Proposal for robust person-to-person communications system for large-scale emergency displaced population of people and pets

David H. Parker

Parker Intellectual Property Enterprises, LLC
Earlysville, VA, USA
david@parker-ip-ent.com

Abstract—Lessons learned about person-to-person communications and reuniting people and pets through major emergencies from September 11, 2001 through 2018 are reviewed. Congressional attempts to rectify problems are listed. Abandonment of the National Emergency Family Register and Locator System (NEFRLS) by FEMA, the American Red Cross Safe and Well Program, and social media systems are reviewed. New enabling technologies, that have heretofore not been exploited for the purpose, are reviewed. A new, rapidly deployable, person-to-person communications method that more fully exploits state-of-the-art communications technology, removes barriers, and is as simple to use as a telephone, is proposed. In particular, the proposed system is equipped to handle a large nomadic component, which could potentially be millions of people and pets. For example, an earthquake, tsunami, nuclear power plant malfunction, chemical plant malfunction, terrorist act, or war.

Index Terms—emergency management, emergency communications, resiliency, degrees of separation, Voice over Internet Protocol, Local Number Portability, North America Numbering Plan, voicemail, email

I. INTRODUCTION

The terrorist attacks on the United States on September 11, 2001 (9/11) exposed a fundamental lack of resiliency in person-to-person communications. In particular, survivors of the attack in New York City were frustrated by telephone networks overloaded by frantic callers desperately trying to locate friends, family members, and business associates. Recall that the iPhone would not be introduced until 6/29/2007, so cell phone use was in its early days, with low bandwidth and expensive pay-by-the-minute plans. Those with cell phones experienced dropped calls, due to the traffic overload, and found the batteries soon depleted by intense

use. Bridges were closed as precautionary measures, which left many thousands without transportation out of the city–and no way to coordinate plans with others, such as car pool riders. Many simply resorted to start walking and hope they could get home, somehow, to anxiously awaiting families.

Title 18 of the US Code, Section 2331 (18 U.S.C. §2331) defines the intent of terrorism to include, "to intimidate or coerce a civilian population". The widespread fear, bolstered by the lack of communications, was clearly one of the predicted objectives of the attack. Moreover, the attack specifically targeted the financial and trade center of the US, as well as the center for the television broadcasting industry, which caused the terrorist intimidation and coercion to radiate around the world.

With entire businesses destroyed, many coworkers lost their only means of communicating with each other. With personnel records lost, and company phone, fax and Internet systems destroyed, surviving employees had no way to coordinate recovery plans. As a last resort, people posted huge numbers of paper messages at locations they shared with missing persons–such as bus stops, bars, restaurants, and hospitals–in hopes that someone could offer some information about the person. This was well illustrated in the iconic AP photo, by Beth Keiser, taken at Ray's Pizza on 9/14/2001 [1], [2].

Nearly 4 years later, on August 29, 2005, New Orleans was flooded, due to Hurricane Katrina, with no better resiliency in the person-to-person communications. Note that this was still before cell phones became ubiquitous, and most telephone communications was via land lines, which in many

cases, the hand sets and answering machines were under feet of water.

For the first few days, television coverage was confusing and limited to aerial views and scenes of refugees huddled on bridges and other higher ground sweltering in the sun. Desperate refugees pleaded for information on loved ones via quick television interviews. But there was no television service to be had by the refugees, and if by chance someone watching that cable network had known something, there was no way to get a message back to the person making the plea! Once they walked away from the interview, they simply blended back into the crowd with no way to follow up.

Eventually, the military established order and the decision was made to evacuate the refugees to cities that had the resources to shelter and feed them. Many were bused to Houston, but others went to other scattered cities in Louisiana and states that offered to help. Due to the large numbers, and desperate conditions (1,836 lives were lost), there was no pretense of registering or tracking the whereabouts of refugees–they were all too happy to get on a bus going anywhere that had food, water, sanitation, shelter from the sun, and a dry bed.

Trying to reconnect families and friends was a huge logistical problem. CNN listed 28 links to aid in locating the missing [3], and there were many others by volunteers, such as one by local attorney Sharon Keeting, which listed 65 links.

At that time, shelters did not accept pets, so many stayed behind to rough it out with their pets. Many pets were lost and collected by rescue volunteers. But even if they had identification, or a micro chip, the owners could not be contacted. Dogs and cats were transported all across the US by volunteers to shelters that would accept them. Attempts were made to reunite owners with pets via the Internet, e.g., see the site by Marfurt [4]. However, in most cases they were never to be seen by their owner again. This also raised legal ownership ramifications, as described by Shapiro [5].

