

CISA 911 - WHAT'S YOUR EMERGENCY?

Underlying Risks Of NextGen 911 Systems

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Abstract

This paper will explore the potential risks of implementing multimedia-based Next Generation 911 (NG911) systems. The study will focus on the central issues that could arise from using multimedia-based NG911 systems, such as the difference in technology, carriers, policies, and resources between different PSAPs, user privacy and consent, secure storage, and data transmission, efficient transmission of data, and consent. We will discuss the implications of NG911, suggest best practices for secure implementation, and comprehensively analyze the risks and solutions based on the interviews conducted with people with a background in the emergency communication system. Finally, the paper suggests the development of standards and baseline requirements for developing robust security protocols and best practices in NextGen 911 to ensure the safety and privacy of users.

Literature Review

The next-generation 911 system is a revolutionary technology aiming to improve the efficiency of emergency response services. It utilizes advanced communication technologies and data analytics to provide real-time information to emergency responders and help them make better decisions in critical situations. This paper analyses the shortcomings of the current emergency communication system, the enhanced 911 system, and the NextGen 911 (NG911). To efficiently analyze the situation, the CISA team had one-on-one interviews with people with a background in emergency communication systems and conducted a comprehensive review of the available literature.

In Singhal and Neustaedter (2018) Caller Needs and Reactions to 9-1-1 Video Calling for Emergencies, The Author explores caller needs and reactions to 9-1-1 Video calling for emergencies. The Author collects information from interviews with 17 people who have called 911. People who have called 911 in the past can better analyze the needs of 911 callers. The Author found that many people would be willing to use video calling in 9-1-1 emergencies, mainly if it could provide helpful information to the 9-1-1 operator, such

as the location of the caller or the situation they are facing. One of the Author's interview participants said, "Having the actual imagery, the actual video would be beneficial because then you can see things that the reporter does not think to report."-P2F, 35-40. Having video-based solutions can indeed increase the accessibility of information as the 911 caller would not have to report every minor detail. The presence of a video-based solution would enable the call taker to watch and make observations for themselves. Implementing video-based solutions might be helpful to extract more information accurately but would also lead to issues that are discussed further.

Singhal and Neustaedter (2018) also identified challenges and potential concerns with implementing Video calling features in 9-1-1 services, such as anonymity, consent, culture and gender-based biases, and camera work based on the interviews. Participants of the interview also suggested that it is essential to get consent for privacy to keep the Video as a shred of evidence, but it should also be able to maintain anonymity for third parties. The interactions through a video can influence the state of mind of a telecommunicator, and the caller might be more susceptible to issues like cultural and gender biases through video interactions than through a voice-only call. The quality of the camera work can also affect the usability of a video call, as people tend to panic in emergencies. This paper gives us an understanding of the issues we should address while implementing a video-based next-generation 911 solution. Although the technical challenges of using multimedia data in call centers, such as video calling, may be addressed, the practical benefits of using Video calling in improving emergency response remain unproven.

In Neustaedter, Jones, O'Hara, and Sellen (n.d.) An analysis of next generation 9-1-1: Video calling for emergency situations. The authors conducted observations and contextual interviews within three emergency response call centers ranging from urban to rural areas for diversity to investigate and identify challenges in designing Video calling systems. Authors suggest addressing issues in designing Video calling in Next-Gen 911, such as control, information overload, and privacy while designing Video calling in

Next-Gen 911. Based on their analysis after observing the functionality of one such call center, the call taker and the dispatcher might be the same person. The CAD system displays questions a call taker asks during a 911 call. Information is filled in the CAD systematically. However, The contextual accuracy of this information needs to be improved. The authors discover that ingesting Video can increase the information a call center receives. It can also cause issues with the secure storage and transmission of the data. The volume of multimedia ingested will be discussed later in the paper.

Neustaedter et al. (n.d.) suggests that Contextual information is vital for 911 dispatchers because there is a state of panic in 911 callers, which hampers their ability to assess or describe their situation correctly. This can be better understood in the work of Kevoe Feldman (2021). Information such as the situation's location and intensity must be conveyed correctly to the responders. Video calls can be a valuable tool and can also aid in cases of language barriers. Neustaedter et al. (n.d.) concludes that there is a need for security standards for the data at rest and in transit, as it could lead to a breach of privacy, and graphic content can induce unwanted stress in call takers. The above study suggests that Video calling could provide more accurate contextual information to dispatchers. However, standards must be set up to control the amount of data along with the way that data is processed so that it does not induce stress or lead to privacy issues.

