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Social Media Influencing C2 in Underdeveloped and Degraded Operational Environments

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Abstract

The ubiquity of online and mobile technologies across the World and their rapid adoption by citizens in the face of emergencies and crises is rapidly changing the C2 operational environment for responses to natural disasters, terrorist threats and social upheavals.

Equipped with sophisticated smartphones, citizens embrace their role as the first *in situ* sensors, displaying an active producer-consumer behavior by capturing high-definition images and videos, sharing these contents and messages and commenting on information posted by others. Similarly, when information is scarce, social media have been elected by citizens as valuable instruments for identifying and locating victims, for assisting search and rescue operations, accessing crisis-related information on open community-based repositories, and even for influencing specific cliques and groups in society, especially in the organization and coordination of mob protests.

This new digital social arena has been brought to C2 operational environments and organizations are under pressure to understand and cope with this new reality.

In this paper, we analyze documented case studies on emergency and crisis events characterized by underdeveloped and degraded operational environments, which involved strong military or security-related intervention and generated significant social media dynamics. Ranging from natural disasters to terrorist events and to social turmoil and upheavals, these cases highlight social media as a fundamental information source in the support of actionable Intelligence and effective connecting and collaboration.

1 INTRODUCTION

A *broadband world* is the term the International Telecommunication Union used in its May 2012 Report on Trends in Telecommunication Reform to address the growing adoption of mobile technology and social media across the Globe [1]. **Social media** refers thus to the *"online technologies and practices to share content, opinions and information, promote discussion and build relationships. Social media services and tools involve a combination of technology, telecommunications and social interaction. They can use a variety of formats, including text, pictures, audio and video*." [2]. Accordingly to Kaplan and Haenlein, there are six different types of social media: collaborative projects (e.g. Wikipedia), blogs and microblogs (e.g. Twitter), content communities (e.g. Youtube), social networking sites (e.g. Facebook), virtual game worlds (e.g. World of Warcraft) and virtual social worlds (e.g. Second Life). The applied technologies include blogs, picture sharing, vlogs, wall-postings, email, instant messaging, music sharing, crowdsourcing and voice over IP [3].

Today, social media play an important role in emergency events with significant national security implications and associated response efforts, enabling citizens' involvement through the provision, seeking and brokering of information, connecting those within and outside the event's geographical space, with implications for both the informal and the formal response effort. In this context, often characterized by underdeveloped and degraded operational environments, public safety and security organizations and their traditional C2 models are required to deal with the new trend of having a digitally enabled social arena in emergency events. Social media indeed qualify as changing the rules of the game, forging a loudly silent transformation from a need-to-know to a need-to-share principle and from a command and control to a *connect and collaborate* paradigm[1].

Early in the digital age, Evans and Wurster identified the two central dimensions that characterize how the Internet has altered communications technology – reach and richness [4]. By *reach*, they meant the extent to which information is shared and how many people have access to it. By *richness*, they meant the quality of information – its content, including the different media (data, text, voice, video) used. While these dimensions have traditionally been traded off with one another, the Internet enabled them to reinforce one another. The relevance of these concepts to military and security applications and the additional importance of the quality of interaction in those applications were detailed in *Understanding Information Age Warfare* [5]. While this is not the place to trace the evolution of social media, their growth on all three key dimensions (reach, richness and quality of interaction) has been massive, in many cases exponential.

An important step in developing our understanding of the power of digital online communications came when the *Tenets of Network Centric Warfare* were articulated in the 2001 Network Centric Warfare Report to US Congress [6], laying out as key logic that

- Networking allows Information Sharing;
- Information Sharing and Collaboration (working together for a common purpose) improve Quality of Information and Shared Situational Awareness;
- Shared Situational Awareness enables further Collaboration and Self-Synchronization;
- These, in turn, dramatically improve Effectiveness.

These statements, originally offered as hypotheses, have been assessed and found valid in a wide variety of contexts over the years (see *Understanding,* op cit.*, Power*

to the Edge [7] and *NATO NEC C2 Maturity Model* [8]). More important, these underlying tenets have proven to apply to a much larger sphere, now termed Network Enabled Capability, which explicitly includes interagency and international collaborative tasks, such as disaster relief, peace operations and humanitarian assistance.

This paper explores how the adoption and use of social media increasingly facilitate those tasks in emergencies and crises, when connecting and collaboration are essential and public support a must.

