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A Survey Study on A Model for Effective National Emergency Services Management using WebRTC, Cloud and Policy Charging Rules Function

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***Abstract*:- The purpose of this study is to come up with an effective model for National Emergency Services management. It is important that access to national emergency service lines is in real-time and not delayed so that people in an emergency receive adequate assistance and on time. Challenges with current setups in handling emergencies are that there are delays, inconsistencies, no facility for deaf people and the systems are not flexible resulting in inefficient service. A survey research design was applied to carry out this study and it was gathered that an effective Emergency Contact Centre can be achieved through implementing the Contact Centre system in the cloud, centralizing service providers using an Interactive Voice Response (IVR) and accessing the platform through text, audio or video in real-time from any device with a web browser using Web Real-Time Communication technology (WebRTC). The model also includes option to share location when in an emergency. Since the service is criticongestioncal data access will be given priority in a telecommunications network using the Policy and Charging Rules Function (PCRF).**

Keywords: WebRTC, Cloud, Emergency Services, Contact Centre Management System, Quality of Service, Telecommunications Network, Interactive Voice Response, Policy and Charging Rule Function, Location

I. INTRODUCTION

National Emergency Contact Centres experience different challenges when handling emergencies depending on their setups. For instance, the Emergency Contact Centre of Zimbabwe MARS is accessed through the normal GSM voice calls where some of the numbers are occasionally unreachable due to faulty lines and calls are manually transferred by the operator to the other service providers resulting in delays. In some countries it is difficult to get the exact location of the caller over a telecommunications network for instance Zimbabwe. Zimbabwe has different National Emergency service providers that have separate Contact Center infrastructure for example ambulance assistance use a different system with police, fire brigade or flood response yet they are all critical in assisting the entire nation. Because the infrastructure for the service providers is different they use separate contact numbers which become difficult for one to remember or recall during an emergency. Another obstacle with the setup is that in some cases voice calls may not provide sufficient information about a crisis resulting in the caller not getting adequate assistance as compared to video calls which provide more detailed information such as surroundings, condition of the caller and many others. The Contact Centre Management Systems or IP PBXs for some service providers run directly on a physical server with no backup or geographical redundancy exposing it to risk of service loss should it fail.

In the United States of America, Emergency service is accessed by making a voice call to 911 from a mobile phone or landline. 911 call centers depend on wireless companies to share the location of the caller if they can't. The information provided by the caller is used to dispatch the relevant service provider (police, fire, ambulance and other services) to the scene of emergency . A similar setup is in the United Kingdom where callers dial 999 to access the Emergency Centre and where there are four major emergency services nationwide which are the police, ambulance services, fire and rescue services and the Coastguard. China has dedicated numbers for each emergency which include Fire, Police, Ambulance and Natural Disasters which are accessed through voice calls. India advanced its Emergency Response System by introducing a system designed to address all emergency requests received through voice call, SMS, email, panic SOS signal or login on to the web portal. The application for the service is obtainable from Google Play and Apple App Store.

The setup for each country differs however there are some characteristics or features that are common. These include separate contacts for each emergency service, no flexibility in adding a new service provider, manual transfer to other service providers by the operator, absence of video calling, absence of text communication for deaf people and unavailability of the facility to share location details. It is against this background that a study has been carried out to come up with a unified model that centralizes all emergency services, speeds up the process to get assistance and effectively assists the people in crisis. The study will mainly focus on how WebRTC, GPS, an Interactive Voice Response, cloud computing and implementation of Policy and Charging Rule Function in a Telecommunications network can improve emergency services management.

II. RESEARCH QUESTIONS

The following questions needed to be addressed by the study to accomplish its purpose

- How can National emergency service providers such as fire brigade, police, roadside assistance, floods response, wildlife response and many others be centralized and accessed using the same contact or channel without any additional infrastructure or cost required?
- How can the process to access any of the service providers be automated with little intervention of an operator?
- How can technology assist a caller in an emergency who might be deaf, dumb and where there might be a language barrier to sufficiently provide information about their situation so they receive adequate assistance?
- Is the technology compatible with most common internet devices?
- How can quality of the service be prioritized or improved in a communication network as it is critical?