On March 11, 2011, an earthquake and tsunami off the coast of Tohoku Japan resulted in 15,878 death, 6,126 injuries, and 2,713 missing [6]. The communications infrastructure was destroyed in a large region of the country. Backup generators for the Fukushima Daiichi Nuclear Power Plant were flooded by the tsunami which resulted in the sudden evacuation of over 200,000 people, in a 20 km radius of the plant, to avoid radiation exposure.

On October 29, 2012, a storm surge by Superstorm Sandy, in New Jersey and New York, resulted in 131 fatalities [7]. Subways and tunnels were flooded and power was pre-emptively shut down. Seven years after Katrina, there was still no central system for reuniting lost pets with owners, which was covered extensively in the news [8]–[17].

On August 25, 2017, Hurricane Harvey made landfall in Texas. It continued to dump rain on the Houston metro for days, causing extensive flooding requiring mandatory evacuation of 725,000 [18], [19]. As reported in the media, lessons from Hurricane Katrina saved lives in south Texas [20], and social media was used as backup to chocked emergency call systems [21]. Even though cell phone use had become common by 2017, person-to-person communications was still a major problem [22].

On September 20, 2017, Hurricane Maria hit Puerto Rico, destroying most of the power and communications infrastructure and killing 2,975 [23]. The American Radio Relay League (ARRL) was called upon to send amateur radio operators to the island in order to establish fundamental communications for rescue efforts [24].

The Camp Fire, in Northern California, started on November 8, 2018 and was contained by November 25. It resulted in 85 deaths and destroyed 18,804 structures [25]. Due to the rapid spread of the fire, people had to evacuate with little warning. Many were trapped and could not evacuate. A New York Times story featured a photo, by Jason Henry [26], of a makeshift bulletin board with postings searching for information on people–much like the Ray's Pizza photo by Beth Keiser, following 9/11. Following what has become a regular pattern, the media and volunteers maintained information sites on the Internet to help locate missing persons and pets [27]–[30].

II. ATTEMPTS TO RECTIFY COMMUNICATIONS AND PET PROBLEMS

In the aftermath of Hurricane Katrina, President Bush enacted Executive Order 13407 authorizing a Public Alert and Warning System. This became the Integrated Public Alert and Warning System

(IPAWS) [31]. Congress enacted the Post-Katrina Emergency Management Reform Act (PKEMRA) on October 4, 2006. The Act made provisions for a National Emergency Family Register and Locator System (NEFRLS) to be implemented by the Federal Emergency Management Agency (FEMA) in order to help reunify families separated after an emergency or major disaster [32]. Congress also enacted the Pets Evacuation and Transportation Standards Act (PETS) on October 6, 2006 [33]. The Act authorized FEMA to give shelter and care to people with service animals and household pets in a major disaster or emergency.

It is somewhat surprising, despite the case histories recited hereinabove, that FEMA has taken the position that there is no longer a need for FEMA to support NEFRLS, and states: [34]

> The National Emergency Family Registry and Locator System (NEFRLS) was developed in compliance with the Department of Homeland Security Appropriations Act, 2007, SEC. 689c to help family members separated after an emergency or major disaster to communicate and reunite with one another.
>
> Since that time, non-federal technologies, including American Red Cross Safe and Well, Facebook Safety Check, and Google Person Finder are now providing these services. In addition, the increased prevalence of smart phone use with texting capability **makes a government-sponsored reunification capability unnecessary** [emphasis added]. Due to the impact of social media and widely accepted innovative solutions, the NEFRLS has been found to be obsolete.

It is ironic that the purpose of NEFRLS was to provide a single registry, in order to eliminate the uncertainty of where to find information on displaced individuals, as experienced following Hurricane Katrina–and all following emergencies. Due to the failure of NEFRLS, other registries sprang up to fill the vacuum [35]–[37]. Now FEMA seems to be encouraging a proliferation of platforms, while backing away from the Congressional mandate of 6 U.S.C. §775 [32].

III. AMERICAN RED CROSS SAFE AND WELL PROGRAM

Of the services cited by FEMA to replace NE-FRLS, the American Red Cross Safe and Well Program [35] is the only organization that provides staffing and support for finding displaced individuals, i.e., Facebook and Google do not send people into the field to assist refugees. None of the cited organizations deal with pets, which are mostly dependent on ad hoc volunteer efforts.

