
FRAMEWORK FOR EMERGENCY CALLING IN CANADA

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ISSUES ADDRESSED: This document outlines a functional architecture for IP location determination suitable for implementation in Canada.

AUTHOR: John Lange
john@johnlange.ca
136 Westwood drive
Winnipeg, MB R3K 1G6

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Background

In "Telecom Decision CRTC 2007-125", the Canadian Radio and Telecommunications Commission (CRTC) tentatively approved a "*proposed functional architecture for the implementation of voice over Internet Protocol (VoIP) enhanced 9-1-1 (E9-1-1) service in Canada*" commonly known as "Canadian i2".

On April 15 2009, the CRTC issued "Telecom Notice of Consultation CRTC 2009-194". Paragraph 17 section IV asks; "Are there alternative solutions that would improve on the current nomadic VoIP 9-1-1 service."

Definition of Service Providers

Access Service Provider (**ASP**): Supplies Internet service to an endpoint. Examples of access service provider networks include digital subscriber lines (DSL), and cable modems.

Public Safety Answering Point (**PSAP**): A 911 call centre.

Incumbent Local Exchange Carrier (**ILEC**): The telephone company which provides the PSAP with connectivity to the telephone network.

Emergency Service Provider (**ESP**): In the context of this document, ESP includes the PSAP and their respective ILECs.

VOIP Service Provider (**VSP**): Supplies voice service to subscribers that resembles traditional telephone land-line service but is delivered over a packet network.

Introduction

Telecom Decision CRTC 2006-60, paragraph 17 states; *"The Commission considers that this architecture should be consistent with the NENA i2 standard, modified as necessary for implementation in Canada."*

The proposed "Canadiani2" does not meet this criteria. Fundamentally, NENAi2 is implemented on the Internet while Canadiani2 is implemented on a ILEC controlled private network.

This distinction can not be overstated.

The private nature of this network means it can not be evolved into a "next generation" system. Next generation VOIP E911 systems require that VOIP endpoints discover their own location and relay that information via the SIP protocol. The private and proprietary nature of the proposed Canadiani2 solution excludes VOIP endpoints from discovering and/or relaying location and this has dramatic impact on the infrastructure both in terms of cost and future functionality.

It is easy to confuse NENAi2 with Canadiani2 because some of the ideas and terminology are borrowed from NENAi2, but they otherwise have almost nothing in common.

For an in-depth technical analysis of the differences between NENAi2 and Canadiani2, please reference "ESCO0277A.doc - 185 KB - CAVP Canadian i2 non-consensus document", available on the CRTC web site in the CISC ESWG section.

Alternative Solutions

The Internet Engineering Task Force (IETF) sets standards for the Internet's core protocols. Since 2003, members of the IETF's Emergency Context Resolution with Internet Technologies (ECRIT) working group and the Geographic Location/Privacy (geopriv) working group have been developing the Internet technologies required to describe location and to manage emergency call routing based on location information.

Many senior members of these groups are the same people who developed NENAi2 and the work of ECRIT builds upon much of the work done there.

This document incorporates various IETF standards required to implement a framework for emergency calling using Internet technologies in Canada.

"Requesting help in an emergency using a communications device such as a telephone or mobile phone is an accepted practice in many parts of the world. As communications devices increasingly utilize the Internet to interconnect and communicate, users will expect to use such devices to request help."

"The emergency response community will have to upgrade their facilities to support a wider range of communications services, but cannot be expected to handle wide variations in device and service capability."

"Supporting emergency calling requires cooperation by a number of elements, their vendors and service providers. This document discusses how end device and applications create emergency calls, how access networks supply location for some of these devices, how service providers assist the establishment and routing, and how PSAPs receive calls from the Internet."¹

Benefits of a "Framework for Emergency Calling In Canada"

