Using Social Media for Enhanced Situational Awareness and Decision Support

Virtual Social Media Working Group and
DHS First Responders Group

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EXECUTIVE SUMMARY

High-impact and high-visibility events have revealed the proliferation and widespread use of mobile devices. Combined with the rise in popularity of social media, the subsequent explosion in available information now spans multiple platforms and formats. Historically, the emergency response community has leveraged multiple data sources, including land mobile radios, maps, computer-aided dispatch, crisis management systems, traffic cameras, geographic information systems, and windshield assessments to collect information. Now, responders can leverage social media as well, both to communicate and to gather and share real-time, dynamic information to enhance situational awareness and assist in decision-making. The volume and speed with which available information is disseminated, combined with an inability to identify, verify, coordinate, aggregate, and contextualize it, however, can leave this information unused and ultimately, un-actionable.

This report discusses examples of how agencies currently leverage social media to enhance situational awareness and support operational decision-making, as well as challenges and potential applications. It also identifies critical areas requiring further consideration and research to address key technology, process, and policy gaps, including:

- **Information Application:** The ability to access, share, search, verify, contextualize, and manage available information. This concept also includes the identification of essential elements of information in social media as they relate to traditional public safety information requirements.
- **Privacy, Legal, and Security Challenges:** There are several challenges associated with the use of social media for situational awareness, especially with regards to user privacy and the use of personally identifiable information (PII); the need to remove details when sharing information across multiple partners; and the security of networks, platforms, tools, and data.
- **Data and Open Standards:** To truly enhance situational awareness, social media must be integrated, both technically and contextually, within the larger information environment and into the public safety operational workflow. Additional considerations include event detection, data formats, data models, ontologies, semantic and linked data, automation, and artificial intelligence.
- **Technology Development:** Challenges associated with the use of third-party platforms, analytics tools, the development of operational requirements, the ability to geo-locate information published to social media, spatial-temporal characteristics (disparate and virtual communities, time decay of posts, etc.), and integration with NextGen911 will require further research.

INTRODUCTION

Social media and collaborative technologies are critical components of emergency preparedness, response, and recovery. From the international response efforts after major tsunamis to hurricane recovery in major U.S. cities, government officials now turn to social media technologies to share information and connect with citizens during all phases of a crisis. The adoption of new tools, however, requires consideration for application, implementation, and integration within traditional systems and methods.

Recognizing the need to address these challenges, the U.S. Department of Homeland Security's (DHS) Science and Technology Directorate (S&T) established the Virtual Social Media Working Group (VSMWG). The VSMWG seeks to provide guidance to the emergency preparedness and response community on the safe and sustainable use of social media technologies before, during, and after emergencies.

Comprised of a cross-section of subject matter experts from local, tribal, state, territorial, and federal responders from across the United States, the VSMWG establishes and collects best practices and solutions that can be leveraged by public safety officials and responders throughout the nation's emergency response community. VSMWG members belong to the agencies listed below.

VSMWG Member Agencies as of April 2014

- American Red Cross
- Anaheim [Calif.] Emergency Management and Preparedness
- Centers for Disease Control and Prevention, Office of Public Health Preparedness and Response
- City of Charlottesville [Va.] Fire Department
- Clark [Wash.] Regional Emergency Services Agency
- Federal Emergency Management Agency
- The George Washington University
- Hampton Roads [Va.] Planning District Commission
- Humanity Road

- Johnson County [Kan.] Sheriff's Office
- Maryland Emergency Management Agency
- City of New Orleans Office of Homeland Security and Emergency Preparedness
- New York City Office of Emergency Management
- Oregon Voluntary Organizations Active in Disaster
- San Francisco Department of Emergency Management
- United States Geological Survey
- United States Northern Command
- University of Washington, Office of Global Affairs

PURPOSE

This report follows the VSMWG's May 2013 publication, *Lessons Learned: Social Media and Hurricane Sandy*, which identifies and analyzes gaps associated with social media technologies, processes, and policies that were identified during the Hurricane Sandy response in the fall of 2012. These include:

- Difficulty discovering available information, resources, and efforts across social media platforms and by multiple stakeholders
- Difficulty sharing information across multiple platforms and stakeholders due to the lack of standardization in nomenclatures, and the need to develop a framework to do so
- Difficulty using social media for purposes other than communications and general information due to an inability to contextualize and integrate social media data within the incident command structure
- An inability to aggregate, search, vet, and validate social media data
- Concerns with existing social media platform features, as well as reliability of service, access to information, simultaneous publication of information, and an inability to match needs to resources available

The purpose of this document is to:

- Introduce and discuss how social media can and is currently being used for situational awareness in public safety by various agencies and organizations
- Discuss challenges associated with the use of social media for situational awareness
- Discuss the integration of social media within the operational environment
- Discuss areas requiring further consideration, research, and development

Examples included in this document are not intended to serve as an all-inclusive list. For more information and additional resources, please visit the DHS First Responder Communities of Practice website.

DEFINITIONS

The terminology used to describe various aspects of Web-related technologies varies in definition, depending on perspective, domain, and discipline. The following apply to key terms used within this document.

Big Data: "Big data" refers to "high-volume, high-velocity, and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision-making."[1]

Crowd-Feeding: Crowd-feeding is the active, two-way feedback loop where information or tasks conducted by the crowd are fed or shared back to the crowd.[2]

Crowd-Harvesting: Crowd-harvesting is the passive, one-way gathering of data to search for information from the crowd information.[3]

Crowd-Seeding: Crowd-seeding is the strategic, one-way request that pre-identifies certain members in a crowd to source from and empower them with tools.[4]

Crowd-Sourcing: Crowd-sourcing is the active, one-way request between the crowd and entity requesting information from the crowd (the crowd-sourcer).[5]

Intelligence: Intelligence is "the combination of credible information with quality analysis – information that has been evaluated and from which conclusions have been drawn."[6]

Metadata: Metadata is data that describes other data. In context with social media, metadata refers to the various attributes available in addition to the text of social media updates (e.g., geo-location, post time, follower count).

Semantic Web: The semantic Web is considered "an extension of the current web in which information is given well-defined meaning, better enabling computers, and people to work in cooperation."[7]

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[1] "Big Data." Information Technology (IT) Glossary. Gartner.com. 27 January 2014. <http://www.gartner.com/it-glossary/big-data/>.
[2] Liu, Sophia B. (2014). "Crisis Crowdsourcing Framework: Designing Strategic Configurations of Crowdsourcing for the Emergency Management Domain." *Computer-Supported Cooperative Work special issue on Crisis Informatics and Collaboration*.
[3] Liu IBID
[4] Liu IBID
[5] Liu IBID
[6] Carter, David L. (2004). Chapter Two; "Understanding Contemporary Law Enforcement Intelligence: Concept and Definition." *Law Enforcement Intelligence: A Guide for State, Local, and Tribal Law Enforcement Agencies*. November 2004. School of Criminal Justice, Michigan State University. http://www.cops.usdoj.gov/CDROMs/Tribal/law/LawEnforcementIntelligenceGuide.pdf>.
[7] "The Semantic Web Made Easy." *World Wide Web Consortium (W3C).* May 2001. <http://www.w3.org/RDF/Metalog/docs/sw-easy>.

Situational Awareness: Situational awareness refers to a state of understanding in which the following occur:[8]

- Knowing and understanding what is happening around you
- Predicting how it will change with time
- Being unified with the dynamics of your environment (i.e., contextualization with the current environment given specific factors, variables, goals, and objectives)

Situational awareness is a "human mental process that can be enhanced using technology to access, analyze, and present information to have a greater understanding of existing conditions and how they will change over time."[9]

The Homeland Security Act of 2002 defines the term "situational awareness" as "information gathered from a variety of sources that, when communicated to emergency managers and decision makers, can form the basis for incident management decision-making."[10]

Social Media: Social media is defined as any online or digital medium that is provided or collected through a channel that enables the two-way sharing of information, involving multiple parties. This includes social networking sites, texting, and blogs.

TECHNOLOGY AND SITUATIONAL AWARENESS

Situational awareness is not a new concept in the field of emergency preparedness, response, and recovery. In fact, it is one of the focus points within most planning and response efforts. Government agencies and response partners work to establish and maintain situational awareness to sustain general communications, gather intelligence from the field, execute logistical plans, track resources, send alerts and warnings, and perform general operations. Traditional methods for achieving and maintaining situational awareness include land mobile radio, paper maps, landlines, email, cellular phones, satellite phones, mobile data (e.g., low-speed wireless data), computer-aided dispatch for incident and unit status, crisis management systems (e.g., E-Team, WebEOC), traffic cameras, amateur (HAM) radios, enhanced 911, reverse 911, mobile text alerts, global positioning services (GPS) for the location of response vehicles, geographic information systems (GIS) for visualization, windshield assessments, and traditional media (e.g., television, radio).

The following graphic,[11] published in ESRI's 2008 report, *Public Safety and Homeland Security Situational Awareness,*[12] illustrates the various traditional data sources available to produce and maintain situational awareness. Sources include maps, media, transportation, infrastructure, communications tools, sensors,

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[8] ESRI. "Public Safety and Homeland Security Situational Awareness*.*" *ESRI*. February 2008: 1. <http://www.esri.com/library/whitepapers/pdfs/situational-awareness.pdf>.
[9] ESRI. "Public Safety and Homeland Security Situational Awareness*.*" *ESRI*. February 2008: 2. <http://www.esri.com/library/whitepapers/pdfs/situational-awareness.pdf>.
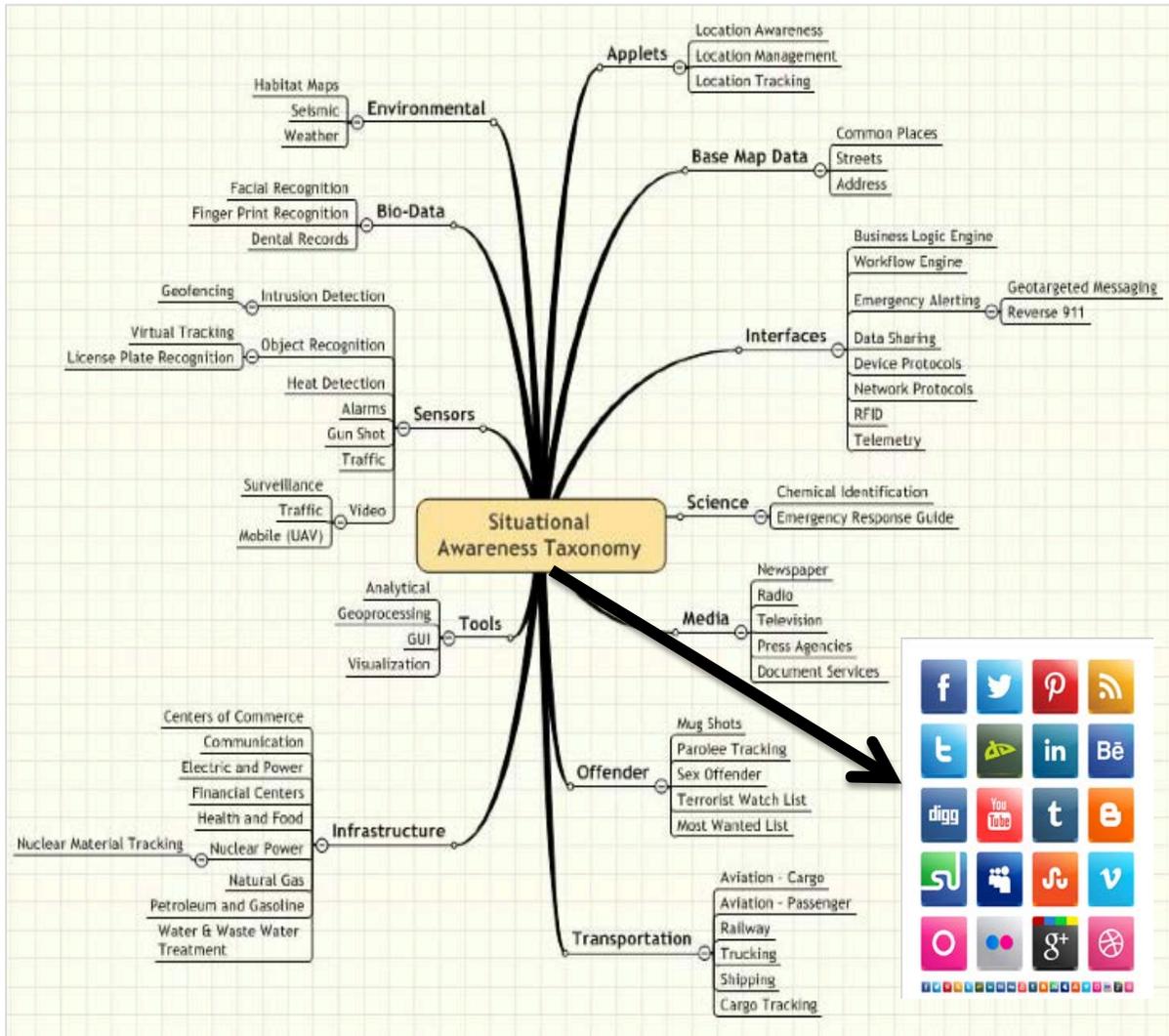[10] United States Congress. "Homeland Security Act of 2002." *107th Congress.* Section 515 (6 U.S.C. 321d(b)(1)) 25 November 2002. <http://www.dhs.gov/xlibrary/assets/hr_5005_enr.pdf>.
[11] ESRI, IBID, Page 3, Icons by Zee Que, Designbolts.com
[12] ESRI, IBID, Page 1.

bio-data, environmental data, base map data, applets such as location tracking, science information such as emergency response guides, and interfaces such as telemetry. Various social media tools have been added to the graphic to illustrate their role in the situational awareness taxonomy.