2 DIGITAL AGE LESSONS IN UNDERDEVELOPED AND DEGRADED OPERATIONAL ENVIRONMENTS

Today, social media are ubiquitous, dramatically changing geopolitics, economic contexts and business competitiveness. They are also increasingly present in emergency and crisis response efforts. The case studies of social media use in natural disasters, terrorist events and social upheavals that follow demonstrate the growing presence of social media in these scenarios and the challenges it presents for crisis management systems, plans, processes and organizations [9].

2.1 NATURAL DISASTER RESPONSES

2.1.1 December 26th 2004 – The Indian Ocean Tsunami

On the morning of December 26th 2004, a 9.3 magnitude earthquake was felt in the Indian Ocean and within minutes a giant tsunami decimated Banda Aceh, on the island of Sumatra, and massively struck twelve countries bordering the Indian Ocean, killing over 280,931 people.

The 2004 Indian Ocean tsunami was the first internet-mediated natural disaster [10] but the ubiquity and power of advanced information and communication technologies failed to map the destruction of coastal Aceh for several hours. No advance warning was given to the affected coastal populations by their governments or others and even information on the destruction of Sri Lanka's coast reached (by telephone) the media, and then the general public, prior to the news of Banda Aceh's fate [10]. Information exchange was severely hindered by the low connectivity and scarce telecommunications access in developing Asia. While the UN Humanitarian Information Centre in Banda Aceh became the local information hub, first reports of the disaster came from tourists who used their phones and digital cameras to snap photos and videos of the surrounding destruction and upload them to the Web. Likewise, more than fifty worldwide contributors built The South-East Asia Earthquake and Tsunami Blog, which aggregated news and set up a tracker for missing persons' reports and humanitarian efforts [11].

2.1.2 August 29th 2005 – Hurricane Katrina

In August 2005, Hurricane Katrina caused severe destruction, including 53 different levee breaches that devastated greater New Orleans and flooded 80% of the region for weeks, forcing 1.2 million residents to evacuate and killing 1,836 people. Katrina was the most destructive and costliest natural disaster in the history of the United States [12].

Criticism of the government's crisis response focused on mismanagement and lack of leadership in relief efforts, leading to the lack of basic coordination and a delayed reaction to both the flooding and the subsequent state of chaos in the Crescent City

[13]. Amongst widespread critical infrastructure collapse, communications were extremely affected. The emergency 911 service was severely damaged and surviving stations were soon overwhelmed by the awesome volume of calls as desperate people tried to get help [14]. The New Orleans Police Department's communications system was inoperative for three days, and only a few backup channels were available to first responders in the area. Likewise, the Mississippi's National Guard could not establish effective communications with the governor or the state's emergency management agency. Eighty percent of the city's emergency networks were incompatible with each other and with those of federal agencies [14]. Land mobile radio and wireless capabilities were degraded as 2,000 cell towers were put out of commission, leaving some areas without cellular connectivity. Alternatives included satellite phones (that worked once the immediate storm passed) and the Amateur Radio Emergency Service (e.g., SATERN network of amateur radio operators helped to locate more than 25,000 survivors).

This near total failure of communications degraded situational awareness and exacerbated problems with agency coordination, command and control, logistics and search and rescue operations. The absence of authoritative and believable information from public officials created a climate of rumor, misinformation and speculation, and added to the loss of citizens' confidence and the government's inability to maintain public order. Because of this situation, field reporters became conduits for information between victims and authorities, often using Internet sites such as blogs, wikis, *fora* and community journalism [15]. Authorities monitoring local and network news broadcasts, as well as Internet sites, attempted to coordinate rescue efforts based on reports. An example of this online effort was NOLA.com, the web affiliate of New Orleans' *Times-Picayune*, whose blog became a vital link for rescue operations and for reuniting scattered residents, as it accepted and posted thousands of individual pleas for rescue. Much of NOLA's information came indirectly from trapped victims via SMS messaging from their cell phones, whenever there was network availability.

2.1.3 October 2007 Southern California Wildfires

From October 20th and for the following twenty days, multiple wildfires in Southern California destroyed 1500 homes and burned over 500,000 acres of land, killing 9 people, injuring 85 and causing evacuation orders to more than half a million people. In the process, six counties were declared disaster areas: Los Angeles, Riverside, Orange, San Bernardino, San Diego and Ventura.