The Safe and Well registry is an Internet based system, i.e., there are no provisions for unassisted registration, or retrieval, by telephone, email, text, etc. A user is presented with an option to "List myself as Safe and Well", or "Search Registrants". The registrant selects from a list of events, list as an individual or Organization, enter a first name and last name (or Organization Name), enter an optional email address, enter an optional birthdate, home country, primary phone, work phone, other phone, home address, and best contact information. The registrant can then select from 14 pre-defined messages, and optionally enter a custom message of 255 characters.

A searcher enters the first and last names (or name of Organization) of the registrant and either a phone number, or a complete home address. If the search produces a hit, the message provided by the registrant will be made available to the searcher. There are no provisions for the searcher to leave a message, or know who else is searching for the registrant.

While the Safe and Well Program has improved over the years, there are still a number of limitations. For example:

1) The registration process requires much information that is not available (or useful) to a searcher, which could be argued is counterproductive under adverse conditions.
2) A name search is problematic since a person may be known only by a nickname, the spelling may be difficult or ambiguous, or it may be very common (particularly for Asian last names), e.g., Bill, Buddy, Cowboy, Dworakowski, Chen, Lee, etc.
3) Internet access by the registrant is required, which probably means equipment and service

must be provided by relief agencies, e.g., it would be cumbersome for an amateur radio operator to relay all of the required registrant information.

4) Due to the systems architecture, there are no provisions for telephone, text, voicemail, or email entry/access.
5) There are no provisions for two-way messaging.
6) There are no provisions for associates of the subject person to exchange information among themselves *about* the subject person (neighbors, co-workers, friends, church members, class mates, etc.).
7) There are no provisions for letting the registrant know a pet has been found.
8) Could take days to implement.

The American Red Cross provides good tips for contacting loved ones [38], such as calling friends and relatives of the subject person, as well as other associates. While good advice, it is still hit-and-miss–and may further choke the existing communications infrastructure.

IV. SOCIAL MEDIA

While social media can be helpful, there are several aspects of the architecture that are inherently counter to the objectives under emergency conditions. By design, social media is structured to provide security of personal information that has already been amassed in a subject's account. It is designed to only let certain people in. Due to the personal nature of the information in a subject's account, they may not want their coworkers, neighbors, church members, etc. to have access to all their social information. For this reason, someone that has not been pre authorized can not communicate with the subject. Moreover, they will not see a posting by, or about, the subject.

If the subject lost their computer and/or smart phone in the emergency, there is a good chance that they will not remember the requisite passwords to access their social media account from another computer or phone. This could particularly be a problem for the elderly, children, and less educated.

V. ENABLING TECHNOLOGIES

It will be argued that there is a convergence of enabling technologies that make a much simpler, and more resilient, person-to-person communications system practical. Moreover, these technologies fall most closely under the expertise of the IEEE membership–which makes this symposium an ideal forum to promote discussions between those that understand the technologies and emergency managers that understand the needs on the ground.

Voice over Internet Protocol (VoIP) allows voice, fax, text, and voice-messaging over the Internet [39]–[41]. Local Number Portability (LNP) means that phone numbers can be assigned without being physically tied to a specific wire in a switching center, i.e., numbers are like a pointer to a particular subscriber, which can automatically be created almost instantly by software [42].

The North America Numbering Plan (NANP) designates three digit area codes–many of which are not assigned [43], [44]. For example, the area code 811, which would be easy to remember as a counterpart to the familiar emergency 911, is not assigned.

Software as a Service (SaaS), Infrastructure as a Service (IaaS), and cloud computing make it practical to contract for hardware and software resources, as a contingency–which can be activated on very short notice [45], [46].

Voice recognition software now routinely, and fairly accurately, converts digital Waveform Audio File Format (WAVE) voice messages to text, which can be sent as an email, text message, or the WAVE attachment. Voicemail is now stored and transmitted digitally, i.e., voicemail boxes are simply folders of data files, which can be sent to the cloud for storage. This allows virtual voice message mailboxes to be created in the cloud, with no need for an associated physical telephone device. Likewise, text to voice software makes email messages retrievable as voice messages.