GIS Situational Awareness Taxonomy

SOCIAL MEDIA AND SITUATIONAL AWARENESS

Combined with the expansion and convergence of broadband and wireless, the advent and rise in popularity of social media now enables the public safety community to request, share, and provide information; real-time, content-rich, profile updates; video; and photo imagery through additional channels. For these sources to become useful, however, various data management, analytics, and operational standards and processes must be developed.

If integrated with traditional data, social media can help emergency responders achieve and maintain situational awareness in real-time. This will assist with decision-making, planning, and resource allocation.

This report discusses the challenges associated with the integration of social media data within the information sharing and operational environment, as well as the potential applications, best practices, and considerations for better leveraging social media to enhance situational awareness and decision support, including:

- Standardization of technology capabilities and tool features across various platforms
- Definition and identification of useful information via social media sources
- Ability to aggregate, sort, filter, verify, and manage information pulled from social media
- Ability to integrate information learned from social media sources within the operational environment in a meaningful way
- Use of social media data to predict and model potential outcomes and cascading effects
- A need for interoperability of social media data, including data standards and content categories to support information sharing among multiple stakeholders

A wide variety of tools is now available to aggregate and analyze social media for the purpose of maintaining situational awareness. Ranging from simple to complex, decision makers must balance the benefit of new technology and capabilities with budgetary and resource realities.[13] Agencies may hesitate to leverage tools that are not provided by another government entity (such as those developed or provided by the private sector or a non-profit organization). Additionally, the variety and availability of tools and technologies may overwhelm decision makers, especially given a lack of guidance on the acquisition, integration, and implementation of new tools with legacy systems.

The role an agency plays in a disaster, in addition to the type of disaster, may determine the type of information needed and available, and ultimately the tool needed or developed. For example, in addition to information about the status of roads, power lines, and the safety of individuals in the aftermath of a hurricane, a public health agency may focus on the community's understanding of water boil notices, the safety of the drinking water, outbreaks resulting from possible contamination, or disease.[14] Additional factors affecting perspective, goals, and objectives for information learned from social media include the type of scenario (man-made versus natural, quick versus slow onset), pre-existing information requirements, mission objectives, functionality (operations versus external affairs and communications), and constituent demographics.

Examples of free and open-source search analytical and mapping tools include MapQuest, Geofeedia, Google Earth, TweetDeck, Social Mention, and HootSuite. Tools offering analytical algorithms, prediction and outcome modeling, and proprietary analytical decision support include Calais, Zemanta, General Dynamics' TIGR (Tactical Ground Reporting System), U.S. Northern Command's (USNORTHCOM) SAGE (Situational Awareness Geospatial Enterprise), Palantir, the Department of Energy's RaptorX, and IBM InfoSphere. The American Red Cross uses the Radian6 platform developed by Salesforce.com to pull social media content from several platforms, including Twitter, Facebook, and blogs. The tool then aggregates and analyzes the data and displays information

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[13] Homeland Security Systems Engineering and Development Institute. *First Responder Big Data Analytics: Roadmap Recommendations*. 5 February 2014.

[14] Hanrion, Natalie. Information provided March 2014.

that is selected to be of interest to the user.[15]

APPLICATIONS OF SOCIAL MEDIA IN PUBLIC SAFETY

While traditional methods for establishing and maintaining situational awareness remain intact, new and innovative methods for identifying, aggregating, visualizing, contextualizing, and operationalizing information are now possible as the popularity of new tools and platforms grows. The following section discusses various applications for information gleaned from social media sources. Social media is no longer solely for communications; many areas of disaster preparedness, mitigation, response, and recovery may benefit from the addition of social media as well. Examples included in this section do not serve as an exhaustive list.

Effective Communications

Stakeholder Identification, Engagement, and Effective Messaging[16]

One of the first examples of the use of social media for public safety purposes is the AMBER Alert program, a voluntary partnership between law enforcement agencies, broadcasters, transportation agencies, and the wireless industry. The AMBER Alert system is activated to send an urgent bulletin in the most serious child abduction cases. Since 2003, AMBER Alerts have interrupted regular programming and are broadcast on the radio, television, and highway signs. The alerts can be printed on lottery tickets, and sent electronically to wireless devices and the Internet. In 2007, Myspace users received notifications on their home page for alerts issued within their registered ZIP code. Facebook followed suit in January 2011, partnering with the Department of Justice and the National Center for Missing and Exploited Children (NCMEC) to issue alerts based on users' states or regions.[17]

Today, public safety can use social media to engage stakeholders strategically, empowered by the platforms' search and targeting capabilities. Additionally, social media channels may serve as a feedback mechanism, assisting communicators in identifying the receipt and success of messaging, necessary changes in content or channel, outcomes of messaging (e.g., actions taken as a result of the message sent), and new demographics requiring specific targeting or further consideration. Success includes penetration of messaging, or how deep into the community the message travels, and the level of "trust" in the message. This includes noticeable or measurable actions taken by individuals if the message requests an action or re-sharing of the message with personal networks.

On July 9, 2013, Shayne Adamski, senior manager of digital engagement for the Federal Emergency Management Agency (FEMA), testified before the House Committee on Homeland Security's Subcommittee on Emergency Preparedness, Response, and Communications. Adamski shared information on how FEMA leverages social media in a variety of ways to "reach the public and provide them with useful information." According to Adamksi, FEMA uses social media in six primary ways:

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[15] DHS Virtual Social Media Working Group. "Lessons Learned: Hurricane Sandy and Social Media." June 2013.

[16] DHS Virtual Social Media Working Group. "Community Engagement and Social Media Best Practices". September 2012.

[17] Howard, Alex. "Facebook Teams up With DoJ, NCMEC to Issue Social AMBER Alerts." *Govfresh.com.* 12 January 2012. <http://gov20.govfresh.com/facebook-teams-up-with-doj-ncmec-to-issue-social-amber-alerts/>.

- To provide up-to-date information about how FEMA and the whole community emergency management team are helping communities and individuals in mitigation, preparedness, response, and recovery from disasters (e.g., posting photos and status updates capturing FEMA activities such as deployment of Disaster Survivor Assistance teams helping survivors)
- To help federal, state, local, tribal, territorial, and private sector partners share key messages (e.g., sharing status updates from key public officials before, during, and after Hurricane Sandy)
- To provide safety and preparedness tips
- To inform the public of the most effective ways to help disaster survivors (e.g., encouraging Americans to donate through trusted charities to help impacted communities)
- To tell disaster survivors where and how to receive assistance from FEMA and other sources
- To gain valuable feedback (e.g., Twitter chats to engage the public on specific issues such as how to receive aid necessary for rebuilding after an event) [18]

Rumor Management[19]

Not all rumors are false or untrue; sometimes they are merely facts not yet verified by an official source. Individuals will often act upon information before it can be verified, in the absence of official information.[20] Misinformation can spread via social media very quickly, especially during an emergency. Additionally, due to the viral nature of social media, misinformation may spread across multiple networks, locations, and disparate groups, leading to ineffective decision-making, hazardous actions, and inaccurate directions. Although the spreading of rumors cannot be completely halted, public safety officials can often correct misinformation through active, ongoing engagement with the public and response partners. This requires both active listening for specific or applicable information as well as passive monitoring for general situational awareness.

Active: Public safety officials can actively "listen" to social media to engage the public and respond to specific comments. Agencies can actively engage the community, specifically requesting information or asking for assistance to identify and correct misinformation.

For example, throughout the course of the response to Hurricane Sandy in the fall of 2012, the American Red Cross monitored social media to identify needs, provide information, and respond to questions and concerns raised by the public. With assistance from digital volunteers, the Red Cross social engagement team tracked and reviewed more than two million posts. Team members and volunteers identified actionable posts and actively sent responses to individuals posting questions about the disaster situation, how to obtain help, and how to offer assistance. They also shared Red Cross messaging, disseminated official response operation information, and provided emotional support through conversations with

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[18] Adamski, Shayne, Senior Manager of Digital Engagement, Federal Emergency Management Agency. Statement to the U.S. House of Representatives Committee on Homeland Security Subcommittee on Emergency Preparedness, Response, and Communications. *Subcommittee Hearing: Emergency MGMT 2.0: How #SocialMedia & New Tech are Transforming Preparedness, Response, & Recovery #Disasters #Part2 #Govt/NGOs.* 9 July 2013. 113th Congress, 1st session. <http://docs.house.gov/meetings/HM/HM12/20130709/101047/HHRG-113-HM12-Wstate-AdamskiS-20130709.pdf>.

[19] DHS Virtual Social Media Working Group. "Lessons Learned: Social Media and Hurricane Sandy." June 2013.

[20] Shibutani, Tomatsu. *Improvised News*. Indianapolis: The Bobbs-Merrill Company, Inc., 1966.

people affected by the disaster.[21]

Passive: Public safety officials can leverage social media to observe chatter regarding general information about their respective agency, mission space, or jurisdiction. Additionally, they can use social media to identify and respond to rumors and misinformation before they are disseminated too widely. For example, throughout the response to Hurricane Sandy, FEMA searched for information, aggregated rumors identified on social networks, and published corrected information on http://www.fema.gov/hurricane-sandy-rumor-control.

Achieving and Maintaining Situational Awareness

Social media provides a means to search for and solicit information for general and specific inquiries, verify pre-existing information, and establish general situational awareness. Many open-source tools feature searches based on a keyword, geographic location, or content, including trending topics, overall sentiment, and popular hashtags. Advanced tools offer additional search functionality as well. Like using social media for effective stakeholder communications and engagement, situational awareness activities also fall within two areas: monitoring and crowdsourcing. Monitoring encompasses a passive information search based on varying degrees of specificity depending on a mission or goals. Crowdsourcing, or active "listening," leverages the crowd in various ways to provide, find, and produce new information. Finally, ongoing monitoring may help to identify baseline trends in order to detect events quickly. Additionally, a lack of noise, when abnormal, may also signify points for further consideration, verification, or follow-up. The next section discusses examples of general searching and monitoring and crowdsourcing capabilities such as seeding, feeding, and harvesting.

Monitoring

The Clark [Wash.] Regional Emergency Services Agency (CRESA) leverages social media tools to establish and maintain situational awareness on an ongoing basis and during emergencies. To streamline monitoring efforts, Cheryl Bledsoe, the emergency manager, and staff utilize the Twitter list function to categorize channels; these include the national news media, local news media, and public safety/responders. The agency also categorizes community members into local versus not local and includes additional interested parties, such as collegial and professional contacts. Leveraging TweetDeck, a free social media tool, the categorized lists serve as filtered streams. Bledsoe and staff sort the categorized lists to maintain awareness of chatter within each group, such as a local story or issue covered by national news. Ms. Bledsoe narrows searches by geographic location, using longitude and latitude, and further defines the area by drawing a radius or polygon on a map, allowing for size adjustment for the affected region. Additionally, CRESA staff members conduct standard hashtag searches, including those known from ongoing conversations and made popular by community partners (e.g., weather, local media).

