



ATIS-0500028

**Analysis of Unwanted User Service Interactions with NG9-1-1
Capabilities**

TECHNICAL REPORT



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ATIS-0500028, *Analysis of Unwanted User Service Interactions with NG9-1-1 Capabilities*

Is an ATIS Standard developed by the **Next Generation Emergency Services (NGES)** Subcommittee under the **ATIS Emergency Services Interconnection Forum (ESIF)**.

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Analysis of Unwanted User Service Interactions with NG9-1-1 Capabilities

Alliance for Telecommunications Industry Solutions

Approved February 2015

Abstract

Through work on NG9-1-1 standards certain scenarios for unwanted service interactions have been identified. This Technical Report illustrates use cases that convey the need for a broader analysis of standardized user service definitions for possible interactions with NG9-1-1 capabilities and identification of which interactions could lead to unwanted behavior.

Foreword

The Alliance for Telecommunication Industry Solutions (ATIS) serves the public through improved understanding between carriers, customers, and manufacturers. The Emergency Services Interconnection Forum (ESIF) provides a forum to facilitate the identification and resolution of technical and/or operational issues related to the interconnection of wireline, wireless, cable, satellites, Internet and emergency services networks.

The mandatory requirements are designated by the word *SHALL* and recommendations by the word *SHOULD*. Where both a mandatory requirement and a recommendation are specified for the same criterion, the recommendation represents a goal currently identifiable as having distinct compatibility or performance advantages. The word *MAY* denotes a optional capability that could augment the standard. The standard is fully functional without the incorporation of this optional capability.

Suggestions for improvement of this document are welcome. They should be sent to the Alliance for Telecommunications Industry Solutions, ESIF, 1200 G Street NW, Suite 500, Washington, DC 20005.

At the time of consensus on this document, ESIF, which was responsible for its development, had the following leadership:

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The **Next Generation Emergency Services (NGES)** Subcommittee was responsible for the development of this Technical Report.

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Analysis of Unwanted User Service Interactions NG9-1-1 Capabilities

1 Scope, Purpose, & Application

1.1 Scope

Through work on NG9-1-1 standards, certain scenarios for unwanted service interactions have been identified. This Technical Report describes those scenarios by providing use cases that illustrate unwanted interactions. Future versions may identify alternative solutions to address these unwanted interactions.

1.2 Purpose

This Technical Report conveys the need for a broader analysis of standardized user service definitions for possible interactions with NG9-1-1 capabilities and identification of which interactions could lead to unwanted behavior. This analysis should be referred to the appropriate ATIS committees and potentially NENA to develop solutions to eliminate or reduce the likelihood of unwanted service interactions.

1.3 Application

Once solutions are identified, they will mitigate the impact of the unwanted service interactions, which include: misdirected emergency service response, preventable injury and loss of life, confusion and mistrust on use of NG9-1-1 by the public, and exposure to DOS/DDOS attacks on NG9-1-1 infrastructure.

2 Informative References

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and the parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

[Ref 100]: NENA 08-003, *Detailed Functional and Interface Standards for the NENA i3 Solution*, Version 1, June 14, 2011.¹

[Ref 101]: NIST SP 800-124 Rev. 1, *Guidelines for Managing the Security of Mobile Devices in the Enterprise*.²

[Ref 102]: ATIS-0700015, *Implementation of 3GPP Common IMS Emergency Procedures for IMS Origination and ESInet/Legacy Selective Router Termination*, 2013³

[Ref 103]: 3GPP TS 22.101 *Service aspects; Service principles*⁴

[Ref 104]: 3GPP TS 22.173 *IP Multimedia Core Network Subsystem (IMS) Multimedia Telephony Service and supplementary services; Stage 1*

[Ref 105]: 3GPP TS 24.229 *IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3*

¹ This document is available from the National Emergency Number Association (NENA). < <http://www.nena.org/> >

² This document is available from the National Institute of Standards and Technology (NIST). < <http://www.nist.gov/> >.

³ This document is available from the Alliance for Telecommunications Industry Solutions (ATIS), 1200 G Street N.W., Suite 500, Washington, DC 20005. < <https://www.atis.org/docstore/product.aspx?id=26080> >

⁴ This document is available from the Third Generation Partnership Project (3GPP) at < <http://www.3gpp.org/specs/specs.htm> >.

3 Definitions, Acronyms, & Abbreviations

3.1 Definitions

3.1.1 NG911⁵: An IP-based system comprised of managed IP-based networks (ESInets), functional elements (applications), and databases that replicate traditional E9-1-1 features and functions and provide additional capabilities. NG9-1-1 is designed to provide access to emergency services from all connected communications sources, and provide multimedia data capabilities for PSAPs and other emergency service organizations. [NENA Master Glossary of 9-1-1 Terminology NENA-00-001, Version 15, March 29, 2011]

3.1.2 NG911 Network: See definition for NG911.

3.1.3 NG911 Services Architecture (NG911SA): A services architecture which provides transit, routing, and other services required for citizen-to-authority Multimedia Emergency Services (MES) between the originating network and intended termination point. NENA's i3 is just one example/instance of an NG911SA which can be deployed in an NG911 network.

3.1.4 NG911 System Service Provider (NG911SSP): A service provider who deploys or manages data transport and services networks providing transit and routing of citizen-to-authority emergency service requests and communication.

3.1.5 Emergency Services IP network (ESInet): A managed IP network that is used for emergency services communications, and which can be shared by all public safety agencies. It provides the IP transport infrastructure upon which independent application platforms and core functional processes can be deployed, including, but not restricted to, those necessary for providing NG911 services. ESInets may be constructed from a mix of dedicated and shared facilities. ESInets may be interconnected at local, regional, state, federal, national and international levels to form an IP-based inter-network (network of networks).

3.2 Acronyms

Term	Description
3GPP	3rd Generation Partnership Project
3GPP2	3rd Generation Partnership Project 2
ATIS	Alliance for Telecommunications Industry Solutions
CSCF	Call Session Control Function
ECRF	Emergency Call Routing Function
E-CSCF	Emergency Call Session Control Function
ESIF	Emergency Services Interconnection Forum
ESInet	Emergency Services IP network
ESRP	Emergency Services Routing Proxy
FMC	Fixed Mobile Convergence
GRUU	Globally Routable UA URI
IM	Instant Messaging

⁵ The term "NG911" used throughout this document is synonymous with the term "NG9-1-1".

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IMS	IP Multimedia Subsystem
IP	Internet Protocol
JSON	JavaScript Object Notation
LIS	Location Information Server (3GPP uses the term Location Server)
LRF	Location Retrieval Function
MMES	Multimedia Emergency Services
NG9-1-1	Next Generation 9-1-1
NGN	Next Generation Network
PCS	Personal Communication Services
P-CSCF	Proxy Call Session Control Function
PNW	Personal Network Whitelist
PRF	Policy Routing Function
PSAP	Public Safety Answering Point
PST	Public Safety Telecommunicator
PSTN	Public Switching Telephone Network
PTSC	Packet Technologies and Systems Committee
RAT	Radio Access Technology
RCS	Real-time Communications Services
RDF	Routing Determination Function
SBC	Session Border Controller
SIP	Session Initiation Protocol
UA	User Agent
UE	User Equipment
URI	Uniform Resource Identifier
webRTC	Web Real-time Communications
WTSC	Wireless Technologies and Systems Committee

4 Introduction

As NG9-1-1 is introduced there is a need for analysis of interactions among services that may result in unwanted behavior. This Technical Report provides use cases that illustrate the potential for such behavior. This Technical Report does not make recommendations to mitigate such behavior but may be used as a resource for future standards work to do so.

5 Use Cases

These use cases identify interactions between users and Public Safety that may arise during the introduction of NG9-1-1. The implications of these unwanted interactions may result in unsatisfactory handling of the emergency incident. The initial view of this group is that chat rooms are not to be supported by citizen to authority emergency communications, and further conclusions need to be developed.

5.1 *PSAP Contacted by IM Client in an Existing Chat Session*

Short Descriptions

Martha initiates a group IM (chat) session with The Doctor. The Doctor is not in the same PSAP service area as Martha. User goes into medical distress during the IM session. The Doctor decides that 911 needs to be contacted and included in the text chat to initiate emergency support for Martha

Actors

- Martha – The patient needing emergency assistance.
- The Doctor – Medical professional included in the group IM chat.
- PSAP A Call Taker – Initial Call Taker that received the text IM request for assistance.

Pre-Conditions

The Doctor is in discussion with Martha about Martha's medical condition. The Doctor is remotely located from Martha.

Post-Conditions

Martha, The Doctor, and PSAP A Call Taker, are engaged in a text IM discussion regarding Martha's medical emergency. Martha's location has not been adequately determined to route to the PSAP serving Martha's location and PSAP A Call Taker is unable to automatically pinpoint Martha's location to assist the medical first responders dispatched to provide medical treatment to Martha.