Prompt evacuation and road blockades were fundamental to reduce public exposure and maximize firefighters' access to threatened locations. Implemented by blocks within zip codes, the Reverse 911 system worked extremely well notifying residents of danger, in spite of provoking increased congestion on exit routes [16]. Unified command was considered a key asset in providing a swift and effective response, for it included all jurisdiction stakeholders - fire officials, law enforcement, emergency medical services and utility and water authorities - engaged in information flow activities and decision-making. Still, the absence of Internet connectivity for the first 48 hours hampered crisis response efforts. The fire's noise level was very disruptive to onsite audio communications. Indeed, the chaos resulting from the evacuation and the need to continuously feed information to the public, media and political representatives frequently overshadowed firefighting activities.

Anticipating a high need for information from the public, the media and political representatives, several local fire authorities ordered a large number of Public

Information Officers (PIO) early on and established a multiagency Joint Information Centre, responsible for providing volunteers the official information and disaster relief contacts as well as for connecting the media and the public to the vast amount of information they required [17]. This unidirectional model of information dissemination failed to account for all the peer-to-peer communications occurring during the 2007 wildfires. Unable to learn critical information from the media, considered too general and often incorrect, people in the affected region used mobile and social media to be informed: mobile phones to contact relatives and friends, information portals and websites to know about road closures and fire-line status [18]. During the course of the fires, citizen journalists used Twitter and Flickr to provide real-time updates about evacuations, meeting points and places to gather supplies or bring animals. These updates combined reports from broadcast television news, local radio, streaming video, instant messages, text messages, online scanner radio feed and e-mails from friends in the area. San Diego's local National Public Radio affiliate turned to Google Maps and Twitter to report the news online when excessive web traffic brought down its website [19]. Likewise, some people acted as *information brokers*, distributing information, giving advice and providing consolation.

2.1.4 January 12th 2010 – The Haiti Earthquake

On Tuesday, January 12th, 2010, a 7.0 magnitude earthquake struck Haiti, killing 316,000 people, injuring as many as 300,000, destroying 300,000 houses and leaving 1,600,000 people homeless, making the Haiti Earthquake one of the deadliest natural disasters in modern history [20].

Amidst the collapse of all critical infrastructure, communications were severely damaged. The public telephone system was not available, two of Haiti's largest cellular telephone providers, Digicel and Comcel Haiti, reported services affected and fiber-optic connectivity disrupted. Nevertheless, within hours of the earthquake, it became clear that most of Haiti's cell phone towers were still operational and that text messages were getting through [21]. Because text messaging (SMS) is the primary means of remote communication in Haiti – surpassing email, traditional mail and actual phone calls – this crucial fact did not escape the notice of several concerned citizens in the Diaspora. Josh Nesbit, the Executive Director of FrontlineSMS: Medic, and Katie Stanton of the US State Department contacted DigiCel hoping to obtain the 4636 short code as a free aid service [22]. Votident established a data connection with Digicel and sent messages were collected by Brian Herbert's Ushahidi software platform, created within hours of the devastation. Energy for Opportunity and Stanford University mobilized a workflow of thousands of Kreyol-speaking volunteers to translate and categorize SMS messages, while plotting the senders' location in a map. The triaged messages were then streamed back to relief groups in Haiti. Within 48 hours, the 4636 Mission was supported by a global collective of leaders in mobile technologies, content management and crisis response. The number was publicized on local radio, making the service known to large numbers of the Haitian population, which was especially crucial in areas outside of Port-au-Prince that wouldn't have direct contact with aid agencies for many days or even weeks to follow. A week later, the Ushahidi Haiti platform was linked directly to the 4636 live feed and, from this time, the US Marines starting taking the feed of messages, establishing a dedicated force to monitor and respond to them. As collaboration expanded, a unified front in disaster relief in Haiti was articulated and the Red Cross, Plan International, Charity Water, the US State Department, the International Medical Corps, AIDG, USAID, FEMA, the US Coast Guard Task Force, the World Food Program, SOUTHCOM, OFDA and UNDP used

the Ushahidi maps to plan and coordinate relief efforts. By the fourth week, messages to 4636 had become steady at about 1000 per day [23]. Response teams were still targeting aid, food and water, and had implemented a stable, efficient system whereby messages were quickly translated, categorized, geo-coordinated and streamed to the response teams. The International Charter on Space and Major Disasters was activated, allowing satellite imagery of affected regions to be shared with rescue and aid organizations.

Members of social networking sites, such as Twitter and Facebook, spread messages and pleas for help [24]. The OpenStreetMap community responded to the disaster by improving the level of mapping available for the area (using post-earthquake satellite photography provided by GeoEye) [25] and tracking website Ushahidi messages to assist Haitians still trapped and keep survivors' families informed [26].

