram (from Section 5.1.4) details the timing configuration for the Google ELS program.



Potential Android Timers Configuration

The configuration changes detailed above will require an upgrade to the WSP location servers which is expected to take 9-12 months to develop, test, and have ready for implementation. As well, testing will be required to evaluate the best location based on a valid current result and the smallest uncertainty.

6.3 Proposed iOS HELO (Apple) Configuration

Based on the analysis in this report, the initial trial results, and input from Apple, the following steps are required for the iOS HELO implementation:

a. Apple will formally enable the Canadian iOS HELO configuration as follows:
   i. Apple configures the handset to calculate handset-based location
   ii. Apple calculates the most accurate location and makes it available in response to the WSP NILR (network-initiated location request) query

b. Once the Canadian iOS HELO software load is complete and in-service, WSPs will, for all wireless 9-1-1 calls:
   i. Undertake a validation process to ensure the iOS HELO result is within the Phase I serving area or the calculated control plane location
   ii. Send the handset-based location result to the PSAP using the existing Phase II configuration
   iii. Maintain the current In-Call Location Update (ICLU) process i.e. no Phase II configuration changes are required; however, it will include iOS HELO location data as part of the most accurate location calculation from the WSP
   iv. Configure their networks to deliver 9-1-1 calls from iOS HELO enabled handsets that do not have a data plan

Since Apple iOS devices can already provide Wi-Fi information, it is used to respond to network requests in real-time so there is no need for timing configurations or an Aggregation point(s) to collect the data. The Wi-Fi information is provided the same way that GPS information is today. The only new requirement is for WSPs to undertake a validation process to ensure the iOS HELO result is within the Phase I serving area. This will require an upgrade to the WSP location servers which is expected to take 9-12 months to develop, test, and have ready for

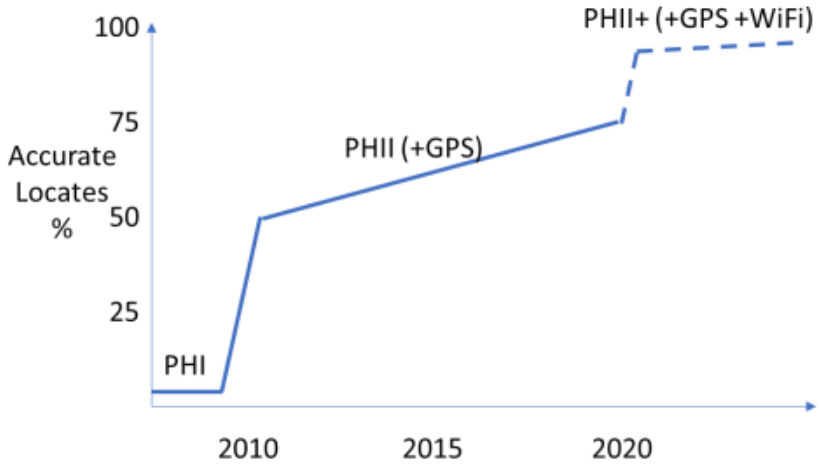
implementation. As well, testing will be required to determine the next best location if the handset-based location validation check returns a negative result.

6.4 Proposed Tool for B9-1-1 to Query Wireless Location Data

As detailed in Section 5.3, currently B9-1-1 PSAPs in Canada do not get location information delivered with the 9-1-1 call. However, as we worked through the logistics to implement handset-based location in Canada using the existing E9-1-1 infrastructure, a new opportunity arose to put a possible solution in place that supports both B9-1-1 and E9-1-1 PSAPs and gets them ready for NG9-1-1. In order to confirm the new B9-1-1 wireless location query tool is viable, the steps detailed in Section 8 (Matters for Further Consideration) – Item 2 will be undertaken, and a follow-up report filed to confirm this proposed arrangement is viable.

6.5 Continued Improvement of Emergency Location for 9-1-1 Calls

The incorporation of Google ELS for Android devices and iOS HELO for Apple devices into today's network with Phase II functionality will significantly improve the number of accurate locations especially indoors. Over the past 10 years Phase II location enhancements have increased the availability of accurate locates from roughly 50% to 75%. The addition of Wi-Fi location has the potential to increase the availability of accurate locates to over 90%. The figure below illustrates the improvement over time for Canada and is based on the CRTC mandated annual national reporting requirements for wireless location accuracy for the majority of 9-1-1 calls for the period 2010 to 2020 *(see Appendix E for further details)*.