Normal Flow

1. Martha experiences a medical emergency while participating in an IM chat session with The Doctor.
2. The Doctor recognizes that 9-1-1 assistance is needed.
3. The Doctor's IM client invites "9-1-1" to the IM session.
4. The Doctor's IM client sends the IM chat invitation to the NG9-1-1 network and normal processing identifies The Doctor's location and selects and routes to the PSAP that serves The Doctor's location (which is not the PSAP serving Martha's area).
5. PSAP A Call Taker joins the IM session, but won't be able to provide the required service since the location used for call routing and dispatch is The Doctor's location, not Martha's location. PSAP A Call Taker would need to employ alternative means to locate Martha, such as verbal conveyance through the IM chat conversation.

Alternative Flow

None

5.2 *PSAP Contacted by IM Server in an Existing Chat Session*

Short Description

A user initiates a group IM (chat) session with their doctor. The Doctor is not in the same PSAP service area as Bill. Bill goes into medical distress during the IM session. The Doctor decides that 911 needs to be contacted and included in the text chat to initiate emergency support for Bill.

Actors

- Bill – The patient needing emergency assistance.
- The Doctor – Medical professional included in the group IM chat.
- PSAP A Call Taker – Initial call taker that received the text IM request for assistance.

Pre-Conditions

The Doctor is in discussion with Bill about Bill's medical condition. The Doctor is remotely located from Bill.

Post-Conditions

Bill, The Doctor, and PSAP A Call Taker, are engaged in a text IM discussion regarding Bill's medical emergency. Bill's location has not been adequately determined to route to the PSAP serving Bill's location and the PSAP A Call Taker is unable to automatically pinpoint the Bill's location to assist the medical first responders dispatched to provide medical treatment to Bill.

Normal Flow

1. Bill experiences a medical emergency while on the IM with The Doctor.
2. The Doctor recognizes that 9-1-1 assistance is needed.
3. The Doctor's IM client requests that the IM server invites "9-1-1" to the IM session.
4. The IM server sends an invitation to join the IM session to the NG9-1-1 network without any location information.
5. The NG9-1-1 network selects and routes to a default PSAP (PSAP A - used when location information is in error or unavailable).
6. PSAP A Call Taker joins the IM session, but won't be able to provide the required service immediately since Bill's location is not available to direct the emergency dispatch. PSAP A Call Taker would need to employ alternative means to locate Bill, such as verbal conveyance through the IM chat conversation.

Alternative Flow

One alternative flow which results in the same post-conditions is if for step 3 in the normal flow, Bill's IM client requests that the IM server invites "911" to the IM session.

5.3 Multi-party IM Session Contacting Multiple PSAPs

Short Description

John adds Dr. Pierce to an existing IM chat session. None of the IM participants are in close proximity and all served by different PSAPs in different states. John goes into medical distress during the call. Subsequently, Dr. Pierce decides that 9-1-1 needs to be contacted and added to the IM chat session to initiate emergency support for the user. Mary, another IM chat participant who is a family member, independently invites "9-1-1" to the chat session.

Actors

- John – The patient needing the emergency assistance.
- Dr. Pierce – Medical professional included in the group IM chat.
- Mary – Family member participating in the IM chat.
- PSAP A – Is the PSAP serving the Dr. Pierce's area.
- PSAP B – Is the PSAP serving Mary's area.

Pre-Conditions

Dr. Pierce and Mary are in discussion with John in an IM session.

Post-Conditions

John, Dr. Pierce, Mary, a call taker in PSAP A, and a call taker in PSAP B, are engaged in an IM session regarding John's medical emergency. John's location has not been adequately determined to route to the PSAP serving John's location and the PSAP A and PSAP B call takers are both unable to automatically pinpoint John's location to assist the medical first responders dispatched to provide medical treatment to John. Additionally, multiple PSAPs have been included in the conversation, none of which are able to provide emergency service.

Normal Flow

1. John experiences a medical emergency while on the IM session with Dr. Pierce and Mary.
2. Both Dr. Pierce and Mary recognize independently that 9-1-1 assistance is needed.
3. Nearly simultaneously, Dr. Pierce's and Mary's IM clients send IM invitations to the NG9-1-1 network.
4. The NG9-1-1 network identifies Dr. Pierce's request for emergency service to be routed to PSAP A.
5. The NG9-1-1 network identifies the Mary's request for emergency service to be routed to PSAP B.
6. A call taker in PSAP A joins the IM session, unaware that PSAP B is also invited.
7. The call taker in PSAP A receives the location of Dr. Pierce.
8. A call taker in PSAP B joins the IM session, unaware that PSAP A has been invited.
9. The call taker in PSAP B receives the location of Mary.
10. Neither PSAP call taker is able to provide the immediate required service to John since the location used for call routing and dispatch is Dr. Pierce's or Mary's location, not John's location. PSAP A Call Taker will need to employ alternative means to locate John, such as verbal conveyance through the IM chat conversation.

Alternative Flow

None

5.4 Sending Photos or Video Clips with Unknown Provenance to a PSAP

Short Descriptions

Photos and video clips can be sent to a PSAP as part of multi-media support. However since the image meta-data is not sent and no attestation is made, the photo can be from any source and can be modified.

Actors

- Shepperton Net – a wireless network operator.
- Dave Bowman – a user of Shepperton Net who is present at a jaywalking crime scene.
- Frank Poole – the PSAP call taker who is selected by the PSAP's network elements to receive Dave Bowman's emergency communication.

Pre-Conditions

Shepperton Net supports Rich Communication Services (RCS) 5.1 and has separate CPM, file store, and voice servers operating as Application Servers (AS) in their IMS network.

Dave Bowman is subscribed to voice, the one-to-one instant message and file delivery services of Shepperton Net and has a smartphone with a camera and an embedded RCS 5.1 client. His IM public user identity is HAL9000@shepperton.net.

All network elements in this scenario support NG9-1-1.

Post-Conditions

Frank Poole receives pictures which are not of the emergency situation, but is unable to identify whether there is an actual emergency situation and what the emergency situation is. If emergency services are dispatched to the scene, they may be the wrong service.

Normal Flow

1. Dave Bowman watches a miscreant jaywalk on a major thoroughfare and takes a picture with his smartphone.
2. Dave Bowman inadvertently sends a picture of his favorite cat stuck in a tree to 911 and it is received by Frank Poole who is unsure what the situation is.
3. Dave Bowman calls 911 and is connected to Frank Poole. He describes the crime scene of jaywalking.
4. Frank Poole indicates that the photo he received was of a cat in a tree.
5. Dave Bowman apologizes and sends the jaywalking picture.
6. Frank Poole dispatches the sidewalk enforcement unit rather than the animal rescue unit.

First Alternative Flow

1. Dave Bowman accidentally sends a picture from the latest zombie movie to 911.

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2. Dave Bowman does not call 911 since the jaywalker disappears into a subway station.
3. Frank Poole receives a picture showing zombies attacking a parade.
4. Frank Poole is not familiar with zombie genre, believes it is a real altercation in progress.

Second Alternative Flow

1. Dave Bowman stages a scene where an out of control car is running over picnickers in a park and takes a photo of it.
2. Dave Bowman sends the picture to 911 without voice calling 911.
3. Frank Poole receives a picture showing this staged mayhem.
4. Frank Poole is unable to verify the source of the photo and dispatches emergency service.

Third Alternative Flow

1. Dave Bowman photo edits the picture of the jaywalker he receives removing the actual jaywalker and inserting a familiar picture of the town's mayor.
2. Dave Bowman sends the picture to 911 and voice calls 911.
3. Frank Poole receives a picture allegedly showing the mayor jaywalking.
4. Frank Poole dispatches the sidewalk enforcement unit to the mayor's office.

Fourth Alternative Flow

1. Dave Bowman finds a horrific photo of the aftermath of an armed insurrection in a distant country several years in the past.
2. Dave Bowman sends the picture to 911 without voice calling 911.
3. Frank Poole receives a picture showing bodies strewn about.
4. Frank Poole is unable to verify the source of the photo and dispatches emergency service.

Analysis Considerations

These scenarios are written around photographs or still images but can apply equally well to video clips. Sending incorrect or misleading photos or videos can be either accidental or deliberate.

The common element to all of these flows is that the photo or video meta-data is either 1) not delivered along with the photo or video or 2) the meta-data may be received with the photo or video but is not used by or available to the PSAP call taker or 3) the photo or video meta-data is deliberately modified (with possible intent to mislead) but this modification cannot be determined or verified.

5.5 UE Behavior for Multi-Media NG911 Sessions Not Sufficiently Standardized

Short Descriptions

3GPP TS 22.101 has the following requirement in clause 10.8:

Supplementary services that interrupt or divert the media path between a PSAP and the end device shall be handled as specified in TS 22.173.

3GPP TS 22.173 have these further requirements:

- Clause 8.2.9.1 - *The use of HOLD on an emergency call, or a call identified as a callback to an emergency call, by a user that is not the PSAP, shall be precluded.*
- Clause 8.2.10.1 – *The ability of the served user to receive communications and to originate emergency communications shall be unaffected by OCB.*
- Clause 8.2.13.1 – *The use of CONF on an emergency call, or a call identified as a callback to an emergency call, by a user that is not the PSAP, shall be precluded.*
- Clause 8.2.15.1 – *The use of ECT on an emergency call, or a call identified as a callback to an emergency call, by a user that is not the PSAP, shall be precluded.*

This requirement about preventing any supplementary service which interrupts or diverts the UE to PSAP media path clearly is applicable to “the olden days” but does not sufficiently cover various media combinations available in NG9-1-1.