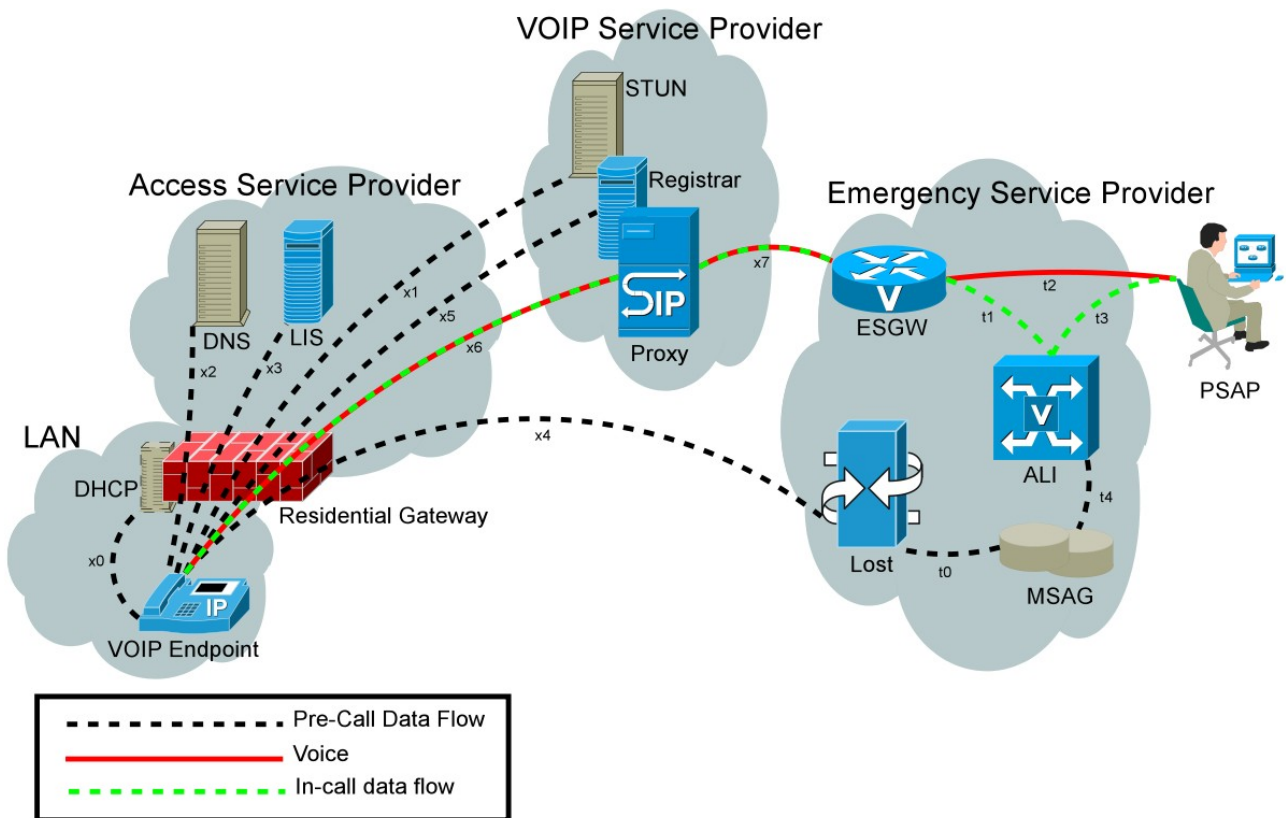
- PSAPs can continue to use legacy equipment.
- Pre-call (non-realtime) location determination minimizes the need for private networks and/or expensive "five-nines"² infrastructure.
- On Behalf Of (OBO) functionality allows integration of legacy VOIP endpoints.
- "Query-and-cache" of location information allows for the discovery of "holes" in the location database or non-compliant ASPs.
- Supports both civic and geospatial locations for compatibility with mobile devices.
- Support for manual configuration of end point locations where all other

1 Excerpted from IETF document "Framework for Emergency Calling using Internet Multimedia. RFC draft-ietf-ecrit-framework-10"

2 Five-nines defines system uptime as 99.999% available. Systems designed to this standard have redundant components and are therefore more expensive.

- location methods are not applicable.
- Shared burden of implementation between all service providers (ASP, VSP, ESP).
- Leverages the existing infrastructure of all providers.
- Based on open (IETF) standards ensuring maximum compatibility with next generation emergency systems.
- A Standards based solution allows the for the availability of products and services from a variety of vendors reducing cost for all service providers.

Diagram of Functional Elements and Call Flow



Call Flow

Off-line Data flow

- 1) **t0:** **LOST** database validates its location database against **MSAG** creating a map of locations to **ESGW** URIs. This mapping is refreshed on a periodic basis at an interval determined by the ESP.
- 2) **t4:** **MSAG** updated by ESP to reflect new PSAP zones.