Graph of Location Accuracy Improvements in Canada Since 2010

7. RECOMMENDATIONS

Based on the conclusion detailed in Section 6, ESWG is recommending the Commission direct WSPs to take the following action steps to implement handset-based location in Canada by 1 October 2021:

7.1 Android ELS (Google) Recommendations

1. That WSPs undertake the following action steps to provision handset-based location technology in Canada for Android ELS (Google) on or before 1 October 2021:

    a. Each facilities-based WSP will enter into an agreement with Google to enable the Canadian ELS configurations as follows:

        i. Set the emergency number as 9-1-1

        ii. Set the minimum handset battery percentage threshold at 10 percent *(i.e. Android ELS will not be calculated or delivered below 10 percent)*

        iii. Push the Android ELS location data simultaneously to the designated NG9-1-1 network providers (Bell and TELUS confirmed, SaskTel decision is pending)

        iv. Deliver the Android ELS location using HTTPS to the applicable aggregation point(s) based on the WSP identifier *(i.e. MCC/MNC)*

        v. Test and confirm Android ELS timers as follows:
            - ✓ Deliver the initial handset first fix location as soon as available
            - ✓ Set the sampling mode timer at 4 seconds *(confirm the optimal value for the best Wi-Fi result during testing e.g. 4, 5, 6, 7, etc.)*
            - ✓ Set the tracking mode timer at every 60 seconds for the duration of the call

        vi. Set the Android ELS location confidence level at 90 percent

    b. Once the Item 1 matters for further consideration action steps are completed, activate the Canadian Android ELS software load by 1 March 2022 to complete the WSP implementation

    c. Once the Canadian Android ELS software load is complete and in-service, WSPs will enable the following functionality for all wireless 9-1-1 calls from compatible Android handsets:

        i. Undertake a validation process to ensure the Android ELS result and/or the calculated control plane location are within the Phase I serving area

        ii. Compare Phase II location with handset-based location *(if available and validated)* to determine the most accurate location result and send it to the PSAP using the existing Phase II configuration

        iii. Maintain the current In-Call Location Update (ICLU) process i.e. no Phase II configuration changes are required; however, it may now include Android ELS location data as part of the most accurate location calculation from the WSP

        iv. Configure their networks to deliver 9-1-1 calls from Android ELS enabled handsets that do not have a data plan in order to deliver the location data to the applicable Aggregation point(s)

7.2 iOS HELO (Apple) Recommendations

2. That WSPs undertake the following action steps to provision handset-based location technology in Canada for iOS HELO (Apple) on or before 1 October 2021:

    a. Each facilities-based WSP will enter into an agreement with Apple to formally enable the Canadian iOS HELO configuration as follows:

        i. Apple configures the handset to calculate handset-based location

        ii. Apple calculates the most accurate location and makes it available in response to the WSP NILR (network-initiated location request) query

    b. Once the Item 1 matters for further consideration action steps are completed, activate the Canadian iOS HELO software load by 1 March 2022 to complete the WSP implementation

    c. Once the Canadian iOS HELO software load is complete and in-service, WSPs will enable the following functionality for all wireless 9-1-1 calls from compatible Apple handsets:

        i. Undertake a validation process to ensure the iOS HELO result is within the Phase I serving area or the calculated control plane location

        ii. Send the handset-based location result to the PSAP using the existing Phase II configuration

        iii. Maintain the current In-Call Location Update (ICLU) process i.e. no Phase II configuration changes are required; however, it will include iOS HELO location data as part of the most accurate location calculation from the WSP

        iv. Configure their networks to deliver 9-1-1 calls from iOS HELO enabled handsets that do not have a data plan

8. Matters for Further Consideration

In addition to the recommendations in Section 7, ESWG recommends that the Commission request that CISC undertake the following additional work starting on or before 1 October 2021:

1. In order to implement this handset-based location technology in Canada, the following steps are required in parallel to this report and approval process:
    a. ESWG will work with WSPs to confirm how HTTPS will be allowed from handsets without a data plan
    b. ESWG will work with WSPs to determine if Data SMS is required in addition to HTTPS for the delivery of Android ELS (Google) location results
    c. ESWG will work with WSPs to determine if the Android ELS (Google) configuration, validation process, and the best location result calculation (i.e. algorithm) perform as expected; subject to the agreed upon test plan
    d. ESWG will work with WSPs to determine if the iOS HELO (Apple) configuration, validation process, and the location result calculated at the handset perform as expected; subject to the agreed upon test plan
    [NOTE: Apple has advised that the comparison with Phase 1 must be thoroughly tested to ensure that inaccurate cell configuration data does not cause a good HELO result to be discarded during the validation process.]
    e. Work with Google (Android) to confirm a single aggregation implementation for Canada that simultaneously sends the ELS location data to the designated NG9-1-1 network providers (Bell and TELUS confirmed, SaskTel decision is pending)
    f. Confirm the process and interconnection required to push the ELS location results delivered from Google to the applicable WSP
    g. Determine if additional processing is required to handle MOCN (Multi-Operator Core Network) arrangements between two WSPs
    h. Confirm how licencing with Google, encryption/decryption, and the privacy of ELS location data will be addressed with this arrangement
    i. Determine the implications of this arrangement (i.e. enhancements required to existing platforms) for TSPs, as well as the pending NG9-1-1 tariffs

    Prior to 1 March 2022, the ESWG will file a follow-up report to confirm the proposed implementation date and changes, if any, to the configuration recommendations

2. In order to implement the new wireless location query tool proposed for B9-1-1 PSAPs in Canada, the following steps are required in parallel to this report and approval process:
    a. Work with Apple to facilitate the delivery of HELO location data to NG9-1-1 network provider Aggregation points (Bell and TELUS confirmed, SaskTel decision is pending).
    b. Confirm the interconnection requirements between a B9-1-1 PSAP and the serving NG9-1-1 network provider
    c. Develop the query tool to be used as detailed in Section 5.3
    d. Conduct a proof of concept trial starting on or before 1 October 2021, through to 15 December 2021, to confirm this proposed solution can implemented.

    ESWG will include this information in the follow-up report required for Item #1 (above).

3. In addition to the proof of concept and implementation steps detailed above for handset-based location and the B9-1-1 wireless location query tool. ESWG will continue to monitor and report, as applicable, on the following list of questions:

a. When will we be able to implement the z-axis (vertical) coordinate in Canada? Google and Apple are actively working on the vertical coordinate, and testing is already possible with Google. ESWG will propose future trial work (1-2 years) to help determine the parameters required to use z-axis in Canada. As well, PSAPs will need to work with their vendors to determine what CAD and mapping changes (if any) are required to support delivery and display of z-axis data. ESWG will continue to monitor developments around the world and file a future report when the technology is ready for deployment in Canada.

b. Can we support parameters beyond a circle radius of uncertainty? The current WSP location technology already supports native shapes (e.g. circle, arc band, elliptical, polygon, etc.), which are converted to a circle for uniform display at PSAPs today. We need to determine when PSAPs will have the ability to display i.e. map different shapes (3-5 years).

c. Does the WSP configuration change when we move from E9-1-1 to NG9-1-1? Currently no changes are expected when we move to NG9-1-1, however future changes (3-5 years) will be required when we move to geo-routing of 9-1-1 calls using the location from the device processing the call. This item will be flagged for follow-up as part of the new ESWG geo-routing task which is scheduled to be started in early 2021.