With a total of seven staff members, including herself, Bledsoe arranges the team's work schedule similar to that of 911 duty officers. Every six weeks, an individual monitors social media channels for an entire week. Each staff member has two computer screens with TweetDeck continually on one screen. Staff monitor on a continual basis for general situational awareness as well as events that may become of

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[21] DHS S&T First Responders Group Virtual Social Media Working Group. Lessons Learned: Social Media and Hurricane Sandy. Washington, DC: DHS, June 2013:20.

interest to CRESA's area of responsibility (AOR). Staff receives training to identify issues applicable to the AOR and to confirm information through a variety of means, including proximity to the search area and applied context within the county boundaries. For example, did someone located within the area post the information or is the individual posting information from a remote location?

Bledsoe notes a difference in search efforts between ongoing monitoring and situational awareness needs during an event. For instance, the level of detail required for specific information may change depending on the event. In a small event, specific details may be necessary; however, during a major and dynamic event, general trends may be sufficient. During an event, CRESA searches for a variety of content, including:

- Individuals unable to reach or utilize the 911 system
- Needs and resources (available and needed)
- Structure outages, infrastructure damage, and damage assessments
- Life safety issues
- Rumors and misinformation (unverified versus untrue)
- Accuracy of county-specific information being shared by other parties

The above categories may change depending on the type of event and the level of response required. The target search areas will change as well depending on the size of the event. Bledsoe also notes that the type of search needed depends on the perspective of the responding agency. For example, a state agency will search trends across multiple jurisdictions, specifically searching for local jurisdictions requiring additional resources; a local agency may focus specifically on one or two of these categories, depending on the agency's mission, jurisdiction, and discipline-specific AOR.

Crowdsourcing

Similar to passive monitoring and active listening for rumors, public safety agencies can also leverage social media to search and engage the crowd for general or specific information. Social media can also be used to engage the public in aggregating information, such as damage reports from the affected area, to enhance information coming in from the field.

Crowdsourcing has recently gained significant attention in the crisis and emergency management domains. The spontaneous digital volunteerism after the 2010 Haiti earthquake led to the development of workflows, protocols, and established applications, offering insights into how crowdsourcing can address information management issues to enhance situational awareness and decision support.[22]
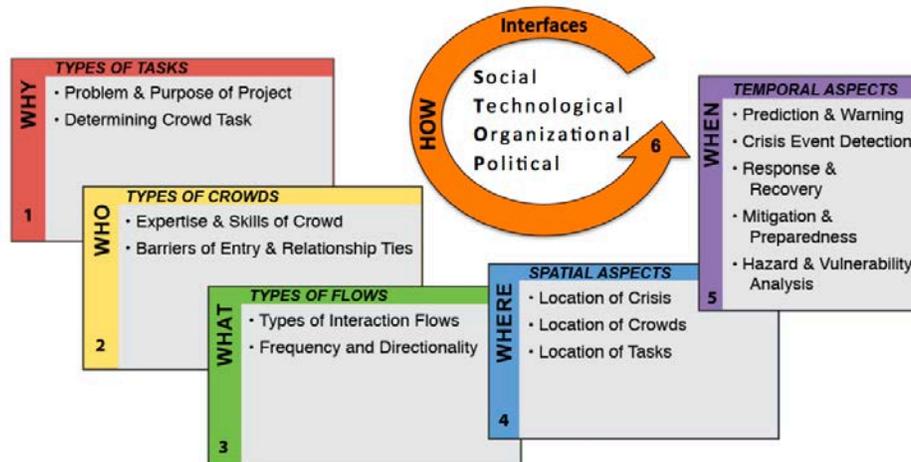
Essentially, crowdsourcing represents a form of civic participation in problem solving, data collection, and analysis processes to address information management issues. Crisis crowdsourcing is a type of cooperative work emerging from improvised uses of Information, Communications, and Technology (ICT) to leverage and manage the convergence of crowds, information, and resources to address emergency management needs. However, emergency management lacks a conceptual framework for understanding the complex coordination and interaction mechanisms that enable crisis crowdsourcing.

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[22] Starbird, Kate. "Digital Volunteerism During Disaster: Crowdsourcing Information Processing." University of Colorado: ATLAS Institute. 2011. < http://crowdresearch.org/chi2011-workshop/papers/starbird.pdf >.

Sophia Liu's 2014 publication, *Crisis Crowdsourcing Framework[23],* provides guidance on strategically identifying the key dimensions to consider when designing and evaluating a crisis crowdsourcing project or system. The Crisis Crowdsourcing Framework (below) is a systematic, problem-driven approach to determining the "why, who, what, where, when, and how" aspects of a crowdsourcing system. It also emphasizes the social, technological, organizational, and policy (STOP) interfaces that need to be designed to reduce the complexity of coordinating across these six dimensions.

Crisis Crowdsourcing Framework

(1) *Why* – Identify the information problem to determine the crowd task needed
(2) *Who* – Identify the types of crowds and expertise needed for the crowd task
(3) *What* – Identify the interaction flows for engaging crowds
(4) *Where* – Identify the spatial aspects of the crisis, crowds, and crowd tasks
(5) *When* – Identify the temporal aspects in relation to the disaster management life cycle
(6) *How* – Identify the STOP interfaces

The framework incorporates the different contingencies caused by crises to strategically guide the development of interfaces that operationalize crowdsourcing for the crisis domain. The STOP interfaces provide a means for enabling and managing the coordination work involved when integrating various crowds, tasks, and interaction flows in disaster management. This framework was used to guide the design of a U.S. Geological Survey (USGS) crowdsourcing application called "iCoast - Did the Coast Change?[24]", but it could also be used to evaluate existing established systems, such
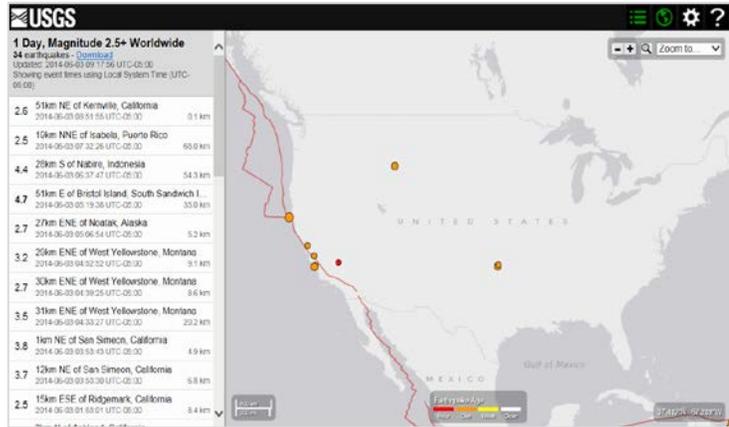
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[23] Liu, Sophia B. (2014). Crisis Crowdsourcing Framework: Designing Strategic Configurations of Crowdsourcing for the Emergency Management Domain. *Computer-Supported Cooperative Work (CSCW) special issue on Crisis Informatics and Collaboration*.

[24] Liu, Sophia B., Barbara S. Poore, Richard J. Snell, Aubrey Goodman, Nathaniel G. Plant, Hilary F. Stockdon, Karen L.M. Morgan, and M. Dennis Krohn. (2014). USGS iCoast – Did the Coast Change?: Designing a Crisis Crowdsourcing App to Validate Coastal Change Models. In Proceedings of the companion publication of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW Companion '14). ACM, New York, NY, USA, 17-20.
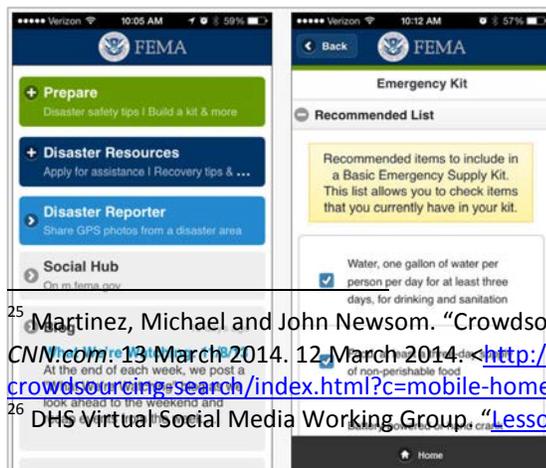
as DigitalGlobe's Tomnod application.

In the days following the disappearance of Malaysian Airlines Flight 370 in March 2014, DigitalGlobe posted detailed satellite images through their Tomnod system. They asked the public to volunteer time searching through imagery of the plane's search zone and tag any relevant visual features such as wreckage and rafts. As the request spread across social media platforms, the large number of volunteers joining the effort crashed DigitalGlobe's website. DigitalGlobe launched a similar crowdsourcing campaign in response to Super Typhoon Haiyan in November 2013, "allowing volunteers to tag online more than 60,000 objects of interest from satellite photos."[25, 26]

"Did You Feel It?" (right) was developed by the United States Geological Survey (USGS) Earthquake Hazards Program to crowd-source information about the severity of an earthquake as experienced by an individual within the affected area. Individuals can click on a map to learn about others' experiences and information about the event itself. It also can provide information to USGS in the event the earthquake was not captured or not yet displayed on the USGS map.

PulsePoint (left) is an enterprise-class, software-as-a-service solution that alerts pre-registered and validated individuals trained in CPR of sudden cardiac arrest calls within their proximity. This is another example of how active crowdsourcing, effectively crowd-seeding, can provide immediate support to enhance traditional response protocols.

Additionally, FEMA released Disaster Reporter (left), a mobile app that enables individuals to submit photos to FEMA directly. Disaster Reporter allows users to take a photograph in a disaster area and submit it with a short text description. This enables citizens and survivors to access useful information on a map. It also provides

[25] Martinez, Michael and John Newsom. "Crowdsourcing Volunteers Comb Satellite Photos for Malaysia Airlines Jet." *CNN.com*. 13 March 2014. 12 March 2014. <http://www.cnn.com/2014/03/11/us/malaysia-airlines-plane-crowdsourcing-search/index.html?c=mobile-homepage-t>.
[26] DHS Virtual Social Media Working Group. "Lessons Learned: Social Media and Hurricane Sandy." June 2013.

additional situational awareness so FEMA can further determine what resources are needed for the photographed areas. Disaster Reporter proved valuable, not only for FEMA, but for the survivors, first responders, and emergency managers responding to flash flooding in Colorado in 2013. Users published more than 120 photos in the aftermath of the storms. Approved submissions can be viewed at www.fema.gov/disaster-reporter, and organizations can pull the data directly into their own map, viewer, or application.

Directing the public to engage in a project, however, may create an expectation that the requesting agency or organization will use the final product in its work. Although not a barrier for all, this may hinder response organizations' attempts to leverage assistance from the public. Further research may help to establish techniques and tools that enable response organizations to leverage information from the public, both automatically and manually. Policy, however, must adapt to support these practices while satisfying legal and security considerations.

Intelligence Gathering

Applications for social media within public safety depend upon the perspective of the user; varying objectives, requirements, restrictions, and stakeholders influence the types of activities conducted. For example, while many agencies and response organizations monitor social media for general situational awareness, law enforcement agencies can monitor social media specifically for intelligence or information that will help in the resolution of an incident, event, or case, and the definition of "intelligence" may vary across agency, discipline, and jurisdiction. In general, public safety officials can leverage social media for four types of information:

- General information about an event, keyword, or trending topic
- Verification of information gathered from social media or another source
- Increased context about known information (e.g., understanding second- and third-order effects, cascading effects, and feedback on past activities or messaging)
- Specific information pertinent for law enforcement or intelligence purposes, whether individual or aggregated

Law enforcement agencies increasingly use social media as an investigative tool for forensics and intelligence. Facebook and Twitter terms of service include process requirements that enable law enforcement authorities, with appropriate warrants, to access general data and metadata of posts associated with criminal activity.[27] Law enforcement agencies can use social media to quickly distinguish relationships between drug users and dealers; identify and illustrate gang affiliations; and provide additional written, photographic, and video evidence to bolster an ongoing investigation. With social media, detectives can quickly search for information; without it they must spend hours manually searching for information and slowly piecing together pieces of evidence.