Actors

- Bubba's AirNet – a wireless network operator.
- Scarlett O'Hara – a user of Bubba's AirNet who wants to report home invasion.
- Rhett Butler – The call taker in the PSAP serving the area of Scarlett O'Hara's home.
- Melanie Hamilton – a user of Bubba's AirNet.

Pre-Conditions

Bubba's AirNet supports Rich Communication Services (RCS) 5.1 and has separate CPM, file store, and voice servers operating as Application Servers (AS) in their IMS network.

Scarlett O'Hara is subscribed to video, voice, the one-to-one instant message and file delivery services of Bubba's AirNet and has a smartphone with a camera and an embedded RCS 5.1 client.

Scarlett O'Hara's UE is capable of terminating multiple independent multi-media sessions and switching between the sessions based on Scarlett O'Hara's actions.

Melanie Hamilton is subscribed to video, voice, the one-to-one instant message and file delivery services of Bubba's AirNet and has a smartphone with a camera and an embedded RCS 5.1 client.

Post-Conditions

Scarlett O'Hara's emergency communication is interrupted by non-emergency communication from Melanie Hamilton within the UE while still meeting the 3GPP requirement specified in TS 22.101 and TS 22.173.

Normal Flow

1. Scarlett O'Hara is at home alone and hears footsteps and strange voices downstairs, decides to make a voice call to emergency services.
2. The call reaches the PSAP and is delivered to Rhett Butler.
3. After a short time, Melanie Hamilton calls Scarlett O'Hara to invite her to a dinner party.
4. The UE receives Melanie Hamilton's call setup request and plays a tone to Scarlett O'Hara indicating this call and interrupting the conversation with Rhett Butler.

First Alternative Flow

1. Scarlett O'Hara is at home alone and hears footsteps and strange voices downstairs, decides to make a video call to emergency services.
2. The call reaches the PSAP and is delivered to Rhett Butler.
3. After a short time, Melanie Hamilton also places a video call to Scarlett O'Hara to find out why she has not shown up for Melanie Hamilton's dinner party. The call setup also includes a recorded video greeting to play to the called party.
4. Scarlett O'Hara's UE supports Picture in Picture (PIP) to play the recorded greeting video only, not the audio component while she is still in an emergency video session with Rhett Butler.
5. Scarlett O'Hara decides not to answer the video call from Melanie Hamilton, rather to direct it to the video mail service.

Second Alternative Flow

1. Scarlett O'Hara is at home alone and hears footsteps and strange voices downstairs, decides to make a voice call to emergency services.
2. The call reaches the PSAP and is delivered to Rhett Butler.
3. After a short time, Melanie Hamilton also sends a one-to-one instant messaging invitation to Scarlett O'Hara for an IM chat.
4. Scarlett O'Hara accepts the IM invitation and tells Melanie Hamilton why she is late to the dinner party while in an emergency voice conversation with Rhett Butler.
5. Scarlett O'Hara invites Rhett Butler to the dinner party.

Impact Considerations

New communication functionality enabled by the SIP and IMS architectures in conjunction with different typical user cognitive abilities to use the various multi-media communication services clearly goes beyond the scope of the current service interaction requirement in 3GPP's TS 22.101.

In re-visiting citizen-to-authority emergency communication service interaction, the following aspects should be considered:

- a) The requirement in 3GPP TS 22.101 and TS 22.173 is defined for supplementary service interactions and only describes voice services; there is no coverage of equivalent capabilities for other forms of communication such as IM.
- b) Some supplementary services can be implemented in the SIP client in the UE rather than the legacy CS presumption that all supplementary services are implemented in the network. Hence the network may not have knowledge of some service interactions.
- c) Devices will have different levels and forms of support for simultaneous IP communication services. For example one device could support video PIP and another device may not support it.
- d) Different types of multi-media have different levels of user cognitive abilities to support or deal with multiple simultaneous disparate sessions (“multi-tasking” abilities). For example, users have limited abilities to handle multiple simultaneous audio conversations whereas users often will be engaged in multiple IM sessions with different social contacts at the same time.

5.6 Emergency SIP registration in RATs with emergency bearers

Short Descriptions

3GPP TS 24.229 specifies SIP emergency registration procedures when the Radio Access Technology (RAT) supports emergency bearer procedures. However these emergency registration procedures are based on a single voice emergency service, using a single public user identity. This limits the ability to support multi-media emergency communication.

Actors

- Oklahoma Mobile – a wireless network operator.
- Curly McLain – a user of Oklahoma Mobile.
- Will Parker – the PSAP call taker in the PSAP with jurisdiction over the political area Curly McLain is present in.

Normal Pre-Conditions

Curly McLain has two public user identities – his MSISDN of 555-555-1212 and Curly.McLain@oklahomamobile.net.

Normal Post-Conditions

Multi-media emergency communication may not work correctly with multiple user identities.

Will Parker may not be able to initiate emergency callbacks even though Curly McLain’s UE is active and has sufficient radio signal conditions to communicate.

Normal Flow

1. Curly McLain sees a tornado forming and decides to alert the authorities.
2. Curly McLain initiates a 911 voice call.
3. The UE requests an emergency bearer and initiates an emergency registration with his MSISDN 555-555-1212.
4. The UE then initiates the voice emergency call using the MSISDN registration.
5. The noise of the tornado becomes too loud and Curly McLain decides to switch to IM session.
6. Curly McLain initiates an IM session to 911.
7. The UE initiates a new emergency registration using the Curly.McLain@oklahomamobile.net public user identity.
8. The Oklahoma Mobile SIP registry deletes the 555-555-1212 emergency registration and registers Curly.McLain@oklahomamobile.net as the emergency registration.
9. Curly McLain disconnects the emergency voice session, but maintains the IM session.
10. Will Parker decides it is important to continue the voice communication and initiates a callback to Curly McLain’s MSISDN.
11. Since the MSISDN is not registered, the Oklahoma Mobile call processing system sends the call back to voice mail handling.

Impact Considerations

The procedures in 3GPP TS 24.229 appear to be based on the assumption that only one user identity would be active at a time during emergency communication (probably voice only) and this seems to limit having multiple user identities being used for multi-media emergency service. This is used at least for call back purposes and routing the signaling and media properly through the emergency bearers.

So the following aspects at a minimum should be reviewed in terms of using multiple identities simultaneously for multi-media emergency services (MMES) (there may be additional aspects to consider as well):

- a) The requirement of using the first public user identity in the ISIM or equivalent for the emergency registration.
- b) Only allowing one public user identity at a time for the emergency registration.
- c) Assuming that the previous emergency public user identity registration to be expired when a new emergency public user identity is registered.

5.7 Emergency Callback Blocked by Whitelists or Privacy Settings

Short Descriptions

Many internet messaging services provide the ability to maintain a Personal Network Whitelist (PNW) of the only identities which are allowed from to contact the user. Others have privacy settings that only allow specific social network connections or classes of social network connections (like family) to contact the user.

Actors

- Pitcairn PCS – a wireless network operator.
- William Bligh – a user of Pitcairn PCS who is on a ship which has foundered on a rocky coast.
- Fletcher Christian – the PSAP call taker who is selected by the PSAP's network elements to receive William Bligh's emergency communication.

Pre-Conditions

Pitcairn PCS supports Rich Communication Services (RCS) 5.1 and has separate CPM, file store, and voice servers operating as Application Servers (AS) in their IMS network.

William Bligh is subscribed to voice, the one-to-one instant message, and file delivery services of Pitcairn PCS and has a smartphone with a camera and an embedded RCS 5.1 client. His IM public user identity is Bounty@PitcairnPCS.net. His privacy settings only allow those in his social network connections to contact him through IM – those are the senior officers on the ship.

Post-Conditions

William Bligh's interrupted emergency communication can't be re-established to complete Fletcher Christian's gathering of the foundering details.

Normal Flow

1. William Bligh is on a ship which founders on a jagged headland on a coast. He decides to communicate with emergency services through IM.
2. William Bligh's UE establishes communication with Fletcher Christian using the identity bounty@pitcairnPCS.net and a few details of the foundering ship are communicated.
3. Radio conditions deteriorate temporarily and the emergency session is disconnected.
4. Radio conditions improve to a level where William Bligh's UE reattaches to the Pitcairn PCS network.
5. Fletcher Christian attempts to re-establish an IM session with William Bligh using the identity from the initial emergency communication session bounty@pitcairnPCS.net.
6. The Pitcairn PCS IM service recognizes that Fletcher Christian's identity is not one of William Bligh's social network connections and due to William Bligh's privacy setting and rejects the request to establish a callback emergency communication session.