Pre-call Data flow (*applies only to location aware VOIP endpoints*)

- 1) VOIP endpoint is connected to the network and requests it's IP address and **option 99** GEOCONF from it's local area network **DHCP** server (**x0**). If

location is provided by the DHCP server, the device MUST accept this as authoritative and not perform further steps in location discovery.

- 2) If location is not obtained, the VOIP endpoint discovers its public IP address by querying a **STUN** server (**x1**).
- 3) The VOIP endpoint performs the **ESGW** discovery steps (see "*ESGW Discovery*").

Note: The Pre-call data flow steps apply to location aware VOIP endpoints only and are completely optional. See "OBO Pre-call Data flow" below for non-location aware VOIP endpoints.

ESGW Discovery

- 1) Perform a reverse DNS lookup to discover the address of the authoritative LIS (**x2**).
- 2) Query the LIS for location and the URL of the authoritative LOST server (**x3**).
- 3) Query the LOST server for the URL of the ESGW (**x4**).

VISP Registration

- 1) Device registers with the VSP Registrar and indicates location (**x5**).

OBO Pre-call Data flow (*non-location aware VOIP endpoints*)

- 1) VOIP endpoint is connected to the network and obtains its IP address via DHCP.
- 2) Device registers with the VSP Registrar (**x5**).
- 3) VSP recognizes that the device is not location aware and performs the same ESGW discovery steps on behalf of (OBO) the VOIP endpoint (see "*ESGW Discovery*").
- 4) VSP caches the ESGW SOS:URI and location on behalf of the device.

In-Call Voice and Data Flow

- 1) VOIP endpoint places an emergency call. If it is location aware it dials the SOS:URI routed through the VSP Proxy. If the device is not location aware, it dials as a normal SIP call (**x6**).
- 2) VSP Proxy recognizes the emergency call and routes the call to the ESGW based on the provided SOS:URI for location aware devices or based on the cached SOS:URI for non-location aware devices. It also relays location to the ESGW using sip-location-conveyance³ (**x7**).
- 3) ESGW populates ALI with location information (**t1**) and hands off the voice portion of the call to the PSAP (**t2**).
- 4) PSAP receives location from ALI using existing methods (**t3**).

³ draft-ietf-sip-location-conveyance-13

Functional Elements

This document does not elaborate on protocols or functional elements which are already well documented elsewhere.

VoIP Endpoint: As defined in CRTC 2004-2 “[a device with] functional characteristics that are the same as circuit-switched voice telecommunications services.”

DHCP Server: RFC 4776 (Dynamic Host Configuration Protocol Option for Civic Addresses Configuration Information) compliant DHCP server.

DNS Server: An RFC compliant Domain Name Server configured with reverse DNS entries to allow LIS discovery.

LIS (Location Information Server): Each ASP MUST have an authoritative LIS assigned to it. Note that this does not preclude multiple ASPs from sharing or jointly operating a LIS.

The functional characteristics of the LIS are:

- The LIS maps every ASP IP address to a PIDF-LO compatible location object and the URI of the corresponding LOST server.⁴
- The LIS is populated by the ASP's internal systems.
- The LIS uses the HELD (*HTTP Enabled Location Delivery*) protocol⁵.

LoST (Location-to-Service): Each Emergency Services Provider must have an authoritative LOST server assigned to it. Note that this does not preclude ESPs from sharing or jointly operating a LOST server.

The functional characteristics of the LoST server are:

- The LOST server maps a PIDF-LO (location object) to the ESGW URI of the PSAP responsible for serving the location of the VOIP endpoint.
- The LOST server periodically validates its location map against the MSAG.
- The LOST server uses the LOST protocol (RFC 5222).

STUN: RFC 5389. Session Traversal Utilities for NAT (STUN). A STUN server is used by an endpoint to determine its public IP address.

SIP Registrar/Proxy: The elements of a VOIP Provider's network which provide call control and routing.

⁴ Because both ASPs and ILECs are geographically based it makes sense that the LIS-to-LOST mappings also be tightly coupled. For example, MTS would operate one LOST server in Manitoba and all ASPs operating in Manitoba would provide that as the answer to LOST discovery.

⁵ draft-ietf-geopriv-http-location-delivery-15.txt

ESGW: Emergency Services Gateway. A VOIP enabled front end responsible for interfacing VOIP calls and location objects with legacy PSAP systems.

ALI: Automatic Location Information. The existing PSAP location system.

MSAG: Municipal (or Master) Street Address Guide. The MSAG maps geographical boundaries to PSAP zones. This determines to which PSAP a caller should be routed.