In Corral-De-Witt et al. (2018) From E-911 to NG-911: overview and challenges in Ecuador, The authors discuss enhanced 911 technology implemented in ECU 911 throughout Ecuador and suggest that it is necessary to identify the existing technology and procedures of the next-generation services. The authors also briefly compare the implementation of the ECU 911 to NG 911. The general direction that has doctrines for training for all the staff members regarding emergency response to elaborating the regulation and procedures to attend alerts and emergencies until it is transferred to the FRIs is suggested based on the analysis of the E-911. It also consists of the guidelines for the use of technology in PSAPs and introduces the Project and Innovation National

Direction, which is responsible for developing new research projects, and implementation of applications that are required for service operation. Furthermore, the Technological Infrastructure Management ensures the proper functioning of all the technological infrastructure deployed to receive alerts and video surveillance along with coordinating emergency responses. The migration to NG 911 includes the standards and regulation doctrines and the integration of ECU911, Geographic information system, and 911 calls. It also allows for inter-PSAP communication, which aids in enhancing the ECU 911 systems. These features show the implementation of NENA standards, and other such implementations are discussed in Kelic, Aamir, Kelic, Jrad, and Mitchell (n.d.) A Generalized Framework for Modeling Next Generation 911 Implementations

The Goldstein (2018) NEXT GENERATION 911-National 911 program could strengthen efforts to assist States; describes the progress of state and local bodies in implementing NextGen 911. It includes extensive research on fee collection and costs for next-gen 911 and identifies the main challenges as funding, evolving technology, operations, and governance. GAO Reports from 2017 make it evident that the State and local funding may be insufficient to support costs associated with transitioning to NG911 equipment and infrastructure. NHTSA and NTIA jointly plan on administering a 115 million dollar grant program to improve 911 services, including the adoption and operation of NG911 services.

Goldstein (2018) indicates that it is difficult to transition from legacy infrastructure to IP-based next-generation systems, which possess technical and operational challenges such as interoperability, cybersecurity risks, and lack of technology-based training. The article is curated with inputs from NHTSA's National 911 Program and DHS officials, which is a guide in 2016 that identifies cybersecurity risks for NG911 and risk mitigation strategies. This shows the challenges related to evolving roles for state and local 911 authorities could hinder NG911 implementation. The paper shows the implementation of an advisory body tasked by the FCC, which is a report that identifies NG911 governance approaches, issues, and recommendations for states, localities, and call centers to consider

when planning for the deployment of NG911. The difference in the existing technology resources from PSAP to PSAP can make it challenging to overcome the requirements gap between legacy systems and next-gen 911. However, sufficient data from the past and motivation by such a periodic report would help understand the progress of the nationwide implementation of next-generation 911 systems.

In Grace and Kropczynski (2020) *Communicating Next-Generation 911 with local 911 professionals*: Preliminary recommendations, the authors present the research conducted based on the 911 early adopter summit. They performed a SWOT analysis based on the experiences of the early adopters of NG-911. The authors suggest preliminary recommendations to improve resources available to local 911 professionals adopting NG911 systems for providing efficient multimedia 911 services. The authors assume that PSAP telecommunications would consider multimedia as a crucial upgrade in technology to improve the current 911 systems. The Author's assumption about the benefits of ingesting multimedia lacks proper research, and the practical benefits of multimedia are yet to be proved.

In Sun, Chen, Chen, and Huang (2017), The authors propose a method for scene classification using discriminative representation. The method involves extracting features from an input image using convolutional neural networks. It has these features to train a classifier using a discriminative representation learning algorithm. The method combines multiple local features, such as GIST and HOG, into a global representation, which is then used to classify the scene. The authors evaluate their method on two famous scene classification datasets, showing that it outperforms several existing methods in classification accuracy. Overall, the paper demonstrates the effectiveness of discriminative representation learning for scene classification, which can be used in the implementation of NextGen 911 for classifying scenes to aid the process of using multimedia to quickly and efficiently utilize resources in 911 centers.

In Vinson, Lapointe, and Lemaire (2022), *An Emergency Centre Call Taker Task*

Analysis An Emergency Centre Call Taker Task Analysis, The authors of this research sought to analyze the task of an emergency center call taker. They conducted a literature review of studies that focused on the task of call takers, including their roles, responsibilities, strategies for handling calls, and strategies for managing stress. The authors found that call takers often take on various roles, including providing emotional support, reassurance, and guidance and helping callers access services, which might increase the stress levels of the telecommunicators. Several strategies were identified for managing the stress associated with this role, such as increasing social support, providing access to mental health services, and managing workloads. The authors also identified several challenges that call takers face, including high levels of stress, the need for frequent retraining, and the need for effective communication with other professionals. Call takers require ongoing support to successfully manage the stress associated with their role and communicate effectively with other professionals. Dicks (2014) Overall, this study provides a critical review of the literature on the tasks of an emergency center call taker.