Impact Considerations

It may be desirable to merely indicate that any “callback” with an emergency service indicator by-pass the personal network whitelist or any privacy settings. However there are several considerations which add complications to the issue and require further study:

- a) There is no consistency for the originators identity presented on an emergency “callback” among the PSAPs. If we assume without any form of consistency, not only could the PSAPs have their own individual identity, they may also have different identities based on the specific communication service. So for example a PSAP could have its main non-emergency phone number as the caller for voice services, it could also have Plainville_emergency_service@plainville.state.gov as its IM identity. Further, some PSAPs could also have a separate identity for each call taker such as their first name, so another possibility is john_plainville_emergency_service@plainville.state.gov. The result is that there could be close to 20,000 identities for PSAPs that would have to be checked in a *global override of PNW and privacy setting database*, and if call taker identities were used as well, there could be well over 100,000 identities with frequent changes due to PSAP staffing turnover that would need to be verified in a *global override of PNW and privacy setting database*.
- b) The use of an emergency service indicator in a callback to by-pass the PNW and privacy settings can open up an easily exploitable opportunity for fraud and spoofing for normal communication to bypass the PNW and privacy settings unless the use of the emergency service callback indicator incorporated an authorization and authentication mechanism.

5.8 User’s Multiple Devices Linked through Globally Routable UA URI (GRUU)

Short Descriptions

A user is able to have multiple UEs and through GRUU they all share the same public user identity. SIP/IMS provides a capability to signal all the user’s devices or distinguish specific devices when appropriate.

Actors

- TransNet – a wireless network operator.
- Janet Weiss – a user of TransNet who has is experiencing dropsy.
- Brad Majors – the PSAP call taker who is selected by the PSAP’s network elements to receive Janet Weiss emergency communication.

Pre-Conditions

Janet Weiss has two mobile devices – one a smartphone and the other a high resolution wireless camera. Both are associated with her subscription under the public user identity of RHPS@transnet.net. The camera does not support any voice or text messaging services.

Post-Conditions

Brad Majors IM communication during the emergency communication may not reach Janet Weiss and callbacks may fail to reach Janet Weiss as well.

Normal Flow

1. Janet Weiss’ dropsy condition flares up and she decides to IM 911.
2. Janet Weiss, on her smartphone establishes an emergency IM session with Brad Majors using her identity RHPS@transnet.net.
3. TransNet.net adds the smartphone instance to the session invitation.
4. Janet Weiss takes a picture on her camera of the dropsy affliction and sends it to 911 using her identity RHPS@transnet.net as well as asking “does this look bad?” in the IM session.
5. TransNet.net adds the camera instance to the photo transfer session invitation.
6. Brad Major’s PSAP infrastructure is able to associate the two sessions (IM and photo) based on the same user identity, however the PSAP infrastructure does not support GRUU and only retains the latest user identity and instance that it received (from the camera).
7. Brad Major’s next IM message is sent to Janet Weiss’ camera instance (last identity stored) rather than to the smartphone.

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8. Janet Weiss' camera does not support IM messaging and hence ignores Brad Major's IM messages.
9. Radio conditions deteriorate temporarily and any emergency sessions to Janet Weiss's devices are disconnected.
10. Radio conditions improve to a level where both of Janet Weiss' UEs reattach to the network.
11. Brad Major initiates an IM callback to Janet Weiss. However since the PSAP infrastructure uses the last known identity, this identity includes her camera's instance.
12. Janet Weiss' camera receives an emergency IM session establishment request but does not support IM services and rejects or refuses the request.

Impact Considerations

PSAP and NG9-1-1 networks will need to support GRUU and utilize the capability appropriate to specific scenarios and policies. It may be worthwhile to standardize some level of appropriate support and policy on addressing GRUU in PSAP and NG9-1-1 infrastructure.

5.9 Multiple Users Sharing a Single GRUU Public User Identity

Short Descriptions

Multiple users are able to share the same public user identity through the use of GRUU. SIP/IMS provides a capability to signal all the users registered for the public user identity or distinguish specific users when appropriate.

Actors

- Big Apple Zone – a wireless network operator.
- Peter Venkman – a user of TransNet.
- Raymond Stantz – a user of TransNet.
- Egon Spengler – a user of TransnNet.
- Dana Barrett – the PSAP call taker who is selected by the PSAP's network elements to receive Peter Venkman emergency communication.

Pre-Conditions

Peter Venkman, Raymond Stantz, and Egon Spengler share a public user identity related to their business – ghostbusters@bigapplezone.net.

The PSAP does not support GRUU instance identifiers.

Normal Flow Post-Conditions

Dana Barrett's IM communication during the emergency communication may reach the wrong person and an emergency callback may be answered by the wrong person.

Normal Flow

1. Peter Venkman witnesses a criminal activity - talking in a library and decides to IM 911.
2. Peter Venkman, on his smartphone establishes an emergency IM session with Dana Barrett using his public identity ghostbusters@bigapplezone.net.
3. Big Apple Net adds the smartphone instance to the session invitation.
4. Dana Barrett's PSAP does not support GRUU instance identifier and drops them from subsequent signaling.
5. When Dana Barrett sends a text message to Peter Venkman, some are received instead by Raymond Stantz and some received by Egon Spengler.
6. Radio conditions deteriorate temporarily and any emergency sessions to Peter Venkman's UE are disconnected.
7. Radio conditions improve to a level where Peter Venkman's UE reattaches to the network.
8. Dana Barrett initiates an IM callback to ghostbusters@bigapplezone.net without an instance identifier.
9. All three users registered for this public user identity are alerted. Raymond Stantz is the first to answer and both Peter Venkman's and Egon Spenger's UEs stop alerting.

Discussion

PSAP and NG9-1-1 networks will need to support GRUU and utilize the capability appropriate to specific scenarios and policies. It may be worthwhile to standardize some level of appropriate support and policy on addressing GRUU in PSAP and NG9-1-1 infrastructure.

5.10 NG-9-1-1 Interaction through a Web Application Using webRTC Services

Short Descriptions

WebRTC is an effort to standardize web based real time communications providing for simplified application development and more rapid deployment. webRTC applications range from online gaming to online inbound customer service centers. webRTC applications may communicate through the PSTN via interworking functions, or may communicate directly with a PSAP or NG9-1-1 network.

Actors

- Grauman's Anywhere – a wireless network operator.
- Don Lockwood – a user of Grauman's Anywhere who sees a plague of locusts.
- Kathy Selden – the PSAP call taker who is selected by the PSAP's network elements to receive Don Lockwood's emergency communication.
- Cosmo Brown & Co. - The company that Don Lockwood works for.
- Lina Lamont – The IT developer working for Cosmo Brown & Co who develops their web based applications.

Pre-Conditions

Lina Lamont has added webRTC support for all voice and video communication used by Cosmo Brown & Co. employees including interfacing to the PSTN.

Don Lockwood's PC has a data modem with a Grauman's Anywhere subscription provided by Cosmo Brown & Co.

Normal Flow Post-Conditions

Kathy Seldon is unable to locate Don Lockwood through any of the NG9-1-1 automated location determination means and must resort to a verbal conversation to locate Don Lockwood and dispatch the public insect control unit.

Normal Flow

1. Don Lockwood observes a massive plague of locusts approaching the town devouring everything in its path.
2. Don Lockwood, on his PC, invokes the voice call function on his web browser entering 911 as the destination number.
3. The Cosmo Brown & Co. web portal application contacts the Cosmo Brown & Co. web server using a proprietary JSON signaling protocol.
4. The Cosmo Brown & Co. web portal initiates a NG9-1-1 call direct to the PSAP through a SIP INVITE bypassing any wireless or broadband operator SIP routing. The call origination is Don Lockwood's home office number. No location information is passed to the PSAP.

First Alternative Post-Conditions

Kathy Seldon is unable to locate Don Lockwood through any of the NG9-1-1 automated location determination means and must resort to a verbal conversation to locate Don Lockwood and dispatch the public insect control unit.

The 911 call is delivered to the wrong PSAP thousands of miles away from Don Lockwood.

First Alternative Flow

1. Don Lockwood moves from the main office in Vermont to a new office in New Mexico.
2. Lina Lamont maintains the current Cosmo Brown & Co. IT setup including maintaining the hardcoded IP address for the local Vermont PSAP.

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3. Don Lockwood is driving in New Mexico and this time sees a plague of frogs hopping toward him on the horizon.
4. Don Lockwood, on his PC, invokes the voice call function on his web browser entering 911 as the destination number.
5. The Cosmo Brown & Co. web portal application contacts the Cosmo Brown & Co. web server using a proprietary JSON signaling protocol.
6. The Cosmo Brown & Co. web portal initiates a NG9-1-1 call direct to the local Vermont PSAP through a SIP INVITE bypassing any wireless or broadband operator SIP routing. The call origination is Don Lockwood's home office number in New Mexico. No location information is passed to the PSAP.

Second Alternative Post-Conditions

Don Lockwood is unable to establish a video session with Kathy Seldon to describe the plague of gnats descending on the town.

Second Alternative Flow

1. Don Lockwood observes a massive plague of gnats approaching the town irritating everything in its path.
2. Don Lockwood, on his PC, invokes the video call function on his web browser entering 911 as the destination number. The web browser webRTC function only supports the VP9 video codec.
3. The Cosmo Brown & Co. web portal application contacts the Cosmo Brown & Co. web server using a proprietary JSON signaling protocol.
4. The Cosmo Brown & Co. web portal initiates a NG9-1-1 call direct to the PSAP through a SIP INVITE bypassing any wireless or broadband operator SIP routing. The call origination is Don Lockwood's home office number. No location information is passed to the PSAP.
5. The PSAP is unable to deal with the VP9 video codec, the only choice is to refuse and reject the connection establishment request (INVITE).