Additionally, law enforcement agencies may use social media to establish a picture of criminal activities in

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[27] "Guidelines for Law Enforcement." *Twitter.com*. <https://support.twitter.com/articles/41949-guidelines-for-law-enforcement>. and "Information for Law Enforcement Authorities." *Facebook.com.* <https://www.facebook.com/safety/groups/law/guidelines/>.

a local area or after an event, such as the Boston Marathon Bombing in April 2013. Following the Boston Marathon Bombing, law enforcement agencies leveraged imagery and content posted to social media platforms to aggregate information from and about the affected area to determine facts, help identify potential suspects, and communicate information to the public.[28]

The bureau chief of public information for the Boston Police Department, Cheryl Fiandaca, actively tweeted throughout the event and in the days following as police searched for the suspects. On April 15, 2013, at 2:39 p.m., the Boston Police Department (@bostonpolice) tweeted (right):

Fiandaca continued to tweet throughout the course of the response, posting directions, injury and casualty reports, and other information directly relayed from internal sources (the team was briefed three to five times a day by commanders; do's and don'ts were clearly articulated). In the days following the bombing, the Twitter account became a central point for individuals looking for license plates to watch out for, pictures of suspects, live updates on their whereabouts, and general information. In addition to posting Twitter messages, the team constantly monitored news sources for reports of misinformation. In a response to a claim made by CNN that a suspect was in custody, the Boston Police team tweeted, "Despite reports to the contrary there has not been an arrest in the Marathon attack.[29]"

Fiandaca and the team continued to post for days after the bombing, providing information about the gunfight that left one of the suspects dead, blurry security camera footage, and warnings to the public not to compromise officer safety by broadcasting live video of officers approaching search locations. The public began to speculate on possible suspects from imagery posted on Twitter, which led to the false publication of a possible suspect. After the FBI released surveillance camera footage of two individuals considered to be suspects, the Boston Police Department released a series of tweets containing this information. The public turned to sites such as Reddit[30] to discuss and research information about the possible suspects as well, which led to another false identification of a possible suspect. Again the media picked on up on these reports and disseminated this information to the public. After television news reports refuted the misinformation, the Boston Police Department released the names of the true suspects.[31] The team published a tweet indicating the suspect was in custody; this message was retweeted approximately 143,000 times, becoming a headline for CNN, NPR, and the Washington Post.[32]

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[28] Gilgoff, Dan and Jane J. Lee. "Social Media Shapes Boston Bombings Response." *National Geographic News*. 15 April 2013. <http://news.nationalgeographic.com/news/2013/13/130415-boston-marathon-bombings-terrorism-social-media-twitter-facebook/>.

[29] IBID.

[30] Reddit is an online community where registered users can submit posts or links and the community votes submissions "up" or "down" to determine the organization of the posts. http://en.wikipedia.org/wiki/Reddit.

[31] Davis III, Edward F., Alejandro A. Alves, and David Alan Sklansky. "Social Media and Police Leadership: Lessons from Boston." *New Perspectives in Policing. March 2014. Harvard University Executive Session on Policing and Public Safety*. <http://news.harvard.edu/gazette/wp-content/uploads/2014/04/Social-Media-and-Police-Leadership.pdf>.

[32] Bindley, Katherine. "Boston Police Twitter: How Cop Team Tweets Led City from Terror to Joy." *Huffington Post*. 26 April 2013. <http://www.huffingtonpost.com/2013/04/26/boston-police-twitter-marathon_n_3157472.html>.

Needs Identification and Planning

Immediately following an event, it can be difficult to organize volunteer efforts, donations, needs, and offers of resources. Needs can go unmet because they are not identified, resources for deployment are not available, or—due to information silos—there is no expedient way of matching needs with appropriate resources. Conversely, offers of resources and assistance remain unused if they do not address a specific or previously identified need. To fill these information and resource gaps, communities, volunteers, and non-profit organizations leverage social media to share resources, requests, and general coordination.[33] Public safety and response organizations can also leverage social media for the same purposes, through engaging with the public and across agencies and locales.

Resources Needed: Social media tools provide a mechanism by which response organizations can both passively and actively search for and identify needs. A response organization can use keyword searches and general monitoring to identify community needs passively or pinpoint and influence responses through engagement, conversations, and targeted messaging and questioning.

Resources Available: Social media tools provide a mechanism by which individuals, groups, agencies, and organizations can make their available resources known. Connections must be made, however, between available resources in various locations with identified needs (both on and offline).

For example, Humanity Road activated and supported multiple aid providers in November 2013 after Super Typhoon Haiyan impacted Palau and the Philippine by monitoring urgent medical, food, and water needs; field hospitals; and areas of population isolated from aid.[34] Humanity Road aggregated and filtered one million tweets, leveraging a filtering tool prototype tool developed by Progeny Systems. Humanity Road used this tool to filter the one million tweets to 40,000 that could be categorized, and then to 4,000 deemed as potentially actionable. Humanity Road provided mission-specific data to organizations such as the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), Americares, and other traditional relief organizations. It also provided summary reports to ReliefWeb (an online service offered by UNOCHA to provide reliable disaster and crisis updates and analysis), and HumanitarianResponse.info. As a result of Humanity Road's efforts, more than 10,000 impacted people received aid. Individuals received aid via airdrop, which saved lives, and families received information through direct relay of filtered and analyzed open-source data with aid providers.[35]

Analysis

General information pulled from social media sources may be useful in its raw form; however, analysis may be necessary in order to contextualize the information within the target operational environment and workflow. For example, daily online trends, volume, and traffic in a large city will differ greatly from that of a smaller city or area. Normal activities in one area may be suggestive of an event or issue in another. Additionally, social media, when combined with other data, may produce new intelligence.

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[33] DHS Virtual Social Media Working Group. "Lessons Learned: Social Media and Hurricane Sandy." June 2013.
[34] "Haiyan Public Health Response." *Humanity Road*. November 2013. <http://humanityroad.org/super-typhoon-haiyan-response/humanity-road-haiyan-ph-response-nov-2013/>.
[35] "Haiyan Public Health Response." *Humanity Road*. November 2013. <http://humanityroad.org/super-typhoon-haiyan-response/humanity-road-haiyan-ph-response-nov-2013/>.

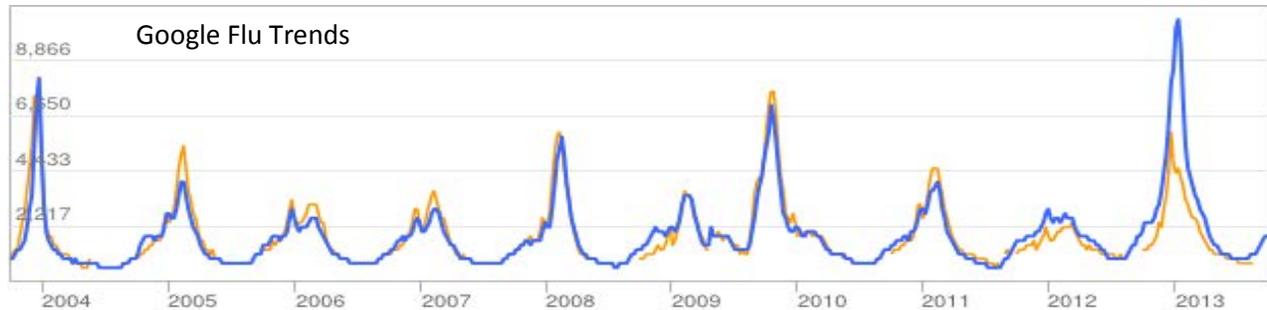## Establishment of Baseline (Normalization) and Event Detection

In order to identify changes in volume, trends, traffic, and topics discussed, a baseline must first be established. Ongoing monitoring of daily activities and trends helps to establish what is "normal" for a given jurisdiction, demographic, or group. Once a baseline has been established, thresholds are necessary to quickly identify changing variables once they approach a level of concern. Identifying and establishing baseline activity, as well as various thresholds, requires ongoing maintenance and consideration.

Certain types of events, however, may require varying thresholds. For example, during the Presidential Inauguration, the World Series, Mardi Gras, or the Super Bowl, the volume, frequency, topics, location, and other factors of content shared on social media will fluctuate outside of normal levels. Compared to normalized daily chatter, activities will fluctuate significantly and most likely extend far outside of pre-supposed levels or geographic areas. These new thresholds must be identified in order to establish a new "normal," therefore enabling the identification of anomalies in a new landscape.

The nature of social media enables early identification of oncoming events, trends, or issues. According to an August 2011 report on Mashable, individuals living in the New York City area learned of the 2010 Virginia earthquake on Twitter before people in Manhattan felt the seismic waves. However, for slower onset events, it may be difficult to distinguish between normal and abnormal activity if baselines are not calibrated beforehand. Defining a baseline is essential to quickly identifying anomalies.

Trend Analysis

Following event detection, social media enables the analysis of trends, whether by topic, location, keyword, or another variable. For example, Google offers an online tool called Google Flu Trends, which uses aggregated Google search data to estimate flu activity in near real-time. The figure below illustrates the trend in actual flu activity, provided by the Centers for Disease Control and Prevention, in relation to the estimated flu activity provided by Google since 2004[36] (Google Flu Trends estimate in blue, United States data in orange).

The same concept, if applied to social media data, may help to identify emerging threats, events, trends, and hazards through the aggregation of keywords and geo-location information. To fully incorporate the concept of event detection through aggregated social media data within an operational environment, however, a location footprint, or identity, must be defined. Each jurisdiction will have varying hazards, concerns, and demographics, as well as varying thresholds for what determines an actual event. The following variables require consideration:

- Area-specific hazards
- Demographics and specific demographic-related concerns
- Critical infrastructure, including location and type
- Special events and potential event-specific threats
- Area-specific topics, applicable timing, and domain awareness indicators
- Location-specific thresholds

Enhanced Decision Support

On its own, social media serves as an additional channel from which to push and pull information in all phases of the disaster life cycle. During disasters, decision-making occurs dynamically and outcomes can change drastically depending on certain variables. Social media provides a means to solicit real-time information to support decision-making in the fast-paced environment of disaster response. Additionally, social media data, if integrated or combined with other information channels, can enhance general situational awareness; provide context to traditional channels; and serve as a means to verify, follow up on, and counteract information provided to and from the public and the field.

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[36] Google Flu Trends. <http://www.google.org/flutrends/us/#US>.

Potential applications for the integration of social media data include communications systems such as 911, 311, and 211. Social media may serve as a means to identify and maintain communication with vulnerable populations and increase inclusivity of messaging to reach whole communities as well as those with disability, access, and functional needs. It may also serve as a way to verify the safety and accuracy of resource deployment to vulnerable populations and specific demographics. Additionally, if integrated with traditional communications systems such as 911, 311, and 211, as well as traditional data sources and sensor data, social media can enhance, verify, or discount information to and from the field for decision-making, resource planning, and allocation. The following sections discuss various social media applications in public safety and situational awareness.

Impact and Outcome Modeling: In 2009, the Namibian Flood *SensorWeb* Emergency Response Pilot project, sponsored by the Committee on Earth Observation Satellites Working Group on Information Systems and Services and the United Nations Office of Outer Space Affairs in collaboration with the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Agency (NOAA), looked at combining multiple data sources and satellite imagery for increased situational awareness and strategic deployment of resources.[37] The team developed a geospatial application that visually combines data from flood models (flood forecasting, flood hazard maps, and hydrological modeling), gauging stations, historical epidemiological data, disease modeling and hazard maps, climate and vegetation conditions, and statistical disease risk alerts to better predict potential outcomes from area flooding.

Coined by Kevin Delin of NASA in 1997,[38] a "Sensor Web,"[39] or a sensor network, is a network of "spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc., and to cooperatively pass their data through the network to a main location."[40] The analysis of social networks, or social media, produces social media data, capturing information on trends, discussion topics, sentiment, and more.[41] Combined with other sensor data, social media can enhance general situational awareness, early warning, and response. Data mash-ups, or the combination of various social media data, sensor data, and traditional data sources, may provide an unprecedented level of contextual understanding.

Prevention: In combination with flood height, historical disease, and other data sources, social media may also inform preparedness activities, including targeting preparedness activities toward specific demographics and leveraging online trends and patterns to attract a wider audience. When used as a communications and data collection tool, social media may help in the development of emergency plans, the development of appropriate messaging for specific audiences, and the pre-positioning of resources

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[37] Moore, John. "Geospatial Apps Help Temper Mother Nature's Fury." *Federal Computer Week (FCW).* 5 March 2010. 28 January 2014. <http://fcw.com/Articles/2010/03/08/FEATURE-Geospatial-and-sensor-integration.aspx?Page=1>.