2.1.5 January 27th 2010 – The Chilean Earthquake

A destructive 8.8-magnitude earthquake shook Chile for about three minutes on January 27th 2010. At least 523 people killed, 24 missing, about 12,000 injured, 800,000 displaced and at least 370,000 houses, 4,013 schools, 79 hospitals and 4,200 boats damaged or destroyed by the earthquake and tsunami in the Valparaiso-Concepcion-Temuco area. The fault rupture, largely offshore, exceeded 100 km in width and extended nearly 500 km parallel to the coast [29]. The quake set off tsunami waves that moved across the Pacific, where fifty-three countries, including Japan and the Philippines, were on alert and ordered limited evacuations [28].

Throughout the affected area, electricity, telecommunications and water supplies were disrupted, cell phone and Internet service were sporadic and major seaports and airports, including the main airport in Santiago, were out of operation across the country's central region.

In the immediate aftermath of the earthquake and tsunami, first responders, emergency personnel and search and rescue teams handled many challenges. Loss of communications was significant and effective collaboration to support life-sustaining efforts was gravely impacted due to the lack of inter- and intra-agency coordination. The prompt response and resilience of individuals and communities was fundamental to the overall response, by providing much of the initial search and rescue capability and surpassing the government's limited situational awareness, that affected the adequate assistance to local needs [30]. The *Oficina Nacional de Emergencias del Ministerio del Interior y Seguridad Pública* (ONEMI or National Emergency Office of the Ministry of Interior) reported that most coastal communities had practiced evacuating the coastal area, contributing to the high level of successful evacuations achieved by the communities hit by the tsunami. The Chilean military played a key role in supporting many aspects of the response, but were not immediately mobilized. With the President's declaration of the "state of catastrophe", the military were sent to take control of the most affected areas and curfews were imposed in some areas of looting and public disorder. Situational awareness gradually increased over the second and third days, but coordinated situation status in the region was not fully achieved for nearly 10 days [30]. Communications were restored over days, but the timeframe was highly variable, depending on modality and location. In the disaster area, no one had situational awareness or means of receiving information and there was a general sense that some media, especially television, exacerbated the chaos rather than providing helpful emergency messaging and risk communications. In Concepción, text messaging became

available within the first day, followed by cell phone communication and Internet. By the end of the first day, half of the hospitals in the Bio-Bio region had been contacted through text messaging.

Social media tools were used in Chile primarily for coordinating relief and aid by non-governmental organizations and private social initiatives. One successful example was the emergence of *Digitales por Chile*, a volunteer organization that used Twitter to gather highly skilled IT professionals and technicians who worked for several months to help citizens affected by the disaster. In just twelve hours, the 300 volunteers of *Digitales por Chile* created the www.chileayuda.com portal, which supported the systematization and integration of the disaster-related information, including Google's Person Finder, geo-referenced mapping, official communications and donations [31]. *Digitales por Chile* intensively used Twitter (in one week, the portal had 4000 followers), Facebook (in a week and a half, it joined more than 150.000 members) and Ushahidi, with its multi-layered maps being constantly updated with information on rescue centers, medical assistance and police warnings.

2.1.6 January 2011 Australian Floods

High intensity rainfall between January 12th and 14th, 2011 caused major flooding across much of the western and central parts of the Australian state of Victoria, leading to thousands of evacuations, twelve dead and seventy-two missing persons. As of 18th January, more than 51 communities had been affected and over 1,730 properties had been flooded, devastating 51,700 hectares of pasture and 41,200 hectares of field crops. Hundreds of roads were closed, train services were disrupted and electricity was down [32] [33].

The Australian Defence Force, Victoria's 4th Reserve Response Force and the South Australian State Emergency Service assisted the Victorian State Emergency Service in gathering information on the impact of the floods on community and private infrastructure [34]. Relief packages were distributed across the affected region with the help of 3,000 emergency service volunteers. Under the aegis of the Australian Red Cross, fifty-seven emergency shelters were set-up in schools, community centers and sport facilities throughout Queensland and, as much as possible, the Australian police went door-to-door ordering evacuations and patrolling flooded suburbs. With emergency services overwhelmed, media and social networking sites were also part of the response to the flooding. Australia's public broadcaster had a dedicated digital radio channel providing interactive mapping of the flooded region and Twitter and Facebook provided updates and messages of support [35].