APPENDIX A: Handset-based Location Information Sources

A. ESCO0576a Bell (March/April 2018): AML and Location Accuracy Considerations

B. Google Location Services (June 2018): Android Emergency Location Service (ELS) presentation

C. Intrado (July 2018): Results of AML testing in the United States

D. Carbyne (July 2018): Wireless Location Accuracy Tools

E. Apple Location Services (August 2018): Enhanced Emergency Data white paper

F. LaaSer (October 2018): Device Data, Location, and Routing Overview

G. NENA et el (March 2019): Recommended Best Practices for Supplemental 9-1-1 Location Data

H. European Emergency Number Association (May 2018): AML Report Card

I. RapidSOS (June 2019): Canadian Aggregator for Android / IOS Location presentations

J. Comtech (July 2019): AML Aggregation with WSPs presentation

K. Intrado (July 2019): Device Based Hybrid Location Options presentation

L. Apple meeting with CRTC Staff and TIF69 Owner (September 2019): see TIF diary serial 92

M. ESCO0587b Chiavaroli (March 2020): Considerations for AML Integration with the Phase II process

APPENDIX B: Acronyms

AML	Advanced Mobile Location
B9-1-1	Basic 9-1-1
CAD	Computer Aided Dispatch
CellID	Cell Identity
CISC	CRTC Interconnection Steering Committee
CRTC	Canadian Radio-television and Telecommunications Commission
E9-1-1	Enhanced 9-1-1
ECID	Enhanced Cell Identity
EED	Enhanced Emergency Data
EENA	European Emergency Number Association
ELS	Emergency Location Service (Google)
ENP	Emergency Number Professional
ESCO	Emergency Services Working Group: Contributions
ESInet	Emergency Services IP Network
ESRE	Emergency Services Working Group: Reports
ESTF	Emergency Services Working Group: Task Identification Form
ESWG	Emergency Services Working Group
ETSI	European Telecommunications Standards Institute
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HELD	HTTP-Enabled Location Delivery
HELO	Hybridized Emergency Location (Apple)
HTTPS	Hypertext Transfer Protocol Secure
ICLU	In-Call Location Update
ILEC	Incumbent Local Exchange Carrier
iOS	Apple Operating System (software)
LIS	Location Information Server
MCC	Mobile Country Code
MNC	Mobile Network Code
MOCN	Multi-Operator Core Network
MS	Mobile Subscriber
NENA	National Emergency Number Association
NG9-1-1	Next Generation 9-1-1
NNI	Network-to-Network Interface
PSAP	Public Safety Answering Point
Smartphone	A smartphone is a cellular telephone with an integrated computer and other features not originally associated with telephones such as an operating system, web browsing, and the ability to run software applications.
SMS	Short Message Service
SRVCC	Single Radio Voice Call Continuity
TIF	Task Identification Form
TSP	Telecommunications Service Provider
Wi-Fi	Wireless Fidelity
WSP	Wireless Service Provider

APPENDIX C: EENA AML Report Card re Transmission Methods

[Excerpt of the Table on Page 62 of the July 2019 AML Report Card]

Transmission of AML

Country	Transmission channel	Are several AML messages sent during the call?	Time Delta defined for the SMS to be sent
Austria	SMS to a long number HTTPS	One via SMS + One via HTTPS	20 seconds
Belgium	SMS to a short number SMS to a long number	Android: Yes (2) iOS: No	Android: at the beginning of the call and another one after 20 sec. Apple: approx. 20 sec.
Estonia	SMS to a short number	No	20 seconds
Finland	SMS to a short number	Android: Yes (2) iOS: No	Android: 5 seconds Apple: 15-20 seconds
Iceland	SMS to a short number	Yes (2)	0 second and 20 seconds
Ireland	SMS to a short number	Android: Yes (4) Apple: No	Not defined
Lithuania	SMS to a short number	No	Android: 30 seconds Apple: Not defined
Moldova	SMS to a short number	Yes	One after 10 seconds; one after 30 seconds; then every 60 seconds
Netherlands (The)	SMS to a short number	Yes	First location, 20 seconds and then every 60 seconds
New Zealand	SMS to a short number	No (planned for Q2 2019)	25 seconds
Norway	SMS to a short number	Yes (2)	One after 10 seconds; another one after 30 seconds
Slovenia	SMS to a short number	Yes (2)	One after 0 second; another one after 25 seconds
United Arab Emirates	SMS to a short number	Yes (2)	5-12 seconds
United Kingdom	SMS to a short number SMS to a long number (for roamers)	No	15-20 seconds
United States	Info to be included soon	Info to be included soon	Info to be included soon