VI. PROPOSED ARCHITECTURE

Clearly, a rapidly deployable person-to-person communications method that more fully exploits state-of-the-art communications technology, removes barriers, and is as simple to use as a telephone, is needed. In particular, one that is equipped

to handle a large nomadic component, which could potentially be millions of people and pets. For example, following an earthquake, tsunami, nuclear power plant malfunction, chemical plant malfunction, terrorist act, or war.

A key feature of the proposed communications system is the need for a unique, unambiguous identifier for the subject. As explained hereinabove, a name search is problematic, and in many cases, associates do not know the subject's address, birthday, etc. However, most associates will know, or can find, a telephone number associated with the subject. For that reason, it will be argued that a telephone number is the best solution for a short, precise, identifier. However, the subject's actual telephone hardware will likely be out of service or destroyed in the emergency. What is needed is a virtual communications channel that utilizes the identifier, but employs hardware that is located outside the emergency region.

An architecture which exploits such a state-of-the-art communications technology will now be proposed.

A central planning sponsor, such as FEMA, the American Red Cross, or other NGO, would secure exclusive use of a presently unassigned area code–811 for example.

Vendors would be contracted to provide a contingency for SaaS and IaaS through cloud resources, on short notice. The vendors would make provisions whereby, when activated by the sponsor, computing and storage would automatically be allocated to set up voicemail boxes for potentially every phone number in the exclusive area code, i.e., up to 10^7 virtual subscribers. Access would be without password protection and available to all to retrieve messages and record messages–but not to delete messages.

Of course the storage resources could be dynamically allocated as needed. For example, the first call to a number could initiate automatic setup of the voicemail box for that number and subsequent calls to the number would be directed to the designated box.

It will be recognized that an emergency may span several area codes and cell phones are assigned many area codes, so in some cases several subscribers may be assigned to the same box, i.e., much like early telephone party lines. Since there is no expectation of privacy anyway, this would not be a problem. Many people have a plurality of phones for different classes of use, e.g., cell phone for family and close friends, business for customers and clients, home for general purpose, etc. Separate accounts would be set up for each number. It will also be recognized that spam messages by robocalls would need to be blocked, or automatically deleted from the messages by the vendor's software.

In addition, email resources would be allocated to create corresponding email addresses that are not password protected–except instead of using the exclusive area code prefix, the 7 digit subscriber number would be the prefix for a unique domain name, such as @redcross.org, as explained in the examples below. Voicemail messages would automatically be converted to text and sent to the corresponding email address. Likewise, email messages would automatically be converted to voicemail messages and deposited in the corresponding voicemail box.

Think of the email and voicemail accounts as an electronic version of the postings in the photos of Ray's Pizza [1], [2] and the Camp Fire [26], except there would only be one unique place for everyone to look for information about a subject associated with a subscriber number.

Security would not be a problem, because just as posting a notice on a billboard, there would be no expectation of privacy. No information is registered with the sponsor–the voicemail box and email are automatically provided *sua sponte* for any telephone number. The subject is free to use it, or not. After the emergency ends, the data would be deleted.

A displaced subject, or associate, would call the 7 digit phone number, using the exclusive area code prefix, e.g., (811)867-5309. The call would be sent to the voicemail box. Messages could be recorded or played by anyone. Likewise the subject, or associate, could access the corresponding email account using the 7 digit phone number, e.g., 8675309@redcross.org, without a password. It would be highly efficient for amateur radio operators to relay a short message, identified only by the subjects telephone number, to an operator outside the emergency region to post as an email message.

Such a system would greatly enhance the person-to-person communications efficiency–with no assistance by the sponsor–and reduce traffic. This

would free emergency workers to concentrate on actual emergencies. By allowing open access to the information–with no registration required–associates, neighbors, church members, co-workers, and people that don't even know each other–but share an interest in the subject in common–could exchange information *about* the subject. While they are already communicating, the subject may in fact be deceased, be in the hospital, or sitting on a rooftop waiting to be rescued.

Meanwhile, associates could construct probable scenarios as to the disposition of the subject, without wasting time and resources on dead ends and repetitious searching. For example, a neighbor may report that his car is not in the driveway, or that the subject was on a business trip to Chicago that week. A co-worker may report that he left work early to go to a ball game. A buddy from the local watering hole may report that he didn't show up at his usual time. A minister may report that he has been admitted at a specific hospital. And this could be communicated either by phone or email.

A lost pet that simply had a telephone number identification, or micro chip, could easily be matched to the owner, or their agent. The phone number could be on the dog tag, collar, or hastily marked on duck tape attached to a leg (like a hospital wrist band). If the owner was not responding, a brother-in-law, cousin, or neighbor could go and pick the pet up and leave a message that the pet is being cared for.