[38] Botts, Mike and Alex Robin. "Bringing the Sensor Web Together." *Geosciences Volume 6*. (October 2007). P. 46-53.

[39] http://en.wikipedia.org/wiki/Sensor_web

[40] http://en.wikipedia.org/wiki/Sensor_network

[41] Breslin, John G., et al. "Integrating Social Networks and Sensor Networks." *W3C Workshop on the Future of Social Networking, Barcelona, Spain, 15-16 January 2009.* World Wide Web Consortium (W3C). <http://www.w3.org/2008/09/msnws/papers/sensors.html>.

based on identified needs. Ultimately, response officials and community members are better informed, connected, and resilient, prior to an event.

Prediction: Social media data, combined with the flood height sensor and other data sources, may help to predict where and how a flood will affect a specific area. This information may help in decisions relating to the allocation of pre-positioned resources, the preparation for potential flooding, or other adverse effects.

In aggregate, the combination of social media data with other sensors may also produce new intelligence. This may include the "what" (an event has occurred or is about to occur), the "who" (who is involved or may be affected), the "why" (what caused the event and possible effects), and the "how" (the context of an event, including the demographics affected and how they are affected, the public's level of understanding, action and reaction to various messages [fact or misinformation]). Aggregated data may even help to predict the cascading effects of an event given relationships between sensors, social media, and other types of data.[42] Historical data can also help to depict how events may occur in the future and the resulting cascading effects for planning and pre-deployment of resources.

Verification: Historical social media data can capture variables prior to the onset of an event – from online traffic patterns to photos taken in pre-damaged areas. Information gleaned from social media may help to verify (or disprove) potential issues, rumors, actions, needs, and other information provided by various sources. Further research is required to develop algorithms and technologies that can quickly scan and compare pre-existing imagery and data to information collected post-event to detect changes. Additionally, crowdsourcing may prove to be a useful process by which potential change detected can quickly become verified.

Triage and Prioritization: Despite best efforts, it is difficult to predict and plan for all potential outcomes. Once an event occurs, variables may change quickly and without warning. Furthermore, the realities on the ground may prove to be very different from the assumptions made during the planning phase. For example, following an event, officials may plan to provide water or other resources to various neighborhoods based on demographics and historical need. However, other areas may need these same resources more urgently due to variables such as population movement and evacuation, demographic changes, and availability of alternative resources. Officials may leverage information from social media to help identify real-time needs and changes in prior planning assumptions. This same concept can apply to triage as well; after an event, response officials may receive thousands of requests for assistance[43] that must be triaged before deploying resources.

Operations and Logistics: For operations and logistics, response officials and partners may use social media and other data for several reasons. Examples include identifying, verifying, and predicting or assigning routes based on the real-time road status as reported by travelers. Additionally, response

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[42] Cohen, Sara Estes and Bill Hyjek. "Social Media as a Sensor: Leveraging Crowd-sourced Data for Early Warning and Response." *G&H International Services, Inc. Blog.* 24 January 2011. <http://www.ghinternational.com/blog/social-media-as-a-sensor-leveraging-crowd-sourced-data-for-early-warning-an#.U0_vYsuYapo>.

[43] Purohit, H., et al. "Emergency-relief Coordination on Social Media: Automatically Matching Resource Requests and Offers." *First Monday 19(1).* 2014. doi:10.5210/fm.v19i1.4848 <http://firstmonday.org/ojs/index.php/fm/article/view/4848/3809>.

officials may use social media to identify the availability of alternative resources (e.g., water, food, and supplies provided by the private sector or non-profit companies and organizations) and to inform transit and other activities relating to operations and logistics.

Following the 2011 earthquake in Japan, Japanese officials worked with Intelligent Transport Systems Japan to compile "probe data" from various automakers to map the roads driven by the vehicles. Prior to the earthquake, officials used this information to mitigate traffic jams and to notify drivers of spots with frequent accidents.[44] Similar data is now available via Waze, a GPS-based geographical navigation application for smartphones, and SeeClickFix, a platform to report various municipal issues such as potholes and downed trees.

Waze is a community-driven application that people can use to report accidents, traffic jams, and other transportation-related information and to update map information such as roads, landmarks, and addresses. The application can then provide information back to the community regarding these issues, helping with route planning, location services, and more.[45] Leveraged during an event, this information may help with evacuations, operations, and resource deployment. SeeClickFix is a communications platform for citizens to report non-emergency issues and for governments to track, manage, and reply to community reports. The information provided to the platform also enhances awareness of ground-level issues and can help prioritize, verify, and triage reports and resources.[46, 47]

CHALLENGES

Analysis of various social media platforms can provide awareness of trends in keywords, topics, geographic activity, and sentiment. For public safety purposes, however, the volume of data available via social media can prove overwhelming. Additionally, not all social media content is applicable to public safety given the various goals and mission objectives of public safety agencies. Furthermore, the level of detail, degree of accuracy, and even veracity of information available from social media sources may not satisfy information requirements. Information available via social media may require consideration regarding its relationship to other data sources, the combination of which may result in new information.

To utilize social media appropriately and effectively in a public safety environment, response officials must consider several points relating to information and data requirements, including:

- Degree of detail and verification needed
- Method of aggregation and filtering
- Challenges associated with volume and access to information
- Applicable search parameters
- Data management considerations such as data format, update frequency, storage, and removal of personally identifiable information (PII)

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[44] http://mnj.gov-online.go.jp/its.html
[45] http://en.wikipedia.org/wiki/Waze
[46] http://seeclickfix.com/about
[47] More information available on SeeClickFix and Hurricane Sandy in DHS Virtual Social Media Working Group "Lessons Learned: Social Media and Hurricane Sandy." June 2013.

- Restrictions and challenges associated with adoption of third-party technologies with respect to legacy technology platforms
- Security and privacy implications

Finally, each of these points may vary depending on the size, scope, type, timeline, and location of an event as well as the agency involved. The urgency to disseminate information may also vary depending on these factors, as well as the information recipients and intended uses (e.g., resource allocation, public information dissemination, life-saving activities, search and rescue).

Challenges fall within three areas: technology, information, and policy (privacy, legal, and security concerns). The following sections discuss each of the aforementioned areas and include various questions, scenarios, possible activities and research areas, and challenges requiring further consideration.

Technology

As technology advances, so too do the associated challenges that include familiarity, tool features, and overall capabilities. Collaboration between technology developers and end users is imperative to mitigate these challenges as tool features must align with operational objectives, requirements, and practices to provide the most assistance in emergency preparedness, response, and recovery.

Third-Party Platforms

In addition to challenges associated with varying data structures and management, third-party platforms vary in cost, features, and languages. Furthermore, the popularity of third-party platforms, such as Facebook, Twitter, TweetDeck, HootSuite, and Google Maps fluctuates over time.

Third-party platform features, privacy settings, and cost structures vary greatly between technologies as well. It is important to note the changes associated with third-party platforms when leveraging these tools for public safety purposes. Often, changes to a platform can render it useless or a risk to a government agency due to a variety of challenges such as security, cost, reach, and legality.

The following table (page 25: Third-Party Platforms: Challenges and Considerations) discusses various challenges and considerations associated with the use and integration of third-party platforms.

Third-Party Platforms: Challenges and Considerations

Cost	• There are costs associated with technology resources, including those needed for support staff and structure over time (e.g., some platforms provide free versions of tools with limited features, but require payment to access the full feature set). • There are costs associated to access necessary data. Without access to the Twitter fire hose, available Twitter data only represents 1 percent of the entire corpus of available tweets. There are significant costs associated with receiving access to the Twitter fire hose, or the entire body of tweets available at any given time. There are also costs associated with the infrastructure and staffing necessary to support and access the Twitter fire hose, including necessary hardware and security measures. • There are costs associated with licensing, requirements, or limitations associated with tool licensing and enterprise solutions, such as sharing data with response partners. • Guidance on general acquisition and use of grant funds for acquisition of social media technologies may help to standardize available platforms and tools by encouraging private sector developers to build to the requirements of public safety users. Additionally, general guidance on acquisition, development, and implementation may assist in opportunities for inclusion of social media requirements within future grant programs.
Training	• Training can lead to the understanding of data access, management, and purposes, or how to apply the tool to a specific need. • Training is necessary to ensure familiarity with applications, tool features, challenges, and additional considerations. Additionally, updates to training will be required as technology advances.
Requirements and Compliance	• Considerations and requirements associated with continuity of operations or business continuity for tools in use by government agencies must be considered. • Additional requirements include those associated with records retention, sunshine laws, records requests, distribution or retention of PII or health information.
Legacy Technology and Data	• Compatibility among traditional and innovative tools must be considered as technology advances and new technologies are purchased or integrated. • New technology can access online platforms through the use of an application programming interface (API). The API specifies how various software components should interact with each other and how all associated data will be handled, shared, or disseminated. Third-party platforms may change the structure of the outbound API, resulting in changes to the underlying data structure and, occasionally, resulting in broken links or dysfunctional data streams. Existing technologies may need to adapt to dynamic changes in the API, requiring ongoing updates to legacy systems. • Additional considerations include the needs associated with availability of data, formats, information needs (portability requirements), partner needs (input and output), and general interoperability and compatibility issues given legacy and partner systems.
Familiarity with Technology	• Challenges exist with regard to the understanding of available technology. • This includes technology features, purpose and potential applications, the

	appropriate application of various technology features, and agency-specific requirements.
Tool Features	• For tool development, acquisition, and integration, end users must consider identifying and developing an appropriate data format for sharing across multiple platforms and agencies. • Tool developers must consider mobile functionality (the ability to push as well as aggregate information and situational awareness to and from the field) for tools used in public safety. • Tool developers must consider identifying, leveraging, and developing the appropriate visualization techniques given data and information requirements, as well as available tools and features of various platforms, APIs, or plug-ins.

Geo-Location

A key challenge associated with the use of social media for situational awareness is that only a small percentage of all social media posts include a geo-location. This is due to a variety of reasons, including users' privacy preference on personal devices; a lack of familiarity with tool features (e.g., how to turn off/on the GPS location of a mobile phone); lack of familiarity with the platform (e.g., how to turn off/on the GPS location for posting to a specific platform); and disparity between a user's physical location, network location, or location self-reported by user and the location about which an individual is posting. To mitigate these issues and concerns, the following may be necessary:

- Training for the community on privacy concerns versus sharing of valuable information (e.g., when to turn on/off the privacy settings in order to include a GPS location within a post)
- Training for responders on the purpose and application of geo-located social media content, how to use information successfully, and technologies available to employ information
- Development of standards on information needed regarding the geo-location of an individual, a post, or a tweet (e.g., how the location is represented, location of topic versus location of individual, how to manage retweets)
- Considerations regarding the possibility of gaming and false geo-location tagging
- Development of processes to leverage input from deployed resources, including Urban Search and Rescue and Community Emergency Response Team members
- Considerations regarding the algorithms associated with third-party platforms and how they affect the available information within an activity feed, including the Facebook activity feed algorithm and the Twitter stream
- Consideration for the creation and use of metadata published to social media platforms and what type of information may be gleaned

Technology Requirements

Collaboration must occur between first responders and technology developers to ensure available technologies address specific public safety needs and considerations. In February 2014, members of the DHS VSMWG and several collaboration partners, including individuals from Anaheim [Calif.] Emergency Management and Preparedness, the San Francisco Department of Emergency Management, the Johnson County [Kan.] Sheriff's Office, the New York City Office of Emergency Management, The George Washington University, Wright State University Kno.e.sis Center, Humanity Road, the U.S. Department of Health and Human Services, USNORTHCOM, the National Guard, and many others, participated in the Joint Interagency Field Exploration (JIFX).