III. REVIEW OF LITERATURE

The study survey mainly focused on the trends in technology used in accessing and handling national emergency services, the benefits and how the technology performs. Its analysis identified areas that need to be improved to effectively help people in crisis. To assist with the research several articles, papers and websites were identified on the internet mainly looking at the benefits of video calling in an emergency, benefits of location details when assisting a person in an emergency, access to service by deaf or dump people in an emergency, the significance of an IVR and cloud in emergency services handling, application of WebRTC for real-time communication in an emergency, its benefits and performance. The research was narrowed down to available relevant and recent articles.

Velev, Dimiter and Zlateva (2012) highlighted the significance of running an Emergency Management system in the cloud. The article outlines benefits such as security for access to the cloud, how the cloud is scalable in response to an increase in demand during a disaster, how cloud services are highly available and able to manage the demand, and how cloud applications can be hosted at geographically dispersed locations enhancing the availability of the service. The research also describes how easily accessible systems in the cloud by merely having access to the Internet. The geographical separation can pose a challenge such as higher bandwidth costs and latency if the systems are widely separated. It is important that critical systems such as the emergency contact center are implemented in a cloud for them to continuously provide service and swiftly adjust to rise in traffic. T.Liu and Y. Duan (2015) look at how cloud computing has been implemented in an emergency scheduling system recognizing how it can improve the efficiency of the system, plan formulation and how it accomplishes real-time emergency dispatch purposes through the cloud's technology of resource scheduling .

Zong, Xuejun et al. (2016) proposed a platform implemented in the cloud for unified complete handling of natural disasters in China. The purpose of the cloud was to integrate different functions which include data collection, risk, monitoring, warning and other functions. The research suggests that the cloud can be used to centralize operations.

Paul Gillman (2006) looks at the benefits of using an Interactive Voice Response (IVR) during Emergency communications as being an effective tool during high traffic and there are few operators or agents to handle it. It gives the caller options to select from and can also be used for announcements or broadcast emergency warnings and lessens pressure on the operator so that they can handle more important calls.

Oftentimes the deaf and dumb community are not included in most emergency services support as there are few facilities readily available which they can use to request assistance when they are in an emergency . Kaplunov E. (2019) highlighted ways in which Deaf people can be better assisted in emergencies which include text messaging and videoconferencing.

Another important feature of the model is video calling. Melbye S et al. (2014) ran a simulation using videoconferencing in emergency medical communication under substandard sound and light conditions particularly focusing on the quality of calls as a factor. Tests were done in three different environments, inside a building with tolerable background noise, outside with light of day and background noise and outside during the night with slight background noise and the rating was done on a scale of not able to see to good video quality. Night calls had lower video quality, but it was still possible to see activity at the emergency sites. From the tests no calls were rated as low audio quality and only 3% were regarded rather difficult. Looking at the different situations and environments the results show that videoconferencing can be used for emergency calls in substandard conditions as the important activity can still be detected in those conditions .

Neustaedter Carman et al. (2018) explore the benefits and encounters of video calling in emergencies. The research carries out experiments to assess the impact of introducing video calling in emergencies. Results show that callers in panic, stress, emotional distress, or injury, children, the deaf, or unable to speak clearly for other reasons such as language barrier have difficulty explaining their situation and are assisted by video. In the experiment, the video call would help the call taker understand the criticality of the situation. Video calls can also act as evidence for some cases such as domestic abuse and the background of a video can also help identify the caller's specific location. However, some challenges were encountered which include privacy concerns and the possibility of exposing the contact center operator to inappropriate content .

The location of a caller in an emergency is a very important component in providing assistance. It ensures swift interventions, confirmation of genuine calls and identifying calls from the same major incident. Medical research even shows that for some cases location can assist in reducing the reaction time by almost a minute thereby improving the chances of survival by 24% . In 2014 British Telecom, EE Limited, and HTC in the United Kingdom developed an Advanced Mobile Location (AML) solution which sends the geographical location of the caller to an operator. Google (2016) announced the availability of AML on android phones version 2.3.7 and above and Apple announced in 2018 for iOS 11.3 and above. A delegated regulation supplementing the Radio Equipment Directive was made that from March 2022 all smartphones sold in the EU must be equipped with AML. As of March 2021 AML has been deployed in 21 other countries and some of them only support android according to Wikipedia . According to Rod Brouhard's article in 2020, America has over 8000 Public Safety Answering Point (Contact Centres) and rely on Enhanced 911 technology to relay the caller's location to them. However in some cases the technology fails resulting in the operator asking the caller to give their location .