At the conclusion of the emergency, the sponsor would notify the vendors to disable the system and free up the cloud resources. Some of the aspects of the proposed architecture are disclosed in a family of US Patents [47]–[49].

By having a single sponsor, as envisioned by the NEFRLS legislation, there would be at least a unique first point of contact. Instead of searching the 28-65 links following Hurricane Katrina, the probability of finding at least some information would be greatly expedited. Moreover, the absence of information after a period of time would justify classifying the person as missing and worthy of search and rescue resources.

It should be noted that the idea that all people are six, or fewer, social connections from each other is exploited by this proposal, i.e., the Six Degrees of Separation Theory [50]. For example, people that are known by the subject are separated from the subject by one degree of separation. However, many of them do not know each other, and are therefor separated from each other by two degrees of separation e.g., a co-worker probably does not know the subjects cousin or neighbor. The proposed system brings the second degree of separation persons together to share information *about* the subject–which greatly improves the efficiency of the process–and reduces the load on the communications infrastructure.

VII. CONCLUSIONS

It can be argued that in all of the previous emergencies cited hereinabove, such a system would have helped expedite reuniting people and pets, reduced the communications load, reduced the anxiety level, and in the case of terrorism, reduce the intimidation level. It can also be argued that as of the California Camp Fire in 2018, a better system is not presently in place.

All of the required enabling technologies and infrastructure already exist and are economically available. Millions enjoy free email services which they can subscribe to in minutes. Telephone service providers can be switched seamlessly while keeping the same number. Voicemail is already stored in the cloud and emails are routinely sent to the subscriber with voice to text and attached WAVE files of recorded voice messages.

What is needed is leadership in the emergency management community to rethink how person-to-person emergency communications can exploit the technologies, which the IEEE community could help shape.

For the purpose of this symposium, the fundamental ideas have been discussed at a high level, avoiding unnecessary technical details. It is inevitable that others will see solutions to overlooked details and enhancements that could improve the implementation.

While the proposed architecture is directed to implementation in the United States, it will be recognized that similar architectures would be beneficial in other countries *mutatis mutandis*.

The author welcomes all comments, suggestions and questions.

REFERENCES

[1] A. Taylor, "9/11: The Decade Since," The Atlantic, Sep. 2011, includes AP Photo by Beth Keiser, taken on 9/14/2001, of missing persons postings on Ray's Pizza store front. [Online]. Available: https://www.theatlantic.com/photo/2011/09/911-the-decade-since/100144/

[2] J. Moss, "Jeremiah's Vanishing New York," Sep. 2012, describes setting for AP Photo by Beth Keiser, taken on 9/14/2001, of missing persons postings on Ray's Pizza store front. [Online]. Available: http://vanishingnewyork.blogspot.com/2012/09/rays-after-911.html

[3] "Hurricane Katrina Help Center," CNN, 2005. [Online]. Available: http://www.cnn.com/SPECIALS/2005/katrina/help.center/

[4] J. Marfurt, "More places to look for missing Katrina/Rita pets," Dec. 2005. [Online]. Available: http://moreplacestolook.blogspot.com/

[5] J. M. Shapiro, "Pet Ownership in the Aftermath of Natural Disasters," Seton Hall University eRepository Seton Hall, May 2014. [Online]. Available: https://scholarship.shu.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1531&context=student_scholarship

[6] "2011 Tohoku earthquake and tsunami," Wikipedia. [Online]. Available: http://en.wikipedia.org/wiki/2011_T%C5%8Dhoku_earthquake_and_tsunami

[7] "Hurricane Sandy," Wikipedia. [Online]. Available: http://en.wikipedia.org/wiki/Hurricane_Sandy

[8] "Pets Lost and Found in Sandy's Wake," ABC News, Nov. 2012. [Online]. Available: https://abcnews.go.com/US/pets-lost-found-sandys-wake/story?id=17616868

[9] A. S. Ayres, L. Cross, and S. Meliker, "After Superstorm Sandy, Pets Are Rescued By Animal Support Groups," Huffington Post, Nov. 2012. [Online]. Available: https://www.huffpost.com/entry/superstorm-hurricane-sandy-pets-animals-rescue_n_2066276