1183 # APPENDIX D: EENA AML Report Card re Operational Use

1184 *[Excerpt of the Table on Page 64 of the July 2019 AML Report Card]*

Operational use of AML

Country	Average % calls where a position was received	% AML messages within 30 sec.	% AML messages within 15 sec.	% AML messages with accuracy below 100m.	% AML messages with accuracy below 50m.	Share of locations per positioning method
Austria	65%	100%	0%	Not available	Not available	Not available
Belgium	Not available	Not available	Not available	Not available	Not available	Not available
Estonia	Not available	Not available	Not available	Not available	Not available	Not available
Finland	50%	Not available (95% within 60 seconds)	Not available	88%	78%	Not available
Iceland	Not available	Not available	Not available	Not available	Not available	Not available
Ireland	50%	100%	95%	97%	85%	GNSS : 51% Wifi : 45% Cell : 4%
Lithuania	45/50%	55%	12%	75%	Not available (43% below 20m.)	GNSS : 32% Wifi : 44% Cell : 19%
Moldova	20%	27%	24%	86%	80%	GNSS : 25% Wifi : 53% Cell : 14%
Netherlands (The)	Approx. 40-45%	Not available	Not available	Approx. 91%	Approx. 86%	Approx. GNSS : 35% Wifi : 58% Cell : 6%
New Zealand	75% (of all genuine emergency calls)	96.85%	14.55%	84.15%	71.12%	GNSS: 54.18% Wifi: 53% Cell: 14%
Norway	50%	Not available	Not available	Not available	Not available	Not available
Slovenia	21.54%	51.68%	32.93%	Not available	Not available	Not available
United Arab Emirates	Not available	Not available	Not available	Not available	Not available	Not available
United Kingdom	60%	97% within 20 seconds	Not available	97% (omitting the results with no location)	74%	GNSS : 50% Wifi : 39% Cell : 4% No loc : 7%
United States	Info to be included soon	Info to be included soon	Info to be included soon	Info to be included soon	Info to be included soon	Info to be included soon

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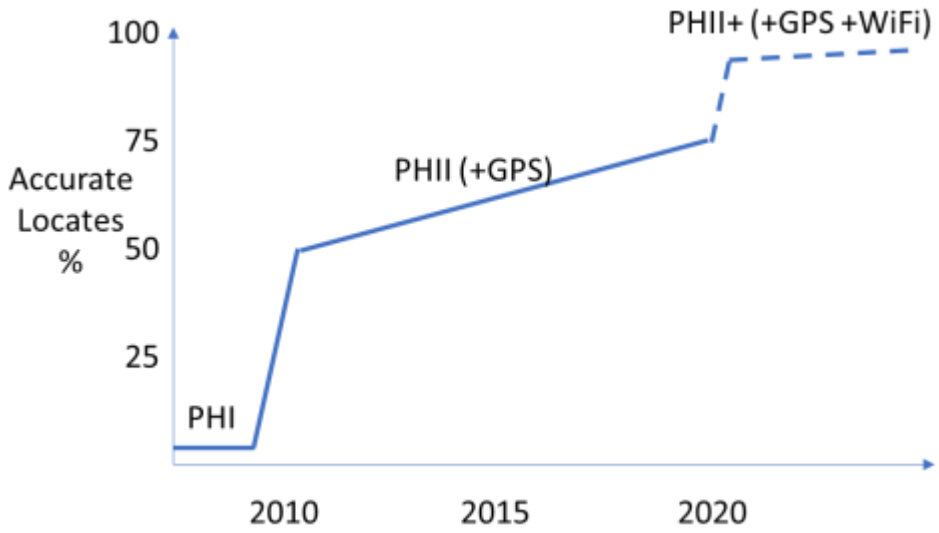
APPENDIX E: The Benefits of Location Technology Improvements

With the addition of Wi-Fi location information, the shortcomings of Phase II location in terms of accuracy are often helped, especially with indoor situations. Phase II location is based on GPS and other network elements which normally work best outside. Wi-Fi location information is based on nearby Wi-Fi routers, the majority of which are available indoors. Over the past 10 years Phase II location enhancements have increased the availability of accurate locates from about 50% to about 75%. The addition of Wi-Fi location has the potential to increase the availability of more accurate locates to over 90%. The figure below illustrates the improvement over time for Canada and is based on the CRTC mandated annual national reporting requirements for wireless location accuracy for the majority of 9-1-1 calls for the period 2010 to 2020.



Graph of Location Accuracy Improvements in Canada Since 2010

These historical location improvements have been helped with the significant growth of Smartphones with GPS and other location sensors.

The availability of Wi-Fi location from Apple (iOS) and Google (Android) handsets has grown exponentially in recent years and is expected to not only improve X,Y (lat/long) location accuracy, work is ongoing to provide vertical (Z axis) accuracy to assist with calls from dense urban calling areas.

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