It is necessary we come up with a model that encompasses all the key features described in this research which include video calling, text messaging, an IVR and location for effective emergency services handling. The Government of India (2015) introduced an emergency response system called ERSS accessed using the number 112, to handle different emergencies. ERSS handles all emergency signals received from people through audio call, text, e-mail, SOS, location and web portal. The mobile application is available on Google Play and Apple Store. The panic call is also available on feature phones. The system does not provide video calling and its mobile application isonly compatible on Android and iOS. In December 2020 America's 911 emergency service introduced a video and text chatting for New Orleans city in the state of Louisiana through a company Carbyne.

The discussed solutions cannot not be easily adopted as standard solutions globally due to the unavailability of technology such as AML in some countries and the costs involved to implement them. Some of the solutions do not have all the important features mentioned in the research in the same place and lastly there is no flexibility in adding or removing a service provider from the system. Finally, accessibility of service in some setups is limited to certain platforms such as Android and iOS which can be difficult to maintain as there will be a need to continuously upgrade them.

IV. PROPOSED SOLUTION

The proposed model will use WebRTC to make audio and video calls, send text messages and share location coordinates. All this will be done from a webpage connecting to a Contact Centre Management System (CCMS) or IP PBX. The CCMS will be hosted in a cloud or virtual data centre with redundancy and elasticity that is automatic provisioning of resources. It is important that the system be hosted in a cloud local in that country for fast and ease of access and by different service providers should one of the service providers experiences a global fault for instance the Facebook outage in 2021 . An IVR will be implemented to routes calls to the different service providers and an operator at each level to further assist the caller to the desired service. The emergency service providers (police, fire, ambulance, flood response and many others) will connect to the CCMS through a webpage or software phone like Zoiper to assist the callers.

WebRTC is compatible with almost all web browsers Apple, Google, Microsoft, Mozilla, and Opera. No plugins or 3 party application is required for it to run and it only requires HTML5 technology making it compatible on most devices. P Vidul et al. (2015) looked at how TeleEmergency services can be implemented in an efficient, cost-effective and less complicated way so that they can be globally used through WebRTC . Andrew Hutton et al. (2016) looked at the benefits of using WebRTC in Emergency services communications having applications that are browser-independent because of a standardized API, session control signaling between client and server can be modified, secure communication through encryption using protocols and capability to add better media such as video and text, without having to wait for an entire infrastructure to be upgraded .

WebRTC performs under low bandwidth and latency and to determine the lowest possible ideal conditions Vucic Dunja et al. (2016) experimented on the impact of different bandwidths on the Quality of Experience. Tests were carried out in which only the video resolution was changed with aspect ratio 960x640, 640x480 and 480x320 under a constant bandwidth to assess the experience differences under each resolution. The tests were then further performed under different bandwidths 300 kbps, 600 kbps and 1200 kbps. Results obtained revealed that higher video resolutions have better quality but lead to an increase in processing demand on the system, and result in congestion and other issues. Differences in observed quality between 480x320 and 640x480 were insignificant. Based on obtained results the ideal resolution is 640x480

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and minimal bandwidth of 300kbps . This supports the fact that WebRTC video calls have good quality under low bandwidth and the proposed minimum for this research is 300kbs.

WebRTC's performance is also affected by different factors in a communications network. Tarım Ergün and Tekin H (2020) assessed the performance of WebRTC for a medical platform in different networks (3G, 4G, local, and Digital Subscriber Line) and browsers (Safari, Opera, Chrome, Firefox, Internet Explorer, iOS). Variables tested were Round Trip Time (RTT), packet loss, framerate, connection and hang time and data collected from the browser through the WebRTC's GetStats API. Packet losses were highest in a Digital Subscriber Line connection compared to the other connection types followed by the 3G network but had better audio calls. 4G and 5G network's packet loss were below 0.01% for audio and video packets. The experiments showed that good communication quality had RTT below 100 milliseconds and packet loss below 1% in different network scenarios . The research revealed that WebRTC can be utilized under numerous setups in different networks and browsers because of its good communication conditions.

Because WebRTC's performance is affected in a communication network where there is congestion, latency and other performance degrading factors it is vital that the emergency service be prioritized. We will incorporate Policy and Charging Rules Function into the model to prioritize all data packets transmitted in a telecommunications network and increase the Quality of Service (QoS). The telecommunications network can be configured such that packets for the service are given the highest priority and QoS than other services as it is important in saving people's lives. Using PCRF the service can be zero-rated that is accessed for free as it is for a National interest. It allows the telecommunications provider to create different use cases for access to their network .