Impact Considerations

This scenario is intended to show how easy it is to develop and deploy SIP applications which support only parts of the NG9-1-1 functionality expected from the originating network (such as no location support or PSAP selection function bypass, or use of new codecs).

The consequence of expanding direct access to PSAPs or NG9-1-1 networks beyond the current regulated operators appears to significantly expand the need for NG9-1-1 ingress points to develop defensive measures against badly (accidentally or deliberately) behaved NG9-1-1 communication sources.

Bad programming practices leading to this can include:

- a) Hardcoding IP addresses rather than using DNS.
- b) Hardcoding location (location by value) in the initial invite and not deploying an LRF.
- c) Not supporting common codecs.
- d) Hardcoding calling party identities leading to incorrect callback attempts.
- e) Violating SIP protocol specifications.

For Future Study: Session Border Controllers (SBC) may support the defensive and correction actions needed; further study regarding the SBC expected behavior and requirements should be undertaken.

5.11 User with a Highly Secure UE

Short Descriptions

A user's communication is secured by the mobile device to only allow trusted connections that can be established through mutually authenticated security associations. Any unsecured communication such as NG9-1-1 is deemed a potential security compromise and may result in some level of device or service deactivation.

Actors

- Q Net – a wireless network operator.

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- James Bond – a user of Q Net who is in a sticky situation resulting in mayhem requiring emergency services to attend. He works in an industry where only secure communication is allowed through his mobile device.
- Auric Goldfinger – the PSAP call taker who is selected by the PSAP's network elements to receive James Bond emergency communication.

Normal Pre-Conditions

James Bond has a UE which will only accept and establish secure, trusted connections established through mutually authenticated security associations.

Q Net supports James Bond's UE by only establishing data transport tunnels with designated secure and trusted networks through mutually authenticated security associations.

Normal Post-Conditions

James Bond is unable to contact 911.

Normal Flow

1. James Bond decides that as a result of some mayhem resulting from his actions, a call to 911 for emergency services is needed.
2. He calls 911 from his smartphone, but since a mutually authenticated connection can't be established for the signaling and media, the call is not completed.

First Alternative Pre-Conditions

James Bond has a UE which will only accept and establish secure, trusted connections established through mutually authenticated security associations.

Q Net supports James Bond's UE by only establishing data transport tunnels with designated secure and trusted networks through mutually authenticated security associations. No location measurements or determinations are provided by the UE. As an exception, James Bond's UE is allowed to place 911 voice only calls.

First Alternative Post-Conditions

James Bond is able to contact 911, and only network based location measurement and determination can be used to locate the UE for call routing and emergency service dispatching. The mobile device's location assistance and determination capabilities have been explicitly disabled for security considerations.

First Alternative Flow

1. James Bond decides that as a result of some mayhem resulting from his actions, a call to 911 for emergency services is needed.
2. He calls 911 from his smartphone.
3. Q Net uses network based location measurement and determination to identify the appropriate PSAP to route the call to.
4. James Bond's 911 call is routed to Auric Goldfinger who answers the call and asks for the caller's name.
5. James Bond responds "Bond. James Bond."
6. Auric Goldfinger initiates an updated position report request through the PSAP's network infrastructure.
7. Q Net is only able to provide any updates to the network based location measurement and determination.

Second Alternative Pre-Conditions

James Bond has a UE which will only accept and establish secure, trusted connections established through mutually authenticated security associations.

Q Net supports James Bond's UE by only establishing data transport tunnels with designated secure and trusted networks through mutually authenticated security associations. As an exception, James Bond's UE is allowed to place 911 voice only calls and provide location measurements only for emergency calls.

Second Alternative Post-Conditions

Auric Goldfinger is unable to complete any emergency callbacks.

Second Alternative Flow

1. James Bond decides that as a result of some mayhem resulting from his actions, a call to 911 for emergency services is needed.

2. He calls 911 from his smartphone.
3. Q Net uses network based location measurement and determination to identify the appropriate PSAP to route the call to.
4. James Bond's 911 call is routed to Auric Goldfinger who answers the call and asks for the caller's name.
5. James Bond responds "Bond. James Bond."
6. Radio conditions deteriorate temporarily and the emergency session is disconnected.
7. Radio conditions improve to a level where James Bond's UE reattaches to the network.
8. Auric Goldfinger initiates an emergency callback to James Bond's UE.
9. Since Auric Goldfinger's PSAP is unable to establish a mutually authenticated security association with Q Net on behalf of James Bond, the call attempt is rejected or refused.

Third Alternative Pre-Conditions

James Bond has a UE which will only accept and establish secure, trusted connections established through mutually authenticated security associations.

Q Net supports James Bond's UE by only establishing data transport tunnels with designated secure and trusted networks through mutually authenticated security associations. James Bond's UE is allowed to use the full set of NG911 multi-media capabilities. However the UE is deemed to be compromised and will permanently disable all future use except for requesting 911 emergency services.

Third Alternative Post-Conditions

James Bond will destroy the UE after being compromised for initiating unsecured 911 emergency service communication.

Third Alternative Flow

1. James Bond decides that as a result of some mayhem resulting from his actions, a call to 911 for emergency services is needed.
2. He calls 911 from his smartphone.
3. The phone wipes all security protected elements from the phone and disables non-emergency service functionality.
4. James Bond's 911 call is routed to Auric Goldfinger who answers the call and asks for the caller's name.
5. James Bond responds "Bond. James Bond."
6. After some period of time, the 911 call is completed.
7. The smartphone completes its software self-destruction preventing any further use of the smartphone.
8. James Bond completes the compromised phone protocol by vaporizing it with a high energy laser.

Impact Considerations

The key to these use cases that for some environments, enterprise security requirements may conflict with unsecured 911 emergency services. The mobile device's security response may lead to reduced support of NG911 functionality, protocols, procedures, and capabilities. The alternative is to accept known vulnerabilities in the attack surface (range of different points where malicious attacks can compromise software) of a smartphone via NG911 functionality.

The guidelines for these approaches for the US government, for example, can be found in NIST SP 800-124 Guidelines for Managing and Securing Mobile Devices in the Enterprise. Actual security implementations are dependent on specific US government deployments.

5.12 Interagency Agreements to Handle Certain NG9-1-1 Media

Short Descriptions

During the transition at least, and possibly permanently, PSAPs will elect to handle only a sub-set of the types of media that is supported by NG9-1-1. Some of these PSAPs may have agreements with other PSAPs with additional media capabilities to handle emergency communication containing these additional media capabilities. However, this could create PSAP selection problems depending on the ordering of the media types requested.

Actors

- Amity Wireless – a wireless network operator.

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- Brody – a user of Amity Wireless.
- Quint – a call taker on duty at the Amity PSAP serving Brody's location.
- Hooper – a call taker on duty at the State Police PSAP.

Normal Pre-Conditions

The Amity PSAP is only able to handle voice NG9-1-1 communications. The Amity PSAP has an agreement with the State Police PSAP that text or video streaming emergency communication will be delivered to the State Police PSAP to handle.

Normal Post-Conditions

Brody establishes NG9-1-1 sessions with two different PSAPs for the same emergency based on media capabilities leading to partial situational information being delivered to each PSAP call taker. Each of the participating PSAP call takers is unaware of the other call taker's involvement.

Normal Flow

1. Brody spots a shark in the ocean and decides to report it to Amity's public safety agency.
2. He calls 911 from his mobile device and is connected to Quint and describes the shark.
3. Brody decides that a video clip of the shark would help show the size of the shark, so he initiates a video streaming session.
4. The video session is initiated and is delivered to Hooper at the State Police PSAP.
5. Hooper does not have any knowledge of emergency issue related to the video clip he is watching.

First Alternative Post-Conditions

Hooper at the State Police PSAP receives all emergency communication.

First Alternative Flow

1. Brody spots a shark in the ocean and decides to report it to Amity's public safety agency.
2. He decides to send a real time video clip of the shark first. He initiates a video streaming session.
3. The video session is initiated and delivered to Hooper at the State Police PSAP.
4. He then adds a voice session to the emergency session and describes the shark sighting to Hooper.
5. Hooper then alerts the Amity public safety agency about the shark.

Second Alternative Post-Conditions

Brody establishes NG9-1-1 sessions with two different PSAPs for the same emergency based on media capabilities leading to partial situational information being delivered to each PSAP call taker. Each of the participating PSAP call taker is unaware of the other call taker involvement.

Second Alternative Flow

1. Brody spots a shark in the ocean and decides to report it to Amity's public safety agency.
2. He decides to send a real time video clip of the shark first. He initiates a video streaming session.
3. The video session is initiated and delivered to Hooper at the State Police PSAP.
4. He then establishes a NG9-1-1 voice session and is connected to Quint and starts talking about the video clip he is sending.
5. Quint does not see the video clip that Brody is describing, and Hooper does not know what emergency the received video clip represents.