This three-day event examined how social media can serve as an information source for situational awareness and decision-making. Several technology companies participated as well, offering their tools to test how to identify, leverage, integrate, and visualize social media and other types of data within an operational environment. Following the event, the DHS Homeland Security Studies and Analysis Institute summarized several capabilities that the participants identified as necessary or useful, including[48]:

- The ability to display emerging Twitter hashtags by topic area, bounded by geographic location, to identify potential urgent circumstances (e.g., power outage, floods)
- The ability to know an urgent event occurred, identify trending topics (tweeted hashtags or keywords) within a geographic location, and to understand real-time public sentiment
- The ability to identify influencers (profiles that appear to impact behavior of the crowd)
- The ability to determine the severity of a specific situation through imagery and text
- The ability to overlay more than one data input on a map to determine correlation or causation (e.g., overlaying weather data on top of power outage data to determine if the weather caused the power outages)
- The ability to identify resource or damage levels within a geographic area (e.g., availability of gas)
- The ability to visually overlay social media data on top of existing data input layers (e.g., power outage data provided by utilities or road condition data provided by Google maps to identify areas that are at risk, and also vulnerable due to demographics, special needs, etc.) to verify the occurrence and understand the cause
- The ability to understand why an event occurred, why a topic is trending, and why public sentiment is either positive or negative
- The ability to understand the severity of broad conditions (e.g., how long drivers remain stationary on a highway)
- The ability to drill down into specific trending subject areas
- The ability to validate social media content without human intervention (e.g., automated facial recognition software that searches for potential suspects given specific variables or evidence)
- The ability to filter urgent requests for assistance from a large volume of social media information
- The ability to gauge public reaction and response to official messages

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[48] Thompson, Kelli et al. "Joint Interagency Field Exploration 14-2 Social Media Experiment: Analysis Report Executive Summary." *DHS Homeland Security Studies and Analysis Institute for DHS S&T*. 28 February 2014.

Spatial-Temporal Lapses, Changes, and Re-Sharing

Social media moves very quickly; information may not be relevant once identified or analyzed. Furthermore, the meaning of information, once published, may change in relation to its time decay. For example, an individual who tweets for help regarding an imminent house fire or flood may require immediate assistance. If the request is not acted upon immediately, however, the individual may require a different form of assistance, such as recovery or re-connection assistance.

Additionally, information, once pulled from social media, may no longer capture the specific location of the person who shared it. Officials may need to account for a change in location and what that change means for response activities. Further research may focus on the identification of various changes in time and space that might occur within social media, and the respective meaning for each. Variables may vary by scenario, event type, location, demographic, or other factors.

Additional changes may occur with respect to re-sharing of information across various platforms. While an original post may describe an immediate or specific need, the re-sharing of this same information may signify various points, including:

- A heightened need for attention, including public perception that a need for help or service remains. Sharing may continue as individuals feel inclined to help, until the community knows or feels that help has arrived, or the situation has been mitigated (closing the loop to prevent unintentional re-sharing).
- A relay of information from a related third party
- A relay of information from an unrelated third party
- An unrelated post from an unrelated party for amplification purposes only

Information

In addition to the underlying technologies, challenges exist with respect to the information available to access and share among response partners. These include a lack of standards in data management; interoperability of technologies and processes; access to available information; and information management, including volume, veracity, aggregation, filtering, and contextualization of information once identified as applicable in an event or activity.

Information Sharing

The use of social media as an additional data source presents new challenges with respect to data management. The multitudes of platforms, technologies, and tools now available produce social media data in a variety of formats, languages, and structures. A lack of standardization exists not only across social media technologies, but also between social media and traditional data within the operational environment. Given the volume and speed with which social media data is available, the following table (page 30: Challenges Associated with Information Sharing) illustrates points that need to be addressed.

Challenges Associated with Information Sharing	
Data Management	• Storage, including server capacity, privacy and security considerations, information technology/disaster recovery considerations, server location, mirrored servers, frequency and number of backups needed or required, upload and download speed, retention policies and requirements, sunshine, and Freedom of Information Act (FOIA) requests • Update frequency • Applicable search parameters • Naming protocols
Coordination	• Privacy, legal, and security concerns • Technology platforms • Processes and policies • Information requirements and essential elements of information
Interoperability	• Data structure, format, syntax, and schema • Taxonomies and ontologies • Output types • Visualization methods

Access to Information

In addition to tool cost, features, and data, third-party platforms often do not provide complete access to information published to their platforms. For example, if using a free aggregation or analysis tool to search tweets, one only has access to approximately 1 percent of all available tweets published at the time of aggregation through the API. Full access requires a significant resource investment.[49] Furthermore, content published to Facebook is not available for public analysis. Facebook privacy settings do not easily enable content sharing outside of the platform. Facebook posts are therefore not necessarily useful for general situational awareness and decision-support.[50]

Additionally, while Facebook and Twitter are two of the most popular social media platforms in 2014, the popularity of social media technologies will fluctuate over time. The universe of available tools is incredibly diverse and dynamic; each is developed individually and with respect to the various developers' interests, objectives, and goals. Until standards are developed and adopted across the development world, inconsistencies with content style, etiquette, data formats, and other technical attributes will remain. Due to the subsequent inconsistencies in technology development, including the need for the identification of operational requirements, response organizations will continue to experience difficulty when accessing information from various platforms.

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[49] "How Do I Get Fire Hose Access?" *Twitter.com*. 28 January 2014. <https://dev.twitter.com/discussions/2752>.
[50] Conversations and communications between a government agency and a response partner on an agency's Facebook page can be useful for general inquiries, discussion, and general information; this information is not available in aggregate, nor is it available externally, across multiple profiles or pages.

Volume and Velocity

On a daily basis, a significant volume of information passes through various social media channels. Twitter reports that its users publish more than 500 million tweets per day[51] and Facebook collects more than 500 terabytes of data each day.[52] During an emergency, volume increases significantly for a portion of time following the onset of the event, amplified by the social networks.[53] This makes it difficult to identify and leverage useful or applicable information. Filtering and verification processes are necessary to mitigate the volume and speed of information produced via social media. The following section discusses needs and challenges associated with aggregation, filtering, and verification, as well as additional points requiring further development or discussion.

Aggregation and Filtering

Response organizations often follow specific mission objectives, both general and scenario-specific, which can be combined with documented or undocumented pre-existing information requirements. Although it may be possible to conduct a landscape analysis of social media channels (e.g., trending topics, keywords, and sentiment analysis), targeted aggregation and searches may prove more effective to identify information that specifically addresses the objectives and information requirements, both on an ongoing basis and specifically during emergencies.

Search parameters will most likely differ between scenario, jurisdiction, agency, sector, demographic, and target objectives. For each set of parameters, considerations may differ depending on a variety of factors, including agency mission, search perspective, event gravity and breadth, objective (e.g., general situational awareness versus resource deployment), agency restrictions (e.g., removal of PII), level of activation, and more. Currently, search parameters may include geographic targeting, trending topics, keywords, hashtags, lists, and individual usernames. As technology advances, further research is required to focus on the use of algorithms utilizing natural language processing techniques and domain-specific "regular expressions," moving toward artificial intelligence and intelligent search.

Veracity and Variety

Actionable information pulled from social media may require verification before officials can respond, deploy resources, or take other actions. Although information can produce general situational awareness, the level to which information requires verification may depend on several factors. These include agencies involved, actions requested, the scenario, the type of hazard, legal considerations, and target objectives. The answers to these factors will dictate the level to which verification, specificity, and data provenance must be known and achieved. Additional challenges include:

- An inability to pull metadata from imagery within the social media stream for analysis
- An inability to verify imagery against known landmarks for unclassified activities
- An inability to match imagery with related information to produce aggregated results

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[51] "Form S-1 Registration Statement of Twitter, Inc." *United States Securities and Exchange Commission*. 3 October 2013. <http://www.sec.gov/Archives/edgar/data/1418091/000119312513390321/d564001ds1.htm>.
[52] Kern, Eliza. "Facebook is Collecting Your Data – 500 Terabytes a Day." *Gigaom.com*. 22 August 2012. <http://gigaom.com/2012/08/22/facebook-is-collecting-your-data-500-terabytes-a-day/>.
[53] Global Disaster Alert and Coordination System (GDACS). <http://portal.gdacs.org/GDACS-Beta/Social-Media-for-GDACS>.

- An inability to determine and assign meaning to information as time progresses
- An inability to understand tool features, including privacy and location settings
- An inability to re-analyze information against new variables and a dynamic environment
- An inability to produce or follow a "verified stream" of information outside of the profiles verified by Twitter
- An inability to identify appropriate information sources given an individual's location or interest in a specific event
- An inability to assign weights to information to prioritize needs
- Difficulties associated with throttling of social media streams, including limitations on the retrieval of data through APIs

The following activities and considerations may mitigate concerns and challenges associated with the volume and veracity of social media data.

Considerations for Mitigating Challenges Associated with the Volume and Veracity of Social Media Data	
Activity	**Task**
Handling and Managing Content	- Identify and leverage verified accounts through the creation of Twitter lists - Establish and adhere to collaborative activities, such as cross-posting of official information and sending updates to response partners
Partnerships	- Maintain ongoing engagement (before, during and after an event) with response partners, community organizations, and volunteer groups - Partner or leverage assistance from third-party organizations (e.g., volunteer, ad-hoc) for creation, management, or direct engagement with online communities, profiles, and pages (e.g., the Digital Red Cross volunteers,[54] Standby Task Force, Virtual Operations Support Teams, Humanity Road)
Activities for Third Parties	- Match newly posted imagery to existing and known photos leveraging third-party tools (e.g., TinEye, Google Search By Image) - Crowd-source for both general and specific information by request or in advance

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[54] American Red Cross. "Super-Storm Sandy: One-Year Update." *American Red Cross.* October 2013. <http://www.redcross.org/images/MEDIA_CustomProductCatalog/m23216738_Superstorm_Sandy_One-Year_Update.pdf>.

Data and Information Integration

Government agencies and response partners maintain specific, pre-existing information requirements to define operational activities prior to an event, which are most often satisfied through traditional channels and methods. Social media may serve as an additional means to answer, enhance, or verify these information requirements, providing actionable, contextualized information in real-time. Combined with other data, social media data may help in prevention, prediction, and impact modeling; event and change detection; needs identification; verification; triage; and prioritization; and operations and logistics.

Social media, if explored strategically and in relation to mission-specific pre-existing information requirements, or "essential elements of information,"[55] may serve as an additional means to answer, enhance, or verify these information requirements. The capabilities identified at the JIFX event in February 2014 may satisfy some of the requirements for the successful integration of social media data. Additional questions exist with regard to the information itself that requires further consideration to identify, organize, manage, and integrate social media data with other data sources. The following table captures various questions and points of consideration.

Questions	Points of Consideration
What specific decisions need to be made?	• Do these decisions vary by disaster phase? • If so, how?
Are you able to answer questions sufficiently and efficiently?	• What determines success, sufficiency, or efficiency? • How quickly must information be disseminated? • How frequently must information be updated?
What information is needed to answer questions?	• What are the traditional sources of information required to answer questions? • Can information be gathered from new sources or locations?
To what degree of certainty do you need to know the answers?	• Do all decisions require 100 percent certainty? • Can certainty vary depending on types of questions and decisions?
To what degree of specificity do you need to know the answers?	• Do all decisions require 100 percent specificity and detail? • To what degree is detail needed and does this vary by decision type, scenario, stakeholder, etc.?
Does the origin of information determine or change its usefulness (official trusted sources versus general)?	• Does all information need to come from trusted sources? • Can unverified information be useful, and if so, for what types of decisions or scenarios?
Can social media enhance, answer, verify,	• What types of information do social media tools

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[55] Department of Homeland Security. "Homeland Security Geospatial Concept of Operations (GeoCONOPS)." Version 5.0. June 2013. Page 22. < https://www.geoplatform.gov/node/575>.

or dispel information?	- provide (e.g., location, keyword or topic trend, sentiment)? Is it applicable to target demographics? - What types of information or decisions might benefit from information gleaned from social media sources? - Is this information available, and if so, what does it look like (e.g., keyword, slang, format, origin, source)?
What are some agency- or organization-specific actions requiring further information in order to proceed?	- How to properly address allocation and deployment of resources (including volume, location, frequency, and type), public information dissemination, alerts and warnings, etc.? - How to manage decisions stemming from updated information or status changes?
Can information be enhanced through the use of crowdsourcing efforts?	- What actions are needed (e.g., geo-tagging, answers, questions, additional information, media)? - Can the crowd be leveraged to help in developing and training algorithms for future searches?
Can a relationship be identified and assigned to social media data to integrate it into operations?	To what pre-existing information structure should tags be assigned (e.g., Emergency Support Functions identified in the National Response Framework, Core Capabilities, or National Information Exchange Model)?
Are terms used identical across platforms, agencies, and response efforts?	How might a public safety ontology or taxonomies serve to assist in the interoperability of social media data across multiple platforms?