[10] A. Hunger, "Hurricane Sandy leaves thousands of pets in need (PHOTOS)," Reuters, RT USA, Nov. 2012. [Online]. Available: https://www.rt.com/usa/sandy-leaves-pets-need-919/

[11] A. Sacks, "Lost and stray animals in wake of Hurricane Sandy need New Yorkers' help,," New York Daily News, Nov. 2012. [Online]. Available: https://www.nydailynews.com/new-york/sandy-displaced-animals-article-1.1199764

[12] V. Dobnik, "Hurricane Sandy: Pets Are A Priority For Some Hit By Storm," The Associated Press, Huffington Post, Nov. 2012. [Online]. Available: www.huffingtonpost.com/2012/11/13/hurricane-sandy-pets-storm_n_2121173

[13] A. Sacks, "Sandy victims hunt for missing pets," New York Daily News, Nov. 2012. [Online]. Available: https://www.nydailynews.com/life-style/sandy-victims-hunt-missing-pets-article-1.1203559

[14] "Rescue groups push to reunite displaced Sandy victims with missing pets," New York Daily News. [Online]. Available: https://www.nydailynews.com/life-style/push-reunite-sandy-vics-pets-article-1.1211360

[15] V. Dobnik, "Fate of pets adds to Sandy survivors' stress," The Associated Press, The Salt Lake Tribune, Nov. 2012. [Online]. Available: https://archive.sltrib.com/article.php?id=55273156&itype=CMSID

[16] A. Sacks, "Pet missing after Hurricane Sandy found by owner at shelter day before he's scheduled to be euthanized," New York Daily News, Jan. 2013. [Online]. Available: https://www.nydailynews.com/life-style/dog-slated-put-found-owner-article-1.1233776

[17] V. Dobnik, "Superstorm priorities for some include saving pets," San Diego Union Tribune (Associated Press), Nov. 2012. [Online]. Available: https://www.sandiegouniontribune.com/sdut-superstorm-priorities-for-some-include-saving-pets-2012nov13-story.html

[18] D. Frosch, "At Houstons Overcrowded Convention Center, Harvey Evacuees Face Fear and Uncertainty," The Wall Street Journal, Aug. 2017. [Online]. Available: https://www.wsj.com/articles/at-houstons-overcrowded-convention-center-harvey-evacuees-face-fear-and-uncertainty-1504048000

[19] R. Gold, D. Frosch, B. Kesling, and C. M. Matthews, "Harvey Makes Landfall in Louisiana as Waters Keep Rising in Texas, Appeared in the August 30, 2017, print edition as 'Harvey Forces Thousands to Flee.'," The Wall Street Journal, Aug. 2017. [Online]. Available: https://www.wsj.com/articles/harvey-continues-assault-on-houston-as-it-turns-toward-louisiana-1504019187

[20] E. Board, "The Hurricane Learning Curve," The Wall Street Journal, Aug. 2017. [Online]. Available: https://www.wsj.com/articles/the-hurricane-learning-curve-1504048070

[21] D. Seetharaman and G. Wells, "Hurricane Harvey Victims Turn to Social Media for Assistance," The Wall Street Journal, Aug. 2017. [Online]. Available: https://www.wsj.com/articles/hurricane-harvey-victims-turn-to-social-media-for-assistance-1503999001

[22] J. Healy, "At a Shelter in Texas, Desperate for Clues to What Happened Back Home," The New York Times, Aug. 2017. [Online]. Available: https://www.nytimes.com/2017/08/28/us/hurricane-harvey-evacuees-shelter-texas.html

[23] "Hurricane maria," Wikipedia, 2017. [Online]. Available: https://en.wikipedia.org/wiki/Hurricane_Maria

[24] "Ham radio operators are saving Puerto Rico one transmission at a time," CNN, Sep. 2017. [Online]. Available: https://www.cnn.com/2017/09/27/us/puerto-rico-maria-ham-radio-operators-trnd/index.html

[25] "Camp fire (2018)," Wikipedia, 2018. [Online]. Available: https://en.wikipedia.org/wiki/Camp_Fire_(2018)

[26] S. Romero, J. A. Del Real, and T. Fuller, "On the California Wildfire Missing List, Name After Name After Name," The New York Times, Nov. 2018. [Online]. Available: https://www.nytimes.com/2018/11/20/us/missing-in-california.html

[27] K. Pilat, "Heres How to Check and Help Update the List of Those Missing After Californias Camp Fire," The New York Times, Nov. 2018. [Online]. Available: https://www.nytimes.com/2018/11/20/reader-center/california-fires-missing.html