2.1.7 March 11th 2011 – The Great Japan Earthquake

On March 11th 2011, a powerful 9.0 magnitude earthquake struck the coast of Japan, causing widespread power outages, fires and a severe tsunami reported to be 40.5 meters high and traveling 10 km inland. At least 15,647 people were killed, 4,643 missing, 5,924 injured, 130,927 displaced and more than 332,395 buildings, 2,126 roads, 56 bridges and 26 railways destroyed or damaged. Electricity, gas and water supplies, telecommunications and railway service were disrupted and several reactors were severely damaged at Fukushima's nuclear power plant.

One minute before the earthquake was felt in Tokyo, the Earthquake Early Warning system, which includes more than 1,000 seismometers in Japan, sent out warnings of impending strong shaking to millions. The early warning is believed by the Japan Meteorological Agency to have saved many lives [36].

Cellular and landline phone service suffered major disruptions in the affected area but internet services were largely unaffected as the system rerouted around the affected segments to redundant links. In an hour, with the Japanese fixed telephone network destroyed, Twitter became the emergency service, with almost 1,200 tweets per minute coming from Tokyo, accordingly to Tweet-o-Meter [37]. Twitter users even shared the tsunami's estimated times of arrival on U.S. shores, long before an official government tsunami warning went into effect. Even the media reported that Twitter was the only functioning communication tool immediately after the earthquake.

Concerning the crisis response effort, more than 100,000 Self-Defence Force personnel were mobilized for the rescue and relief work. But Japan lacks a unified Disaster Management framework allowing the swift mobilization of separate agencies under a unified operational command [38]. Thus, failures at the tactical and operational level were mostly derived from the lack of leadership at the political level. In fact, there was no clear decision-making structure that would allow the disparate stakeholders on disaster recovery to work together. The traditional *ringiseido* Japanese decision-making process[2], mixed with the stove-piped *tatewarigyousei* and protective *nawabari* cultures, makes the protection of own information the priority, prompting an agency-centric response management instead of a coordinated and integrated capability [38].

Japan's earthquake tragedy is a case study in crisis communications, particularly with respect to the way the Japanese authorities, specifically Cabinet Secretary Yukio Edano, used social media tools to calm public fears and remedy media speculation. As expected, the crisis at the Fukushima power plant was catapulted online almost instantly and within a few days generated 64% of blog links and 32% of Twitter news links, according to research conducted by the Pew Research Centre's Project for Excellence in Journalism [39]. As public criticism in the Japanese society of both the government and Tepco, the operator of the plant, started to rise, Cabinet Secretary Edano's live press conferences were praised on Twitter, for being clear, articulate and unafraid of difficult questions.

2.1.8 October 29th 2012 – Hurricane Sandy

On October 29th 2012, around 9h00pm, Hurricane Sandy struck the United States' East Coast with winds of 90 miles per hour, heavy rain, blizzard, snow and four-meter waves that sent a surge of seawater over seawalls and highways and into low-lying streets. The water inundated tunnels, subway stations and the electrical system powering the New York area collapsed, leaving 750 thousand people in total darkness, a part of the 8.2 million people affected by power outages. The storm claimed 39 lives and more than 6000 people were in emergency shelters after nearly 400,000 people were ordered to evacuate from parts of New York City and all along the eastern seaboard [40]. The cost of the damage caused by the storm is estimated to be around $20 billion, making it one of the costliest natural disasters on record in the United States [41].

A sense of the unfolding events was delivered around the world through social media services, such as Facebook, Twitter, YouTube and Instagram. Immediately after the storm made landfall, several photos and videos went viral, reporting incidents in New York City before news organizations could confirm their authenticity [42]. Many reports were found to be true and gave snapshots of flooding and power outages in real time. But there were also fabricated reports, such as a photo of soldiers standing guard at the Tomb of the Unknown Soldier, a picture of a giant wave slamming into

the Statue of Liberty and TV reports that 3 feet of water flooded the New York Stock Exchange. Attentive to these dynamics, the Fire Department of New York (FDNY) posted a message that read "*There is much misinformation being spread about #Sandy's impact on #NYC*" and pointed people to official city Twitter feeds for accurate information [43], in what proved to be a good example of rumor management, fundamental to dealing with online social media environments.