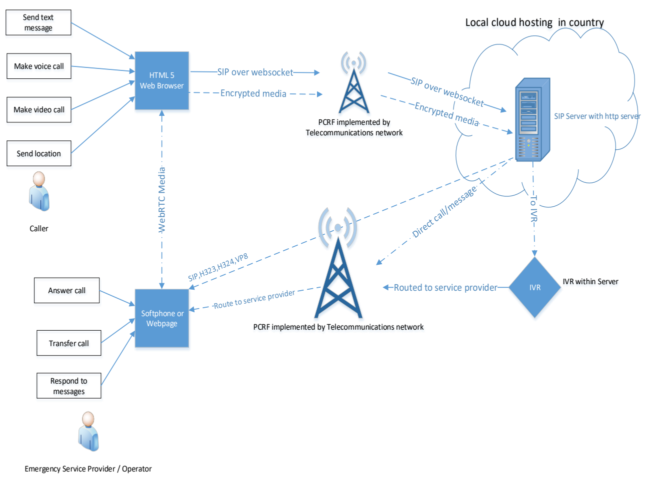

Figure 1 Proposed model overview

Process flow

- Caller accesses the National Emergency Services website.
- The Caller is requested to enter their phone number and retrieve location coordinates of where they are through a provided button or feature. The information is important so that the Caller can be called back and their location is known in the event the call prematurely disconnects.
- The Caller is then given the option to make an audio call, video call or send a message.
- The Caller's number and location details are passed via the media stream as text to the operator or emergency services provider who retrieves it on their end once communication has been established.
- The communication network prioritizes packets for the service through implementing Policy and Charging Rules Function such that the service has priority over other services in that network.
- For the service to be effective countrywide the Government or Regulatory board has to mandate all telecommunications service providers for that country to give the service the highest priority so that its performance is not compromised as it switches between networks.

V. CONCLUSION AND FUTURE WORK

The proposed model incorporates all the necessary features for effective emergency services management which include video calling, location, text messaging, voice calling, an Interactive Voice Response and cloud computing. WebRTC is flexible and using it in this model it will allow more features to be added in the future such as sending files (documents, images and other formats). PCRF in the telecommunications network is required to prioritize the service so that there is little disturbance from factors such as congestion, latency and many others. PCRF also allows a Government to apply policies such as zero-rating service as it is critical in handling emergency services for the entire nation. Packet loss, RTT, audio quality and video quality were identified as important variables in determining the performance of the service. The model is easy to implement as WebRTC is flexible to work with and cheaper to implement as most SIP servers that can be used on a large scale are open source such as Asterisk. Future research needs to look at how the quality of calls can be maintained as they switch from one mobile network to another. Quality of Service for each telecommunications network is determined by how its configured, telecommunications networks have different configurations, equipment and ways of operating hence, as a result, the quality will not be the same so a standard needs to be set across all networks. Future work also needs to look at how to manage calls of the same priority in the same communication channel when an incident occurs in the same location by implementing concepts such as FIFO, an algorithm or artificial intelligence determining which emergency call should be attended to first.