[28] "CAMP FIRE Paradise CA Area LOST FOUND ANIMALS," facebook Public group, 2018. [Online]. Available: https://m.facebook.com/groups/328735554607757/about/

[29] C. Riotta, "California wildfires: Residents share images of missing loved ones and pets as search for hundreds continues," Independent, Nov. 2018. [Online]. Available: https://www.independent.co.uk/news/world/americas/california-wildfires-missing-death-toll-animals-pictures-pets-horses-woolsey-fire-camp-hill-a8630411.html

[30] S. Williams, "How Social Media Is Helping Victims of California Wildfires Find Their Missing Pets," Inside Edition, Nov. 2018. [Online]. Available: https://www.insideedition.com/how-social-media-helping-victims-california-wildfires-find-their-missing-pets-48449

[31] "Integrated Public Alert and Warning System (IPAWS),"

Wikipedia, Jun. 2006. [Online]. Available: https://en.wikipedia.org/wiki/Integrated_Public_Alert_and_Warning_System

[32] "National Emergency Family Registry Locator System (NEFRLS)," 6 U.S.C. 775, Oct. 2006. [Online]. Available: http://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title6-section775&num=0&edition=prelim

[33] "Pets Evacuation and Transportation Standards Act (PETS)," Wikipedia, Oct. 2006, amended 42 U.S.C. 5196 and 5170. [Online]. Available: https://en.wikipedia.org/wiki/Pets_Evacuation_and_Transportation_Standards_Act

[34] "National Emergency Family Registry and Locator System Fact Sheet," FEMA. [Online]. Available: https://www.fema.gov/national-emergency-family-registry-and-locator-system-fact-sheet

[35] "American Red Cross, Safe and Well," American Red Cross. [Online]. Available: https://safeandwell.communityos.org/cms/index.php

[36] "Facebook Safety Check," Wikipedia. [Online]. Available: https://en.wikipedia.org/wiki/Facebook_Safety_Check

[37] "Google Person Finder," Wikipedia. [Online]. Available: https://en.wikipedia.org/wiki/Google_Person_Finder

[38] "American red cross contact loved ones," American Red Cross, provides tips for contacting loved ones. [Online]. Available: https://www.redcross.org/get-help/disaster-relief-and-recovery-services/contact-and-locate-loved-ones.html

[39] "Voice over IP," Wikipedia. [Online]. Available: http://en.wikipedia.org/wiki/Voice_over_IP

[40] "Vonage," Wikipedia. [Online]. Available: http://en.wikipedia.org/wiki/Vonage

[41] "Skype," Wikipedia. [Online]. Available: http://en.wikipedia.org/wiki/Skype

[42] "Local number portability," Wikipedia. [Online]. Available: http://en.wikipedia.org/wiki/Local_number_portability

[43] "Telephone numbering plan," Wikipedia. [Online]. Available: https://en.m.wikipedia.org/wiki/Telephone_numbering_plan

[44] "List of North American Numbering Plan area codes," Wikipedia. [Online]. Available: https://en.m.wikipedia.org/wiki/List_of_North_American_Numbering_Plan_area_codes

[45] "Software as a service," Wikipedia. [Online]. Available: https://en.wikipedia.org/wiki/Software_as_a_service

[46] "Infrastructure as a service," Wikipedia. [Online]. Available: http://en.wikipedia.org/wiki/Infrastructure_as_a_service

[47] D. H. Parker and G. B. Parker, "Method for establishing sua sponte large-scale person-to-person emergency electronic messaging communications based in part on subscriber telephone numbers," US Patent 8,358,751, Jan. 2013. [Online]. Available: http://www.freepatentsonline.com/8358751.pdf

[48] ——, "Sua sponte establishment of large-scale person-to-person emergency electronic messaging communications based in part on subscriber telephone numbers," US Patent 9,246,870, Jan. 2016. [Online]. Available: http://www.freepatentsonline.com/9246870.pdf

[49] E. Hansen, "Reuniting people and pets," The Daily Progress, May 2016. [Online]. Available: https://www.dailyprogress.com/townnews/telephony/reuniting-people-and-pets/article_7ff8d4cf-a55f-52c2-9c4c-424483b19b6c.html

[50] "Six degrees of separation," Wikipedia. [Online]. Available: https://en.wikipedia.org/wiki/Six_degrees_of_separation