Impact Considerations

When a PSAP offloads handling of specific media types by agreement to other PSAPs, emergency service handling, and service consistency is affected by the following conditions:

- a) The order in which media types are activated over a period of time.
- b) The ability to associate the different media types to the same emergency communication session.

5.13 NG9-1-1 voice call initiated remotely

Short Descriptions

A user of a call control application that includes remote desktop support for the UE (e.g., a smartphone or tablet). This call control application is able to initiate both emergency IM messaging and NG9-1-1 voice calls through both the local and remote User Interface.

Actors

- Happy Mobile – the call control application which includes a remote desktop support capability accessed through the UE's IP data service.
- Moose – the user whose UE is running the Happy Mobile application.
- Rodent – the IT helpdesk agent who is able to remotely login to the Happy Mobile application with complete control over desktop actions.
- Night Owl – the emergency call taker.
- Trudge Network – Moose's wireless network provider.
- Vineland, NJ PSAP – the PSAP serving the area of the smart phone initiating the 9-1-1 text message.

Normal Pre-Conditions

Trudge Network provides wireless service to the Vineland, NJ which is also in the Vineland, NJ PSAP service area.

Moose's UE is powered on, connected to Trudge Network and operating normally.

Moose and Rodent work for the same company.

Normal Post-Conditions

An emergency call was placed by a UE under control external to the user and the UE's environment.

Normal Flow

1. Moose has gone to sleep for the evening but leaves his UE on.
2. Rodent, performing work on an IT trouble ticket that Moose opened on another company application on his UE, remotely logs into Moose's UE through the Happy Mobile application.
3. Rodent is remotely accessing the UE's desktop UI begins to access applications on the UE.
4. Rodent remotely invokes the "place emergency call" function in the Happy Mobile application which invokes the voice call API with "911" as the destination.
5. The UE initiates a NG9-1-1 call and is routed to Night Owl at the Vineland, NJ PSAP.
6. Since Rodent is unable to also remotely access the audio media of the call, Night Owl is unable get any audio response.
7. Believing that the caller has become unconscious, Night Owl dispatches emergency services to the location determined for Moose's UE – his home.
8. Emergency service forcibly enters Moose's home and wakes Moose up to find out what the emergency is.
9. Moose does not have the slightest knowledge of what is going on.

First Alternative Pre-Conditions

Rodent is a disgruntled soon to be terminated employee and plans malicious activity against Moose, a senior executive.

First Alternative Post-Conditions

Rodent is able to initiate and participate in a bogus emergency IM conversation with Night Owl.

First Alternative Flow

1. Moose has gone to sleep for the evening but leaves his UE on.
2. Rodent, without authorization, but using his existing IT access credentials logs on remotely to Moose's UE through the Happy Mobile application.
3. Rodent is remotely accessing the UE's desktop UI begins to access applications on the UE.
4. Rodent remotely invokes the "place emergency texting" function in the Happy Mobile application which invokes the IM application on the UE with "911" as the destination.

5. The UE initiates NG9-1-1 IM session and is routed to Night Owl at the Vineland, NJ PSAP.
6. Rodent is able to engage in an IM conversation with Night Owl leading Night Owl to believe that Moose is a terrorist threat.
7. A heavy force response team is sent to Moose's house to prevent a perceived terrorist action.
8. Moose does not have the slightest knowledge of what is going on.

Impact Considerations

This use case shows that the UE as an application platform with remote data networks and API access to normal voice communication and other applications on the UE are able to be controlled remotely even for emergency communication.

5.14 Insufficient Congestion Detection, Reporting, & Mitigation for Multi-Media

Short Descriptions

As multi-media, especially video, becomes more prevalent in emergency communication, dealing with dynamic network congestion, especially overall congestion impacting an entire PSAP operations becomes more critical for consideration.

Actors

- Wisbourg Wireless – a wireless network operator.
- Graf Orlok – a user of Wisbourg Wireless.
- Ellen Hutter – a user of Wisbourg Wireless.
- Professor Bulwer – a user of Wisbourg Wireless.
- Professor Sievers – a user of Wisbourg Wireless.
- Wisbourg PSAP – the PSAP whose jurisdiction encompasses the location of the Wisbourg Wireless users in this use case.

Normal Pre-Conditions

The Wisbourg PSAP has 3 call takers on duty at any point in time and has engineered its emergency trunks to handle 10 voice calls for peak traffic.

The video codec supported by the Wisbourg PSAP is assumed to be 10 times the bit rate of a voice call.

Normal Post-Conditions

The Wisbourg PSAP is experiencing trunk congestion for all callers and is unable to attempt to mitigate the congestion except by explicitly terminating emergency sessions prematurely. The congestion prevents any meaningful video from reaching the PSAP and preventing voice communication from the call takers to the user to stop sending any streaming video.

The Wisbourg PSAP is presented with the video traffic approximately equivalent to 40 voice calls, significantly higher than the engineered capacity of the PSAP trunk. The Wisbourg is unable to indicate any congestion conditions to either the originating UEs or Wisbourg Wireless infrastructure to attempt to reduce the video codec rates to acceptable levels.

Normal Flow

1. A multi-car traffic accident occurs and Graf Orlok, Ellen Hutter, Professor Bulwer, and Professor Sievers independently witness the accident and decide to contact 911.
2. Graf Orlok calls 911 and is connected to a call taker at the Wisbourg PSAP.
3. Ellen Hutter calls 911 and is connected to a call taker at the Wisbourg PSAP.
4. Professor Bulwer calls 911 and is connected to a call taker at the Wisbourg PSAP.
5. Graf Orlok informs the call taker that he can send a streaming video of the traffic accident.
6. Ellen Hutter informs the call taker that she can send a streaming video of the traffic accident.
7. Professor Bulwer informs the call taker that he can send a streaming video of the traffic accident.
8. Graf Orlok initiates a video stream to the PSAP using a negotiated fixed rate codec.
9. Ellen Hutter initiates an emergency video stream to the PSAP using the same negotiated fixed rate codec.

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10. Professor Bulwer initiates an emergency video stream to the PSAP using the same negotiated fixed rate codec.
11. Professor Sievers decides to send the streaming video of the accident before placing a voice call to the Wisebourg PSAP.
12. Professor Sievers initiates an emergency video stream to the PSAP using the same negotiated fixed rate codec.
13. The Wisebourg PSAP trunk is experiencing extreme congestion allowing very little signaling or media traffic to flow through the trunk.
14. Professor Sievers attempts a 911 call to the Wisebourg PSAP but the call attempt is not delivered to the Wisebourg PSAP due to the congestion.
15. Professor Sievers hears a network indication of the unsuccessful emergency voice call attempt to the Wisebourg PSAP.

Impact Considerations

Wireless networks to a significant extent and fixed broadband networks to some extent are developing tools and mechanisms to deal with significant congestion introduced by the multi-media explosion occurring on the internet. Some of these tools include codecs which can dynamically reconfigure coding rates based on inband signaling and transporting of congestion indication end to end to allow activation of congestion mitigation at the appropriate network element. The development of NG9-1-1 standards has not kept pace with these types of network developments in originating devices and networks to allow for smooth operation of emergency communication during high traffic and congestion periods.

For Future Study: It is recommended that end-to-end congestion detection, reporting and mitigation is for future study. This should be completed before significant NG9-1-1 traffic loading affects delivery of PSAP emergency services.

5.15 Use of Both Legacy & IP Based Services for Emergency Communication

Short Descriptions

There will be a period of transition, possibly lasting decades where existing legacy communication services such as SMS are still available and used alongside IP based communication services. Likewise, citizen-to-authority emergency communication utilizing these commercial services will be available as mixed legacy and IP based capabilities until the commercial legacy services are retired. The existence of this mixed citizen to authority emergency communication service environment introduces challenges in the originating network which can negatively impact the ability to provide seamless emergency services.

Actors

- Left Coast 2 Go – a wireless network operator.
- Scottie Ferguson – a user of Left Coast 2 Go.
- Dublin PSAP – the PSAP whose jurisdiction encompasses the initial location of Scottie Ferguson.
- Danville PSAP – the PSAP whose jurisdiction encompasses the subsequent location of Scottie Ferguson.
- Judy Barton – the call taker on duty at the Dublin PSAP.
- Gavin Elster – the call taker on duty at the Danville PSAP.
- Frisco S&L – the bank in Pottersville where the hostage situation begins.

Normal Pre-Conditions

Left Coast 2 Go has deployed IMS capabilities for voice services including 911 voice calls only. SMS signaling continues to operate on legacy SMS infrastructure.

Normal Post-Conditions

Scottie Ferguson's 911 voice communication is with Judy Barton in the Dublin PSAP and the text-to-911 communication is with Ernie Bishop in the Danville PSAP leading to incomplete situational information available at each PSAP leading to delays in rescuing Scottie Ferguson.

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The Danville PSAP communication is likely to be delayed from Ernie needing to be filled in on the emergency situation and Scottie Ferguson's confusion why the emergency service person in the conversation doesn't already know what the situation is from the previous 911 voice call.