Research Design / Methodology

Next-generation 911 (NG911) systems are designed to handle various communication methods, including multimedia, such as text messages, images, and video. When prioritizing multimedia incidents in an NG911 system, several factors can be considered, such as the type of emergency, the location of the incident, and the amount of information the caller provides. For example, a call reporting a life-threatening emergency, such as a heart attack or a shooting, would likely be prioritized over a call reporting a less serious issue, such as a power outage or a traffic accident. Similarly, a call reporting an incident in a high-risk area, such as a school or a hospital, would likely be prioritized over a call reporting an incident in a less critical location. In addition to the type of emergency and location, the amount and quality of information the caller provides can also be used to prioritize multimedia incidents. For example, a call that includes detailed information, such as a description of the incident and the caller's location, would likely be prioritized over a call that provides little or no information. Overall, the specific criteria used to prioritize multimedia incidents in an NG911 system may vary depending on the specific requirements and policies of the organization implementing the system.

Interview Process

Interviews are an important part of the research process because they allow researchers to gain insight into the experiences and perspectives of the people they are studying. Interviews can identify emergency responders' specific challenges and needs and help develop methodologies for next-generation 911 problems. By understanding these stakeholders' unique issues and concerns, researchers can develop methodologies tailored to address their needs and are more likely to address the problems facing the 911 system effectively. Additionally, interviews can provide valuable information about the current state of the 911 system, including any gaps or limitations in the existing infrastructure and technologies, which can help researchers identify areas where new approaches and solutions are needed.

The CISA-sponsored research started around August 2023 to understand the underlying risks and prioritize multimedia incidents information to dispatch resources quickly and effectively to reduce the stress on PSAP call takers. The best way to find a solution/methodology is through beneficiary discovery. There are many research suggestions for the smooth integration of next-gen 911 problems. The initial discovery suggests the apparent solution of implementing artificial intelligence to process and prioritize multimedia. However, Interviewing personnel with experience in Emergency communication systems, such as PSAP call takers, 911 program directors, 911 State administrators, dispatchers, and various responders, revealed that there are many underlying risks in doing so without having a comprehensive study on its benefits and consequences.

When Joni Harvey, the 911 state administrator of Michigan, was asked about their views on the NextGen 911, she said NextGen 911 could change how we look at emergency communication services, but there is a lack of standardization. The authorities should ensure that multimedia is integrated with existing 911 systems to provide a seamless user experience. There is a strong need to provide a secure, reliable, and fast connection for multimedia transmissions. It is essential to work with law enforcement and stakeholders to prioritize the development of protocols and standards that allow efficient multimedia integration with the current 911 system. It also requires developing tools and technologies that support multimedia integration into 911 systems. Finally, there is a need to create training and educational materials for 911 operators on effectively using multimedia in 911 systems. The Most valuable product (MVP) is designed after analysis of the interviews with personnel related to emergency communication systems

Artificial Intelligence

The development of artificial intelligence (AI) has provided an innovative approach to addressing the challenges of prioritizing multimedia in next-gen 911 emergency services. AI-based solutions can use machine learning algorithms to analyze and prioritize incoming

multimedia messages. However, the accuracy and efficiency of implementing such a solution in life-or-death emergencies are yet to be proven.

First, AI-based solutions can use natural language processing (NLP) to identify relevant keywords in multimedia messages and assign them a priority level. For example, NLP can detect words that indicate a severe emergency, such as "fire" or "help," and prioritize those messages accordingly, which can help emergency responders quickly identify correctly and respond to urgent situations. Secondly, AI-based solutions can also analyze incoming multimedia messages for contextual information. Multimedia can include determining the geographical location of the call as well as the caller's age and gender, which can help to decide which responders are best suited to handle the emergency. Scrapping the multimedia for such contextual information can ensure that dispatchers allocate the right resources to address each crisis quickly and effectively. Using scene classification algorithms can be helpful in understanding situations better, such as fire, accidents, drowning, or theft. Finally, AI-based solutions can utilize object detection technology to identify potential emergencies. This technology can detect objects, people, and even animals in real-time, allowing emergency services to respond more quickly and accurately. Object detection can identify hazardous materials, weapons, and possible explosives. It can also identify objects indicating a crime in progress or a potential terrorist threat, monitor traffic, detect fires, and monitor weather conditions. Object detection can also pinpoint suspicious activity in public areas, such as parks and schools.