VI. REFERENCES

[1] Government of Zimbabwe, "Emergency Services," 2020. [Online]. Available: http://www.zim.gov.zw/index.php/en/my-government/government-ministries/about-zimbabwe/466-emergency-services.
[2] Wikipedia, "Enhanced_9-1-1," 2021. [Online]. Available: https://en.wikipedia.org/wiki/Enhanced_9-1-1.
[3] Wikipedia, "Emergency control centre United Kingdom "999"," 2021. [Online]. Available: https://en.wikipedia.org/wiki/Emergency_control_centre.
[4] Wikipedia, "List of Emergency Telephone Numbers World Wide," 2021. [Online]. Available: https://en.wikipedia.org/wiki/List_of_emergency_telephone_numbers.
[5] Government of India, "Nationwide Emergency Response System (NERS), Emergency Number '112'," 2015. [Online]. Available: https://www.mha.gov.in/sites/default/files/NERSGuideline_2100815.pdf.
[6] Velev Dimiter & Zlateva Plamena, "A Feasibility Analysis of Emergency Management with Cloud Computing Integration," vol. 3, pp. 188-193, 2012.
[7] Liu Tongjuan and Yanlin Duan "Application of cloud computing in the emergency scheduling architecture of the Internet of Things." 2015 6th IEEE International Conference on Software Engineering and Service Science (ICSESS) (2015): 1063-1067.
[8] Zong Xuejun, Li Qiang, Yang Zhongjun, He Kan and Velev Dimiter, "Comprehensive Management Platform of Natural Disasters Based on Cloud Computing," International Journal of Machine Learning and Computing, vol. 6, pp. 179-183, 2016.
[9] P. Gillman, "Using an IVR System during Emergency Communications," Database Systems Corp, 2006. [Online]. Available: https://www.prweb.com/releases/2006/03/prweb364814.htm.
[10] Reeves David, Kokoruwe Brian, Dobbins Jackie and Newton Valerie (2002). Access to Primary Care and Accident & Emergency Services for Deaf People in the North West. A report for the NHS Executive North West Research and Development Directorate 2002.
[11] Alexa Kuenburg, Paul Fellinger, Johannes Fellinger, "Health Care Access Among Deaf People, The Journal of Deaf Studies and Deaf Education," pp. 1-10, 2016.
[12] Kaplunov E, "TOWARDS BETTER HEALTH COMMUNICATION AMONG DEAF PEOPLE: A MIXED METHODS APPROACH TO UNDERSTANDING THE FEASIBILITY AND EFFICACY OF A NOVEL MHEALTH VIDEOCONFERENCING TOOL," 2019.
[13] Melbye, Sigurd & Hotvedt, Martin & Bolle, Stein. (2014). Mobile videoconferencing for enhanced emergency medical communication - a shot in the dark or a walk in the park? — A simulation study. Scandinavian journal of trauma, resuscitation and emergency medicine. 22. 35. 10.1186/1757-7241-22-35.
[14] Neustaedter Carman, Jones Brennan, O'Hara Kenton and Sellen Abigail, "The Benefits and Challenges of Video Calling for Emergency Situations," pp. 1-13, 2018.
[15] O'Keeffe C, Nicholl J, Turner J, Goodacre S, "Role of ambulance response times in the survival of patients with out-of-hospital cardiac arrest," Emergency medicine journal, vol. 28, pp. 703-6, 2011.
[16] European Emergency Number Association EENA, "Caller Location in Support of Emergency Services," EENA, 2014. [Online]. Available: https://eena.org/document/caller-location-in-support-of-emergency-services-updated/.
[17] Wikipedia, "Advanced Mobile Location Service," 2021. [Online]. Available: https://en.wikipedia.org/wiki/Advanced_Mobile_Location.
[18] Google, "Android Emergency Location Service," Google, 2016. [Online]. Available: https://crisisresponse.google/emergencylocationservice/how-it-works/.
[19] Rod Brouhard, "Understanding How 911 Works," EMT-P, 2020. [Online]. Available: https://www.verywellhealth.com/how-911-works-1298365.
[20] Jessica Williams, "New Orleans Deploys Video Chat Option for 911 Callers," The Times-Picayune, 23 December 2020. [Online]. Available: https://www.govtech.com/public-safety/new-orleans-deploys-video-chat-option-for-911-callers.html.
[21] Wikipedia, "Facebook outage," 2021. [Online]. Available: https://en.wikipedia.org/wiki/2021_Facebook_outage .
[22] P Vidul, Hari Shibin,P Pranave, J Vysakh and R Archana, "Telemedicine for emergency care management using WebRTC," pp. 1741-1745, 2015.
[23] Andrew Hutton, EENA, "WebRTC and Emergency Services," vol. 1, pp. 9-12, 2016.
[24] Vucic Dunja, Skorin-Kapov Lea, Suznjevic Mirko, "The impact of bandwidth limitations and video resolution size on Quality of Experience for WebRTC-based mobile multi-party video conferencing," pp. 59-63, 2016.
[25] Tarım Ergün and Tekin H, "Performance evaluation of WebRTC-based online consultation platform," Turkish Journal of Electrical Engineering and Computer Sciences, vol. 27, pp. 4314-4327, 2020.
[26] M. HOUSHMAND, "Policy and Charging Rules Function (PCRF) in LTE EPC Core NetworkTechnology," pp. 4-7, 2016.