The Dublin PSAP communication could either lead to further confusion if Judy Barton initiates an SMS session with Scottie Ferguson where the text messages from both Judy Barton and Ernie Bishop are only identified as coming from 911, the UE client may display messages from Judy Barton and Ernie Bishop as part of the same SMS conversation (911). Or if Judy Barton initiates a voice call back, it could either compromise Scottie Ferguson's hostage position, or hasten the battery discharge.

Normal Flow

1. Scottie Ferguson is in the Frisco S&L to make a deposit.
2. A bank robbery begins and Scottie Ferguson is able to make a voice call to 911 without being detected to report the robbery in progress.
3. The 911 call is delivered to Judy Barton at the Dublin PSAP.
4. Scottie Ferguson tells Judy Barton that a bank robbery is in progress, but he can't talk without risking discovery.
5. Scottie Ferguson keeps the 911 voice session going so that Judy Barton may pick up some of the background talk.
6. The bank robbery encounters unplanned events and Scottie Ferguson is taken hostage.
7. The bank robbers drive to Danville with captive Scottie Ferguson.
8. Scottie Ferguson notices that his phone is low on battery power, decides to switch to SMS to 911.
9. Scottie Ferguson sends an initial SMS to 911 message saying he is switching and will hang up on the 911 voice session.
10. Because the SMS to 911 is considered a new emergency session, it is routed to the Danville PSAP.
11. The SMS to 911 text message is delivered to Gavin Elster in the Danville PSAP who does not know anything about the emergency situation.
12. Scottie Ferguson hangs up the 911 voice call.
13. Gavin Elster does not know what the emergency situation is and sends text messages to get background information.
14. Scottie Ferguson's mobile device runs out of battery power from the text messages filling in Gavin Elster on the emergency situation.

Impact Considerations

This is another example where the originating network services are based on separate infrastructure and the citizen to authority emergency communication using those services will also operate through those separate infrastructures. This service separation in normal commercial use is not noticeable by the end user, but can be detrimental for services with geo-political based routing such as 911 and text to 911 because of service specific routing.

For example, normal commercial communication services such as voice and SMS, originating network, and terminating network mobility management handles movement within the network so that a voice call and text message to the same MSISDN will be delivered properly. However with geo-political based service delivery and routing, the assumption of consistent delivery to a single endpoint does not work for emergency communications in many mobility scenarios.

5.16 Multiple Devices of Different Capabilities Sharing a Single User Identity via GRUU

Short Descriptions

GRUU provides the capability for a user to have multiple devices with different media and usage capabilities all operating under the same user identity. The capabilities of the devices may need to be retained by the PSAP for proper emergency communication operation.

Actors

- Pottersville Cellular – a wireless network operator.
- George Bailey – a user of Pottersville Cellular.
- Bedford Falls PSAP – the PSAP whose jurisdiction encompasses the location of George Bailey.
- Mary Hatch – the call taker on duty at the Bedford Falls PSAP.

Normal Pre-Conditions

George Bailey has a smartphone and a tablet, each has a separate IMS private user identity. The smartphone has two public user identities – a MSISDN of 15555551234 and GBailey@pottersvillecell.net. The tablet has two public user identities – a MSISDN of 15555554321 and Gbailey@pottersvillecell.net – and does not support voice services (it does not have a microphone).

It is assumed that the PSAP is able to properly correlate sessions with the same user identity from different devices and deliver to the correct call taker.

Normal and Alternative Post-Conditions

The PSAP callback and some PSAP initiated SIP signaling such as the MESSAGE method may be delivered to the wrong device with capabilities not supported by the device or may be rejected by the wrong device due since it is not supported by the device.

Or emergency communication may be delivered to multiple devices the user has leading to potential user confusion.

Normal Flow

1. George Bailey has crashed his car into a tree and decides to contact 911.
2. George Bailey decides to use instant messaging to report the emergency and establishes the IM session with Mary Hatch using GBailey@pottersvillecell.net as the user identity.
3. George Bailey decides to take a picture of the crash scene and send it to Mary Hatch with his tablet using GBailey@pottersvillecell.net as the user identity.
4. The Bedford Falls PSAP only retains the last received user identity including the GRUU Instance ID (the tablet's Instance ID).
5. Radio conditions deteriorate temporarily and the IM emergency session is disconnected.
6. Radio conditions improve to a level where George Bailey's smartphone and tablets reattach to the network.
7. Mary Hatch initiates an IM session (callback) with George Bailey, but the PSAP has only retained the tablet's Instance ID.
8. The IM invitation is delivered to George Bailey's tablet, but George Bailey is not aware it has arrived since his previous IM session was on his smartphone and that is where he is expecting further IM exchanges.

First Alternative Flow

1. George Bailey has crashed his car into a tree and decides to contact 911.
2. George Bailey decides to use instant messaging to report the emergency and establishes the IM session with Mary Hatch using GBailey@pottersvillecell.net as the user identity.
3. George Bailey decides to take a picture of the crash scene and send it to Mary Hatch with his tablet using GBailey@pottersvillecell.net as the user identity.
4. The Bedford Falls PSAP only retains the last received user identity including the GRUU Instance ID (the tablet's Instance ID).
5. Radio conditions deteriorate temporarily and the IM emergency session is disconnected.
6. Radio conditions improve to a level where George Bailey's smartphone and tablets reattach to the network.

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7. Mary Hatch initiates a voice callback session with George Bailey, but the PSAP has only retained the tablet's Instance ID.
8. The voice call session invitation is delivered to George Bailey's tablet. The tablet does not support voice services and rejects the callback.

Second Alternative Flow

1. George Bailey has crashed his car into a tree and decides to contact 911.
2. George Bailey decides to use instant messaging to report the emergency and establishes the IM session with Mary Hatch using GBailey@pottersvillecell.net as the user identity.
3. George Bailey decides to take a picture of the crash scene and send it to Mary Hatch with his tablet using GBailey@pottersvillecell.net as the user identity.
4. The Bedford Falls PSAP only retains the last received user identity including the GRUU Instance ID (the tablet's Instance ID).
5. Radio conditions deteriorate temporarily and the IM emergency session is disconnected.
6. Radio conditions improve to a level where George Bailey's smartphone and tablets reattach to the network.
7. Mary Hatch initiates a voice callback session with George Bailey, and the PSAP recognizes that this is a new media capability it has not utilized with George Bailey's public user ID so it does not send any GRUU Instance ID.
8. The voice callback attempt is delivered to all of George Bailey's devices registered with the public user identity of GBailey@pottersvillecell.net (both the smartphone and the tablet).
9. George Bailey answers the 911 callback on his smartphone and the voice session reject by the tablet is ignored.

Impact Considerations

There are several aspects of GRUU which needs further study in order for GRUU capabilities to interact in a well behaved fashion with NG9-1-1 multi-media capabilities:

- a) The PSAP must be able to associate different devices a user (person) has which share a public user identity used in the emergency communication.
- b) The PSAP must be able to distinguish different users (people) which share a public user identity used in the emergency communication.
- c) The PSAP must be able to associate and distinguish various combinations of both a. and b.
- d) The PSAP is likely to have to retain some device/user state information based on Instance IDs and public user identities.
- e) The scenarios for when an Instance ID must be supplied and when all GRUU instances of a shared public user identity employed by the PSAP need to be developed.

5.17 Multiple Service Specific User Identities Requesting 911 Assistance

Short Descriptions

A multi-media user can have multiple identities which are used for different services. For example a user can have an email identity which is different from their telephone number. The use of different identities during the course of a citizen to authority emergency communication can create obstacles to efficient and timely communication regarding the emergency.

Actors

- Citymove– a wireless network operator.
- Ben Braddock – a user of Citymove.
- Suburville PSAP – the PSAP whose jurisdiction encompasses the location of Ben Braddock.
- Elaine Robinson – A call taker on duty at the Suburville PSAP.
- Carl Smith – A call taker on duty at the Suburville PSAP.

Normal Pre-Conditions

Ben Braddock has a user identity (MSISDN) of 15555551212 for voice calls and BBplastics@citymove.com as his IM user identity.

Citymove has deployed IMS voice and IM services.

Normal Post-Conditions

The Suburville PSAP will not be able to correlate any of Ben Braddock's voice emergency sessions identified by his MSISDN with any of his IM emergency sessions identified by his BBplastics@citymove.com IM identity.

Normal Flow

1. Ben Braddock is doing a home experiment with plastics with a chain reaction which starts to go out of control.
2. He decides he better call 911 and alert the Hazmat team that he needs assistance.
3. He calls 911 and the UE initiates a 911 voice session with the MSISDN identity of 15551212.
4. The emergency voice session is delivered to Elaine Robinson at the Suburville PSAP.
5. Ben Braddock starts explaining the situation, but when he starts naming the chemical compounds involved in the experiment, Elaine Robinson is unable to understand Ben Braddock properly and asks him to IM the chemicals to get the proper spelling.
6. Ben Braddock then initiates an IM session on his UE to the emergency URI using his IM identity of BBplastics@citymove.com.
7. The IM session request is delivered to the Suburville PSAP.
8. Because the IM session is a new session and the identity does not match any identity associated with any emergency sessions in progress, it is delivered to Carl Smith.
9. Carl Smith receives an IM session describing some chemical compounds and does not have any idea what it is about and terminates the session, assuming a nuisance request.