In an interview with the senior engineers of Securelogix, the company that is currently developing artificial intelligence algorithms for NextGen 911, they said that there is a lack of labeled datasets to train such artificial intelligence models, and it is difficult to train algorithms for a high accuracy without the availability of abundant datasets. Overall, AI-based solutions can help improve the efficiency and effectiveness of next-gen 911 services by providing more accurate, timely, and effective emergency responses. However, using machine learning algorithms to analyze and prioritize incoming multimedia messages can

have a lot of underlying risks.

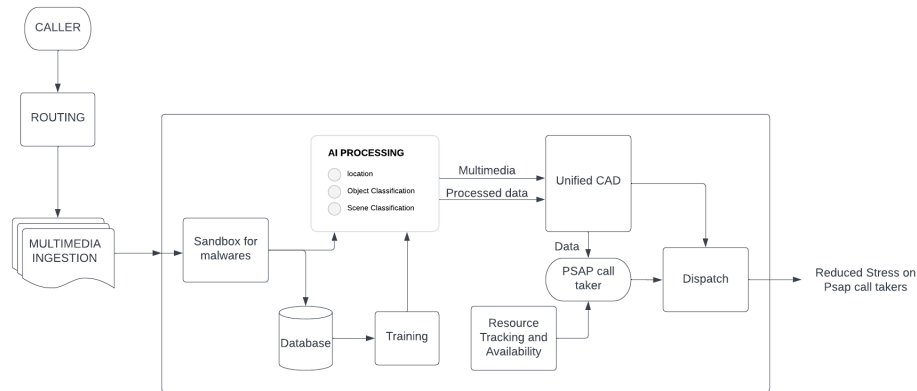


Figure 1: Most Valuable Product

Security Implications

Ingesting any multimedia into a unified system can lead to various security risks. The best way is to scan the multimedia for malware in a sandbox environment. Copy only the benign files to a central database for training the AI after the scan is completed for better prediction and evidence purposes in the future based on consent.

In an interview, Christopher Fish said that PSAP call takers have to deal with a lot of stressful activities daily showing multimedia to them might increase their stress levels even more. Directly routing multimedia to PSAP call takers might induce stress and hamper decision-making ability. Therefore our MVP suggests that the AI process the data for information and only send the processed information to the PSAP call taker. The call taker can use this information to utilize available resources and route the multimedia to the appropriate responder. According to the processed information, a dispatcher will assign the task and send the multimedia to a responder. Responders can prepare better for the situation using multimedia. The AI can be used as an assistant until the trained dataset can achieve perfect accuracy to prioritize incidents and allocate resources.

Standardization

Later stages of discovery revealed a lot of underlying risks in the implementation of an AI solution. There is a massive gap between the current resources and the desired next-gen

911 systems, which brings a need for standards in 911 systems throughout the nation.

When Darold Whitmer, Executive Vice President of NGA 911, was asked about the central issue in the implementation of NextGen 911, he said that the significant point is that 911 centers do not have standard protocols or authorities, which can lead to severe problems, 911 centers operate at the local, state, and even federal levels. Which can lead to differences in how calls PSAPs answer call, the types of equipment used, and the protocols in place for responding to emergencies.

For example, not all 911 centers have the same kinds of CAD equipment. Some may have outdated technology or inadequate equipment. In contrast, others may have the latest communication and response technology which can lead to delayed response times or even missed calls if the equipment needs to be up to the task. In addition, some 911 centers may have different protocols for responding to emergency calls. Sometimes, this can result in delayed responses or even missed calls.

The lack of standardization can also lead to a lack of training for the PSAP call takers. 911 centers may not provide training to their staff, or they may not provide the same level of training to all of their employees, which can lead to a lack of knowledge and expertise and might make it challenging to provide the best possible service to needy citizens.

Finally, the lack of standardization can lead to confusion when multiple 911 centers are involved in an emergency. Clear protocols and standards make it easier to coordinate between multiple centers, leading to delays in response times and potential confusion. The lack of standardization in 911 centers is a serious issue that can lead to delayed response times and missed calls.

To ensure the best possible service, 911 centers need standardized protocols, up-to-date equipment, and proper training for their staff. Standardization can also solve the discrepancy in funding from PSAP to PSAP and make migration to NextGen 911 a smooth process.

Conclusion

In conclusion, It is necessary to evaluate the potential benefits of multimedia in enhancing the efficacy of 911 systems. There is a strong need to implement standards and baseline requirements for next-gen 911 before any artificial intelligence solution can be deployed for processing multimedia. Without such measures, the next-gen 911 would be vulnerable to loopholes and attacks. Future work can include research on the impact of these new standards, further studies on reducing stress on telecommunicators, and aim for the development of new technology to enhance the Next Generation 911.

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