Interfaces

x0: DHCP (with option 99 – GEOCONF when available)

x1: STUN for IP address discovery

x2: Reverse DNS for LIS discovery

x3: LIS query for location and LOST discovery

x4: LOST query for ESGW discovery

x5: SIP Registration (optionally with location conveyance)

x6: SIP emergency call to VSP Proxy (optionally with location conveyance)

x7: SIP emergency call to ESGW (with location conveyance)

t0: LOST is validated to the MSAG (*draft-ietf-ecrit-lost-sync*)

t1: Location populated to ALI

t2: Voice Routed to PSAP via existing infrastructure

t3: Location push/pull to PSAP call taker

t4: MSAG updated by PSAP (Existing system)

Specific Benefits of “Query-and-Cache On Behalf Of” (OBO) Functionality

The “Framework for Emergency Calling In Canada” allows for “on behalf of” (OBO) functionality provided by the VSP. OBO is not a new idea, however the suggestion that the OBO should be done at registration time rather than only during an emergency call provides significant benefits.

Providing location information on behalf of devices which are not capable of determining their own location is understood to be a requirement of any nomadic VOIP emergency solution. However, in most descriptions of this functionality it is assumed that this OBO location determination will be done at the time the emergency call is placed. Little thought has been given to the ramifications of this methodology and there has been no proposals for other location query models.

When a VOIP endpoint registers with its VSP, it should indicate that it is location aware. If it does not indicate that it is location aware, the SIP Registrar should undertake to determine the location on behalf of the VOIP endpoint and cache the result.

This pre-call location query-cache mechanism has major benefits; VSPs will be able to quickly identify subscribers for which there is no location information available. This will be especially critical in the early stages of the framework's implementation as it allows for the discovery of "holes" in the IP-to-location mappings as well as identification of ASPs who are not compatible with location discovery.

Without a pre-call query cache mechanism, entire blocks of IP address ranges or indeed entire ASP networks may not have functioning location identification and there would be no method of discovering this until an emergency call is placed.

In situations where the lack of location from the ASP is for legitimate reasons (outside of Canada, etc.) the VSP could manually provision the location information or take other corrective actions as required.

Privacy

Privacy and security are implemented by utilizing query keys instead of actual location information. The VSP will cache only a query key and ESGW URL. It passes the key to the ESGW which translates it into location for populating the ALI. Only the ESGW will be authorized to translate keys into actual location information.

Data and voice encryption as well as the ESGW-to-LOST location query key methodology does not add functionality (it only describes privacy and security) and it is therefore, for the sake of clarity, they are not shown on the diagram or described in the call flow. In all cases it should be assumed that appropriate security and privacy considerations are to be observed.

Impact on PSAPs

In general terms, this proposed framework is does not alter the PSAP requirements proposed in Canadiani2 so the impact on PSAPs is expected to be unchanged.

In brief, it is understood that the ESGW will accept location information from the VSP and inject it into the ALI system where it will be delivered to the PSAP using existing methods.

The ESPs are expected to implement the necessary modifications to the PSAP facing equipment and details of this implementation have not been revealed by the ILECs. It is therefore not possible to comment on any specific changes.

Cost of Implementation

The detailed information required to do a proper cost analysis is considered to be a trade secret and therefore not available to the author.

It is never the less safe to say that the cost of implementing this solution will be lower given that:

- It does not require the construction of a private network between all the providers.
- The significant new functional elements (LIS & LOST) can be shared between several providers.
- It leverages existing well established infrastructure (Internet) and protocols (DHCP, SIP, STUN, DNS) wherever possible.
- New protocols (e.g. Sip-location-conveyance and others) are based on open standards developed by the IETF in the ECRIT and GEOPRIV working groups thereby allowing a variety of vendors to supply products.
- The aspects of the implementation to be done by the ESPs to interface the PSAPs with the ESGW remains unchanged from the proposed Canadiani2.

Billing Model

Regardless of which solution is implemented, any cost that is to be recovered from consumers must be done on a per-subscriber basis applied evenly to all users of the system wireline, wireless, and VOIP.

- The number of users remains relatively static, it is only the method of accessing emergency services that changes as users migrate between wireline, wireless, and VOIP.
- Access to emergency services should not be used as a competitive advantage. A uniform per-user charge across all technologies ensures a level competitive playing field not only between competing technologies, but also between large and small providers.

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