Disparate and Virtual Communities

Information sharing during an emergency is not limited by proximity. Cellular and wireless coverage can be intermittent due to overloading or infrastructure damage depending on the size and type of event. Additionally, individuals no longer identify with a given community based solely on location. As a result, disparate or even virtual communities now engage in information sharing during emergencies with original, shared, or re-posted content as well. Combined with limited use of geo-location, as well as the ability to change the location included on a social media profile, public safety agencies may experience difficulty deciphering whether information being shared and discussed is actually applicable to immediate response operations.

In recent disasters, virtual "clearing houses" have appeared, developed by individuals outside the affected area. This occurred after several events, including the Tuscaloosa and Joplin tornadoes, Hurricane Sandy, and the Boston Marathon bombing.[56] These pages are useful for general information, often serving as a central point for community reconnection and the re-publication and amplification of information. These pages also may include information relayed from the friends and family of those affected, sent and received via text over cellular networks. Further research is required to establish best practices and tools to verify, aggregate, and amplify information via unofficial channels.

Potential areas of future research may include the following questions:

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[56] DHS Virtual Social Media Working Group. "Lessons Learned: Social Media and Hurricane Sandy." June 2013.

- Is the information applicable to the event? If so, is it informational or actionable?[57]
- Is information identified as originating from within the proximity of an event?
- If information is identified as applicable, but originating from outside of the proximity of an event, is there a relationship between the poster and the affected area?
- What is the connection of the poster to the affected area, and with what priority should the information be considered (e.g., informational, actionable, immediate, requiring follow up, requiring resources)?

Gaming

As technology advances, so too do the concerns associated with its applications, specifically with regard to emergency planning, response, and recovery. Various techniques exist, from simple manual manipulation to complicated and technically advanced algorithms and viruses. The goals of those wishing to game a social network often include:

- Inability to access service
- Delayed access to service
- Propagation of misinformation
- Misrepresentation of affected, involved, or reporting network
- Misrepresentation of event details

To address concerns associated with gaming, additional research requires focus on social network analysis, including profile verification, validation of content, validation of imagery (content and location), and methods for mitigation against attacks meant to overwhelm social networks.

Policy (Privacy, Legal, and Security-Related) Challenges

Social media, its applications, and the extent of its possibilities are not yet fully known. Because of this, the legal system has experienced a difficult time keeping up with the pace with which technology is advancing. Concerns regarding the privacy and security of users, as well as the information itself, continue as new methods of monitoring, aggregation, and application progress.

The issue of privacy remains a focus of litigation involving social media sites. In *United States v. Jones*, 132 S. Ct. 945, 950 (2012), the court declared that to "establish a violation of the Fourth Amendment, a defendant must show either (1) a physical intrusion onto defendant's personal property; or (2) a violation of a defendant's reasonable expectation of privacy."[58]

A few courts decided that publically available social media should be considered an open information source. For example, in *The People of the State of New York v. Malcolm Harris*, Slip Op, N.Y. Criminal Court,

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[57] Vieweg, Sarah E. *Situational Awareness in Mass Emergency: A Behavioral and Linguistic Analysis of Microblogged Communications.* Dissertation, University of Colorado at Boulder, January 2012. <http://works.bepress.com/vieweg/15>.

[58] *The United States v. Jones.* 132 S. Ct. 945, 950 (2012). United States Supreme Court. <http://www.witkin.com/pages/recent_dev_pages/current_pages/illegal_jones.htm>.

June 20, 2012**,** the court determined:

> *"If you post a tweet, just like if you scream it out the window, there is no*
> *reasonable expectation of privacy. There is no proprietary interest in your tweets,*
> *which you have now gifted to the world. This is not the same as a private email, a*
> *private direct message, a private chat, or any of the other readily available ways*
> *to have a private conversation via the Internet that now exist. Those private*
> *dialogues would require a warrant based on probable cause in order to access the*
> *relevant information."[59]*

In *Moreno v. Hanford Sentinel, Inc.*, 172 Cal. App. 4th 1125 (2009), the court decided "there is no expectation of privacy when public postings are made on social media networks." This applied even when the postings were intended for a limited audience. In *Zimmerman v. Weis Markets, Inc.*, NO. CV 09-1535, Pa. D & C 4th May 19, 2011, the court decided, "When a person voluntarily posts information to share with other users of social networks, they cannot then claim that a reasonable expectation of privacy exists."[60] Finally, in *Romano v. Steelcase, Inc.*, 30 Misc. 3d 426, N.Y. Sup. Ct. (2010), the court decided, "Privately posted material on social network sites is discoverable during litigation."

Despite court decisions in favor of disclosure of information via social media, concerns remain regarding the privacy of individuals, specifically with respect to government use of information gleaned from social media platforms. Per the US Department of Homeland Security Office of Operations and Planning Privacy Impact Assessment (PIA), the department may "provide situational awareness and establish a common operating picture for the entire Federal Government, and for state, local, and tribal governments as appropriate… to ensure that critical disaster-related information reaches government decision makers."[61] There are several restrictions to activities under this initiative, however, as identified in the PIA. The NOC is prohibited from:

- Posting information on social media sites
- Actively seeking to connect with other individual social media users
- Accepting invitations to connect from other individual social media users
- Interacting on social media sites

Additional restrictions drive information that can be gathered and shared by the NOC on an ongoing basis, as outlined in the PIA. In some circumstances, PII must be stripped before information can be shared.

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[59] *The People of the State of New York v. Malcolm Harris*. 2011NY080152. Criminal Court of the City of New York, County of New York: Jury 2, p. 5. 2012. 12 March 2014.
<http://www.aclu.org/files/assets/owsharristwitterdec63012.pdf>.
[60] *Zimmerman v. Weis Markets, Inc.* NO. CV 09-1535, Pa. D & C 4th. Northumberland County, Pennsylvania Civil Action. May 19, 2011. <http://www.gtleblog.com/uploads/file/Zimmerman.pdf>.
[61] DHS Office of Operations Coordination and Planning. *Privacy Impact Assessment: Publicly Available Social Media Monitoring and Situational Awareness Initiative Update*. Washington, DC: DHS, p.2. 1 April 2013.
<http://www.dhs.gov/sites/default/files/publications/privacy/PIAs/privacy_pia_ops_NOC%20MMC%20Update_April 2013.pdf>.

Social media information with PII removed, however, may not provide enough information to response officials to inform operational decisions. Further research is needed to identify and develop best practices for coordination among response partners to encourage appropriate information sharing given various restrictions, responsibilities, and capabilities. Questions include:

- What, specifically, is the definition of social media information that is considered to be personally identifiable, and can this definition become standardized across government agencies?
- For what purposes is information accessed?
- Do varying purposes require varying restrictions or considerations?
- Do varying purposes elicit varying activities (e.g., method of storage, frequency of update or deletion, sharing of data)?
- Does the information include PII and does the removal of PII render the resulting data useless?
- What processes, if any, can be developed to enable those not subject to PII restrictions to manage, handle, and share redacted information with others?
- From where is the data aggregated? Do requirements and challenges differ depending on the origin of aggregated information (e.g., acquired from a government website and/or social media profile; passively monitored and aggregated to enhance situational awareness)?
- Is encryption a viable option for enabling multiple parties with varying access requirements and restrictions to share social media data? If so, what encryption methods are needed? Are there requirements for data format and/or structure required to enable data encryption?
- Can PII restrictions vary by scenario, dictated by declaration status or enactment of the [Robert T. Stafford Disaster Relief and Emergency Assistance Act](#) or other applicable disaster legislation?
- What, if any, restrictions require specific consideration for [Health Insurance Portability and Accountability Act of 1996](#) (HIPPA)-applicable data? Do these considerations differ from non-HIPPA-related information or for those agencies determined to be "covered entities"?

To address the issues relating to the veracity and provenance of social media data, the following questions may require further consideration:

- Does the need for information determine the level to which its veracity can be established?
- Does the application or purpose of information determine the level to which veracity and data provenance can be confirmed?? If so, to what degree must veracity and/or data provenance be determined for various information types?
- Does the level to which veracity and data provenance vary depend on the beneficiary?
- How does the application of social media data (e.g., situational awareness, intelligence) determine its handling requirements?

AREAS OF FUTURE RESEARCH

Social media will continue to grow as an information source to be used throughout all phases of the disaster life cycle. Its use may prove beneficial for general situational awareness; however, further research is required to truly operationalize and institutionalize its use. In addition to those research questions already addressed, several additional areas require further research as well. These areas are addressed in the following table.

Research Area	Description
Essential Elements of Information (EEIs)	Given the nature of the response environment, pre-existing information requirements can serve as a basis for defining search parameters, decision points, priorities, applicable parties, and resources needed. Much of the information needed to answer some of these questions can be found within traditional means, including windshield assessments, field reporting, and partner data. Information extracted from social media can serve to answer, enhance, verify, or disprove data from traditional sources. In order to leverage unstructured data extracted from social media platforms, however, agencies must consider the following points: type, attributes, source, format, and additional data requirements (e.g., frequency, volume, management, restrictions). A public safety ontology or information structure may also be required to assist in the organization of social media data and integration with existing EEIs.
Open Standards	Potential research may focus on the integration of social media in the larger data sharing environment through the application of standards such as the Emergency Data Exchange Language (EDXL), Humanitarian eXchange Language (HXL),[62] Common Alerting Protocol (CAP), and National Information Exchange Model.

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[62] Humanitarian Exchange Language (HXL) <http://hxl.humanitarianresponse.info/ns/index.html>. Information provided by Patrick Meier, Qatar Computing Research Institute.

Decision Support	In the report from the workshop on "Field-Based Decision Makers' Information Needs in Sudden Onset Disasters,"[63] the authors discuss the results of a two-day workshop conducted with subject matter experts from various humanitarian response-related fields. The workshop aimed to help Volunteer Technical Communities (VTC) understand the type of information required to make decisions from the field by providing: (1) a framework and set of information required by field-based decision makers, (2) categories and types of decisions made by decision makers, and (3) a large set of decisions brainstormed by workshop participants. The results of the workshop highlight the type of information needed to make informed decisions, organized by dimension and category. This same structure must be identified and applied to domestic response.
Tool Development	As technology advances, the possibilities for using new tools in public safety will also expand. To ensure tools are developed in a manner that is useful and accessible by public safety agencies, the following areas of research and accessibility must be considered: • Standardization of data formats, ontologies, data models, and data management • Established baselines • Access to Twitter Fire hose • Anomaly detection • Visualization of data • Geospatial standards
Integration of Crowd-Sourcing	Outside of mapping and crowd-sourced tools (e.g., Ushahidi, CrisisMappers, Virtual Operations Support Teams) few structured, streamlined systems for managing data exist. Much of the data must still be manually processed; crowd education must take place to leverage tagging or training systems. Qatar Computing Research Institute is currently developing AIDR (artificial intelligence for disaster response). AIDR is a free, open-source platform that automatically filters and classifies relevant tweets that are posted during humanitarian crises, combining human and machine intelligence to process data that neither can do alone.[64]
Integration with Next Gen 911	While the Federal Communications Commission has reported that some 911 call centers have deployed text-to-911 service, most only accept voice.[65] As the transition occurs from voice to data, further research must include both technical and operational considerations, including data format, process, and analysis.

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[63] Goentzel, Jarrod, Dr. Erica Gralla, and Bartel Van de Walle. "Report from the Workshop On Field-Based Decision Makers' Information Needs in Sudden Onset Disasters.", *24-25 September 2012.* Digital Humanitarian Network. October 2013. <https://app.box.com/s/uf0ark7n8fzkf1bi4oc7 >.

[64] Artificial Intelligence for Disaster Response (AIDR). Qatar Computer Research Institute. http://aidr.qcri.org/.

[65] For information on Text-to-911 Deployments, see: http://transition.fcc.gov/cgb/text-to-911-deployments.pdf.