Impact Considerations

For normal commercial multi-media communication, users will have multiple user identities which are specific to the service or the service provider. The use of these communication capabilities for emergency communication means that the PSAPs may receive multiple session setups from the same user but with different identities. For normal person-to-person communication, users can handle this, knowing the multiple identities of the person who contacts them (or it is sorted out by the UE's address book). However, a PSAP does not have this information available which can lead to lost emergency communication, miscommunication or delay in providing needed emergency service.

5.18 Forwarding or Alternate Routing Interactions with Multiple Emergency Sessions

Short Descriptions

When a user initiates multi-media emergency communication of different media and services, each service may setup a separate emergency communication session with the PSAP. Call or session forwarding and selective alternate routing⁶ can create obstacles to efficient and timely communication regarding the emergency.

Actors

- MalteseNet– a wireless network operator.
- Samuel Spade – a user of MalteseNet.
- San Francisco PSAP – the PSAP whose jurisdiction encompasses the location of Ben Braddock.
- Oakland PSAP – has an agreement with the San Francisco PSAP for mutual alternate routing when all call takers are busy.
- Eva Archer – A call taker on duty at the San Francisco PSAP.
- Joel Cairo – A call taker on duty at the Oakland PSAP.

Normal Pre-Conditions

MalteseNet has deployed IMS voice and IM services.

⁶ Selective alternate routing is when PSAP alternate routing is employed based on some policy or criteria rules such as overflow, media type or service type. Unconditional alternate routing will not exhibit this behavior except possibly at the beginning and end of the unconditional alternate routing period.

Normal Post-Conditions

Neither the San Francisco nor the Oakland PSAP will be able to correlate any of Samuel Spade's voice emergency sessions with any of his IM emergency sessions.

Normal Flow

1. Samuel Spade has a home invasion looking for a valuable bird.
2. He decides he better contact 911 through IM so not alert the home invaders that he is contacting the authorities.
3. He contacts 911 and the UE initiates a 911 IM session.
4. The emergency IM session is delivered to Eva Archer at the San Francisco PSAP.
5. Samuel Spade starts explaining the situation via IM.
6. The home invaders unsatisfied at not finding the valuable bird set fire to Sam Samuel Spade's office.
7. Samuel Spade realizing time is of the essence decides to initiate a voice 911 session.
8. The call is routed toward the San Francisco PSAP.
9. At this point all call takers in the San Francisco PSAP are determined to be busy.
10. The San Francisco alternate routing function routes the call to the Oakland PSAP.
11. The voice call is delivered to Joel Cairo in the Oakland PSAP.
12. Joel Cairo is unaware of the situation and has to obtain background information about the emergency.
13. Samuel Spade is frustrated that he has to give the information to the call taker all over again.

Impact Considerations

A user is likely to have multiple applications either built in or downloaded to the UE, which can create multiple sessions for multi-media emergency communication. These separate applications are likely to establish different emergency sessions, separate from each other. If the sessions are not set up at the same point in time, any selective re-routing of the emergency sessions is not likely to carry over to any subsequent multi-media session requests.

5.19 Multi-Media Emergency Service Dependent on Home Network Service Platforms

Short Descriptions

Some multi-media services such as those supporting time shifted communication or store and forward capabilities may be optimally deployed with the media storage or time shifting occurring on a service platform in the home network. Current 911 delivery optimizations don't allow these services to work correctly when the multi-media service is used for NG9-1-1 communication.

Actors

- Andy Dufresne – A 911 caller.
- Shawshank PCS – A mobile operator.
- Shawshank PSAP – a PSAPs whose jurisdiction covers Andy Dufresne's location.

Normal Pre-Conditions

Shawshank PCS deploys an instant message service platform with store and forward capability for individual text messages (controlling or participating function).

Shawshank PSAP supports multi-media NG9-1-1 including SIP based instant messaging. The support of instant messaging is as an IM client only.

The IM client in Andy Dufresne's UE expects to connect to the Shawshank PCS IM service platform for each IM session to operate properly.

Normal and Alternative Post-Conditions

Andy Dufresne is unable to establish an IM session with the Shawshank PSAP.

Normal Flow

1. Andy Dufresne turns on his UE and it registers with the Shawshank PCS IM service platform.

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2. Andy Dufresne witnesses a prison breakout and decides to initiate an IM NG9-1-1 session so as not to bring attention by the escaping prisoners.
3. The NG9-1-1 IM session is initiated by the UE towards the Shawshank PCS IM service platform.
4. The Shawshank PCS P-CSCF detects that the session initiation (INVITE) an emergency request (NG9-1-1) and routes the signaling to the Shawshank PCS E-CSCF.
5. The Shawshank PCS E-CSCF routes the session invitation towards the Shawshank appropriate PSAP bypassing the Shawshank PCS IM service platform.
6. The Shawshank PSAP receives the session invitation, but acts as an IM service client and does not provide the IM service platform capabilities expected by the IM client in Andy Dufresne's UE.
7. Andy Dufresne's IM client terminates the emergency IM session because the expected IM service platform interaction was not received.

Impact Considerations

This scenario demonstrates two conditions which will cause problems with the local breakout assumptions built into the current IMS architecture:

1. Where the session UNI between the UE's client and the home service platform is different from the session NNI between networks (including NG9-1-1).
2. Where the multi-media service relies on specific functionality provided by the home service platform such as message store-and-forward.

For both of these, the reason for this is that the emergency SIP INVITE is routed from the P-CSCF to the E-CSCF, bypassing any treatment by the multi-media service platform. This scenario applies to the user in the home network as well as roaming.

5.20 Applying Multiple PRFs Policy Routing to NG9-1-1 Calls

Short Descriptions

A NG9-1-1 can have an ESRP using both a geo-political routing function in the form of an ECRF and a policy routing function (PRF). However, when an emergency call routes through multiple ESRPs where policy rules modify the next hop SIP rules in any but the last ESRP, unexpected results can occur such as NG9-1-1 network element overload or crashes.

Actors

- Tom Joad – A 911 caller.
- Dirtland PSAP – the PSAP whose jurisdiction encompasses the location of Tom Joad.
- Dirt County NG9-1-1 – the NG9-1-1 network serving all the PSAPs in the Dirt County including Dirtland PSAP.
- Riverbend PSAP – a PSAP whose jurisdiction is adjacent to Dirtland PSAP's jurisdiction.
- River County NG9-1-1 – the NG9-1-1 network serving all the PSAPs in River County including Riverbend PSAP.

Normal Pre-Conditions

Dirtland PSAP and Riverbend PSAP have a mutual aid agreement to handle each other's overflow 911 calls.

Dirt County NG9-1-1 and River County NG9-1-1 have policy rules implementing the Dirtland PSAP and Riverbend PSAP mutual aid agreement for routing overflow 911 calls to the other PSAP.

Normal and Alternative Post-Conditions

When the Dirtland PSAP is in an overload condition and 911 calls are forwarded by Dirt County NG9-1-1 to River County NG9-1-1 based on the mutual aid agreement policy rules, the 911 calls will never be delivered to either PSAP and can result in the following conditions (among other possible conditions):

1. Due to infinite looping of the 911 call, all free SIP resources on one or both of the ESRP are consumed leading to the ESRP hanging or crashing and no further 911 calls being delivered to either PSAPs.
2. The SIP loop is detected by one of the ESRP and the appropriate SIP error is returned, leading to the 911 call being rejected.

Normal Flow

1. Tom Joad discovers he has a life threatening hangnail and decides to call 911.
2. The call is delivered to Dirt County NG9-1-1 which applies the geo-political location routing first and determines that the target PSAP is the Dirtland PSAP.
3. All of Dirtland PSAP's call takers are handling other 911 calls.
4. The Dirt County NG9-1-1 ESRP applies the mutual aid policy rules and determines that the call is to be routed to the River County NG9-1-1 ESRP for handling by the Riverbend PSAP.
5. The Dirt County NG9-1-1 ESRP delivers the 911 call to the River County ESRP.
6. The River County ESRP receives the 911 call and applies the geo-political routing from the ECRF on the call and based on the caller's location determines the call should be handled by the Dirtland PSAP and the call needs to be routed to the Dirt County NG9-1-1. The mutual aid policy rules did not account for this condition of having to match 911 calls destined for other NG9-1-1 networks which may have been routed to this NG9-1-1 network based on other policy rules.
7. The River County NG9-1-1 routes the 911 call back to the Dirt County NG9-1-1.

Impact Considerations

This scenario is showing how applying policy routing rules to modify the geo-political location routing rules in any ESRP except the final ESRP delivering the 911 call to the PSAP can cause significant routing problems because subsequent ESRPs will first attempt to route the 911 call to toward the PSAP whose jurisdiction covers the location of the caller.

It is possible that the Route action cause code stored in the History-Info from the Policy Routing Rules can be used to help mitigate multiple policy ruleset interactions. It may be beneficial to add to the appropriate NENA standards, manual actions PSAPs can undertake as well as automated verification procedures that Policy Routing Functions should support.