Automation and Semantic Web (Linked Data)[66]	Situational awareness combines several information sources, one of which is social media. The interpretation of integrated information from social and traditional data sources is challenging, however, and less useful without proper contextualization. Information may be identified as useful to response coordination only through extraction, processing, and interpretation. Semantic Web or Web 3.0 technologies provide an opportunity for preserving context while storing and integrating various data layers, such as in the form of provenance-aware Resource Description Framework (RDF) data. Furthermore, Linked Data and Open Government Data clouds provide several data sets that can be leveraged for better situational awareness for the affected crisis region, such as the power network layers, population census data, and demographics information. There is a need for further research to: (1) identify the relevant datasets and (2) integrate them with various other sources while preserving the context of information. Future research also needs to evaluate the value of traditional data enhanced with social media for response teams in real-time operations. Potential instances in which social media might enhance situational awareness include ongoing or changing events, transportation blockages, weather issues, and impacts to building conditions, which can be extracted via social media data abstraction.

CONCLUSION

As technology capabilities, access, and familiarity with new tools grow, the possibilities for integration within the field of public safety also expand. Recent disasters illustrate a rising trend in the use of mobile technology for information sharing and communications, a phenomenon that greatly increases the ability to find and share information with the field during an event. In addition to serving as a communications channel, social media, if integrated with other data sources, may increase situational awareness to enhance operational decision-making.

With technological advances comes a need for further research and development in technology, processes, and policies to manage volume, variety, velocity, and veracity of available data, as well to identify and establish the appropriate placement of social media data within the larger information sharing environment. With further consideration, social media can become a meaningful and truly integrated information source within the context of public safety and public safety operations.

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[66] Purohit, Hemant. Information provided March 2014.

REFERENCES

Adamski, Shayne, Senior Manager of Digital Engagement, Federal Emergency Management Agency. Statement to the U.S. House of Representatives Committee on Homeland Security Subcommittee on Emergency Preparedness, Response, and Communications. *Subcommittee Hearing: Emergency MGMT 2.0: How #SocialMedia & New Tech are Transforming Preparedness, Response & Recovery #Disasters #Part2 #Govt/NGOs.* 9 July 2013. 113th Congress, 1st session. <http://docs.house.gov/meetings/HM/HM12/20130709/101047/HHRG-113-HM12-Wstate-AdamskiS-20130709.pdf>.

American Red Cross. "Superstorm Sandy: One-Year Update." *American Red Cross.* October 2013. <http://www.redcross.org/images/MEDIA_CustomProductCatalog/m23216738_Superstorm_Sandy_One-Year_Update.pdf>.

"Big Data." Information Technology (IT) Glossary. Gartner.com. 27 January 2014. <http://www.gartner.com/it-glossary/big-data/>.

Bindley, Katherine. "Boston Police Twitter: How Cop Team Tweets Led City from Terror to Joy." *Huffington Post.* 26 April 2013. <http://www.huffingtonpost.com/2013/04/26/boston-police-twitter-marathon_n_3157472.html>.

Botts, Mike and Alex Robin. "Bringing the Sensor Web Together." *Geosciences Volume 6*. (October 2007).

Breslin, John G., et al. "Integrating Social Networks and Sensor Networks." *W3C Workshop on the Future of Social Networking, Barcelona, Spain, 15-16 January 2009.* World Wide Web Consortium (W3C). <http://www.w3.org/2008/09/msnws/papers/sensors.html>.

Carter, David L. (2004). Chapter Two; "Understanding Contemporary Law Enforcement Intelligence: Concept and Definition." *Law Enforcement Intelligence: A Guide for State, Local, and Tribal Law Enforcement Agencies*. November 2004. School of Criminal Justice, Michigan State University. http://www.cops.usdoj.gov/CDROMs/Tribal/law/LawEnforcementIntelligenceGuide.pdf>.

Cohen, Sara Estes and Bill Hyjek. "Social Media as a Sensor: Leveraging Crowd-sourced Data for Early Warning and Response." *G&H International Services, Inc. Blog.* 24 January 2011. <http://www.ghinternational.com/blog/social-media-as-a-sensor-leveraging-crowd-sourced-data-for-early-warning-an#.U0_vYsuYapo>.

Davis III, Edward F., Alejandro A. Alves, and David Alan Sklansky. "Social Media and Police Leadership: Lessons from Boston." *New Perspectives in Policing.* March 2014. Harvard University Executive Session on Policing and Public Safety. <http://news.harvard.edu/gazette/wp-content/uploads/2014/04/Social-Media-and-Police-Leadership.pdf>.

Department of Homeland Security. "Homeland Security Geospatial Concept of Operations (GeoCONOPS)." Version 5.0. June 2013. Page 22. < https://www.geoplatform.gov/node/575>.

Department of Homeland Security (DHS) Office of Operations Coordination and Planning. *Privacy Impact Assessment: Publically Available Social Media Monitoring and Situational Awareness Initiative Update*. Washington, DC: DHS, 1 April 2013.

Department of Homeland Security (DHS) Science and Technology Directorate (S&T) First Responders Group Virtual Social Media Working Group (VSMWG). "Community Engagement and Social Media Best Practices." Washington, DC: DHS, September 2012. <https://communities.firstresponder.gov/DHS_VSMWG_Community_Engagement_Formatted_May_2013_FINAL.pdf>.

DHS S&T First Responders Group VSMWG. "Lessons Learned: Social Media and Hurricane Sandy." Washington, DC: DHS, June 2013. <https://communities.firstresponder.gov/DHS_VSMWG_Lessons_Learned_Social_Media_and_Hurricane_Sandy_Formatted_June_2013_FINAL.pdf>.

DHS S&T and National Geospatial-Intelligence Agency. *Identification of Key Knowledge Gaps in Social Media Use During Disasters Workshop Report*. Washington, DC: DHS, 22-23 July 2013.

ESRI. "Public Safety and Homeland Security Situational Awareness." *ESRI*. February 2008. <http://www.esri.com/library/whitepapers/pdfs/situational-awareness.pdf>.

"First Responder Big Data Analytics: Roadmap Recommendations." *Homeland Security Systems Engineering and Development Institute*. 5 February 2014.

"Form S-1 Registration Statement of Twitter, Inc." *United States Securities and Exchange Commission*. 3 October 2013. <http://www.sec.gov/Archives/edgar/data/1418091/000119312513390321/d564001ds1.htm>.

Gilgoff, Dan and Jane J. Lee. "Social Media Shapes Boston Bombings Response." *National Geographic News*. 15 April 2013. <http://news.nationalgeographic.com/news/2013/13/130415-boston-marathon-bombings-terrorism-social-media-twitter-facebook/>.

Goentzel, Jarrod, Dr. Eric Gralla, and Bartel Van de Walle. "Report from the Workshop." *Workshop on Field-Based Decision Makers' Information Needs in Sudden Onset Disasters, 24-25 September 2012.* Digital Humanitarian Network. October 2013. <https://app.box.com/s/uf0ark7n8fzkf1bi4oc7>.

"Google Flu Trends." *Google.com.* <http://www.google.org/flutrends/us/#US>.

"Guidelines for Law Enforcement." *Twitter.com*. <https://support.twitter.com/articles/41949-guidelines-for-law-enforcement>.

"Haiyan Public Health Response." *Humanity Road.* November 2013. <http://humanityroad.org/super-typhoon-haiyan-response/>.

Howard, Alex. "Facebook Teams up With DoJ, NCMEC to Issue Social AMBER Alerts." *Govfresh.com.* 12 January 2012. <http://gov20.govfresh.com/facebook-teams-up-with-doj-ncmec-to-issue-social-amber-alerts/>.

"How Do I Get Fire Hose Access?" *Twitter.com*. 28 January 2014. <https://dev.twitter.com/discussions/2752>.

Humanitarian Exchange Language (HXL) http://hxl.humanitarianresponse.info/ns/index.html. Information provided by Patrick Meier, Qatar Computing Research Institute.

 "Information for Law Enforcement Authorities." *Facebook.com.* <https://www.facebook.com/safety/groups/law/guidelines/>.

Kern, Eliza. "Facebook is Collecting Your Data – 500 Terabytes a Day." *Gigaom.com*. 22 August 2012. <http://gigaom.com/2012/08/22/facebook-is-collecting-your-data-500-terabytes-a-day/>.

Liu, Sophia B. (2014). Crisis Crowdsourcing Framework: Designing Strategic Configurations of Crowdsourcing for the Emergency Management Domain. *Computer-Supported Cooperative Work (CSCW) special issue on Crisis Informatics and Collaboration*.

Liu, Sophia B., Barbara S. Poore, Richard J. Snell, Aubrey Goodman, Nathaniel G. Plant, Hilary F. Stockdon, Karen L.M. Morgan, and M. Dennis Krohn. (2014). USGS iCoast – Did the Coast Change?: Designing a Crisis Crowdsourcing App to Validate Coastal Change Models. In Proceedings of the companion publication of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW Companion '14). ACM, New York, NY, USA, 17-20.

Martinez, Michael and John Newsom. "Crowdsourcing Volunteers Comb Satellite Photos for Malaysia Airlines Jet." *CNN.com.* 12 March 2014. 13 March 2014. <http://www.cnn.com/2014/03/11/us/malaysia-airlines-plane-crowdsourcing-search/index.html?c=mobile-homepage-t>.

Moore, John. "Geospatial Apps Help Temper Mother Nature's Fury." *Federal Computer Week (FCW).* 5 March 2010. 28 January 2014. <http://fcw.com/Articles/2010/03/08/FEATURE-Geospatial-and-sensor-integration.aspx?Page=1>.

The People of the State of New York v. Malcolm Harris. 2011NY080152. Criminal Court of the City of New York, County of New York: 2 July 2012. <http://www.aclu.org/files/assets/owsharristwitterdec63012.pdf>.

Purohit, H., et al. "Emergency-Relief Coordination on Social Media: Automatically Matching Resource Requests and Offers." *First Monday 19(1).* 2014. doi:10.5210/fm.v19i1.4848 <http://firstmonday.org/ojs/index.php/fm/article/view/4848/3809>.

"Reddit." *Wikipedia, the Free Encyclopedia*. Wikimedia Foundation. 16 May 2014. <http://en.wikipedia.org/wiki/Reddit>.

"The Semantic Web Made Easy." *World Wide Web Consortium (W3C).* May 2001. <http://www.w3.org/RDF/Metalog/docs/sw-easy>.

"Sensor Network." *Wikipedia, the Free Encyclopedia*. Wikimedia Foundation. 6 May 2014. <http://en.wikipedia.org/wiki/Sensor_network>.

"Sensor Web." *Wikipedia, the Free Encyclopedia*. Wikimedia Foundation. 3 January 2014. <http://en.wikipedia.org/wiki/Sensor_web>.

Shibutani, Tomatsu. *Improvised News*. Indianapolis: The Bobbs-Merrill Company, Inc., 1966.

"Social Media Response Super Typhoon Haiyan Philippines 2013." *Humanity Road*. 12 December 2013. <http://humanityroad.org/wp-content/uploads/2014/04/Humanity-Road-Haiyan-PH-Response-Nov-2013.pdf>.

Starbird, Kate. "Digital Volunteerism During Disaster: Crowdsourcing Information Processing." University of Colorado, ATLAS Institute. 2011. < http://crowdresearch.org/chi2011-workshop/papers/starbird.pdf>.

Thompson, Kelli et al. "Joint Interagency (JIFX) 14-2 Social Media Experiment: Analysis Report Executive Summary." *DHS Homeland Security Studies and Analysis Institute for DHS S&T*. 28 February 2014.

United States Congress. "The Homeland Security Act of 2002." *107th Congress.* Section 515 (6 U.S.C. 321d(b)(1)). 25 November 2002. <http://www.dhs.gov/xlibrary/assets/hr_5005_enr.pdf>.

The United States v. Jones. 132 S. Ct. 945, 950 (2012) United States Supreme Court. <http://www.witkin.com/pages/recent_dev_pages/current_pages/illegal_jones.htm>.

Vieweg, Sarah E. *Situational Awareness in Mass Emergency: A Behavioral and Linguistic Analysis of Microblogged Communications.* Dissertation, University of Colorado at Boulder, January 2012. <http://works.bepress.com/vieweg/15>.

"Waze." *Wikipedia, the Free Encyclopedia*. Wikimedia Foundation. 17 May 2014. <http://en.wikipedia.org/wiki/Waze>.

Zimmerman v. Weis Markets, Inc. NO. CV 09-1535, Pa. D & C 4th. Northumberland County, Pennsylvania Civil Action. May 19, 2011. <*http://www.gtleblog.com/uploads/file/Zimmerman.pdf*>.