Apart from the curiosities, social media were also instrumental in passing on vital information to those who could not access traditional news outlets, like TV or radio, and even the 911 emergency line that was overwhelmed with incoming calls (10 thousand calls per half-hour) [44]. Social media connected public authorities to the public at large. Google Crisis presented a page on Sandy with the map of the US East Coast, signaling evacuation zones and routes and emergency shelters and providing information on power outage, traffic, public alerts and weather-related reports. This page linked to official social media - the New York City Office of Emergency Management (NYC OEM) on Facebook and Twitter, the City of New York (NYC) and the Fire Department of New York (FDNY). Twitter created a page dedicated to Sandy with accounts of government, politicians, public safety officials and weather reports. FEMA tweeted direction for finding shelters using SMS messages. FDNY tweeted incidents of major fires through the night via Twitter, and had a dedicated person monitoring its Twitter account to respond to people tweeting emergencies (FDNY responded to over 100 tweets overnight). New York City mayor Michael Bloomberg's office sent out several tweets, telling citizens that water was safe to drink, that bridges and schools were closed, that cabs and livery should be shared and that those affected should register for assistance. These official social media sites were fundamental for authorities to debunk rumors and correct misinformation in real time. FEMA has now created a “rumor control” section on its website to dispel misinformation on social networks [45].

As of early afternoon on Monday the 29th, the *hashtag* Sandy had 233,000 photos on Instagram, the mobile photo-sharing service owned by Facebook. “Hurricanesandy,” had 100,000 photos and Frankenstorm had 20,000 and these figures kept growing. The social analytics firm Topsy reported nearly 3.5 million tweets with the *hashtag* #sandy in the 24 hours after Hurricane Sandy's landfall [42] and Instagram announced that about 10 pictures per second were being uploaded to Instagram with the *hashtag* #sandy. Facebook reported that the 10 words and phrases used during the height of the storm were all Sandy-related: Sandy, hurricane, Hurricane Sandy, stay safe, be safe and storm [46].

2.2 RESPONSE TO TERRORIST ACTIVITY

2.2.1 March 11th 2004 – Madrid Train Bombings

On the morning of March 11th 2004, the commuter train system of Madrid suffered a terrorist attack of 10 bomb explosions that killed 191 people and wounded 1,800. Thirteen improvised explosive devices, detonated by cell phones, were placed on four trains travelling between Alcalá de Henares and the Atocha station in Madrid during the peak of that morning’s rush hour.

The RENFE CCTV surveillance supervisors alerted emergency services as the attacks unfolded and, within 15 minutes of the explosion, emergency services, including the police, the fire department and the ambulance service - a total of 70,000 people - arrived at the scene, intervening independently, with their own communication systems and technologies [47]. The radio frequencies of the different

emergency services were not compatible and there were no shared tactical channels for responders in the field, so communications among the different emergency services at the scene was only possible via personal contact or telephone. There was a swift and massive medical response, although very uncoordinated and with serious lack of command in every emergency service, specifically attributed to inappropriate planning since no common emergency plan clearly sets responsibilities and procedures in the event of a major crisis [48]. The situation quickly deteriorated when the mobile telephone network experienced overload (or when the police intentionally blocked frequencies in certain areas to prevent potential activation of secondary devices), leaving many units without any possible means of communication. Because no joint field command post for all of the emergency services was set up, inter-agency coordination followed a pattern of improvisation and informality.

2.2.2 July 7th 2005 – London Tube Bombings

The first XXI century terrorist suicide attacks in Western Europe occurred on July 7th 2005, at 8:50 a.m., with three bombs detonated on three London Underground trains and a fourth bomb on a double-decker bus. The attacks were the deadliest in London since World War II, killing 52 people and injuring more than 700 others [49].

Initial information was scarce and passengers fled from multiple station exits, which were located in three different police jurisdictions, causing confusion about the number of attack sites, adding to coordination-related problems and exacerbating failures in leadership [49]. The City of London Police, responsible for the Square Mile in the center of London, restricted cell phone network access to specific users to reduce network traffic and improve first responders' access. However, this action had the unintended consequence of cutting off access for many responding agencies, including the London Ambulance Service.

Responders also encountered problems with radio communications. Although the radio systems used by the British Transport Police and London Underground staff worked in the subway tunnels, the radios of other responding agencies, including the Metropolitan Police Service (MPS), did not. Additionally, the Connect radio system used by London Underground staff was still not fully compatible with the Airwave system used by the emergency services. Thus, information and requests for help and assistance were not passed on to the surface [49].

Legal issues also complicated the agencies' response, for the United Kingdom's Data Protection Act prohibits sharing personal data without the consent of those concerned, thus limiting what information officials could give agencies and families on the identity and status of victims [50]. One of the biggest challenges faced by the London agencies was how to communicate with the victims' families. Family members and friends found it difficult to get information on the status and location of injured or deceased loved ones - so MPS set up a family assistance center on the day following the bombings.

Vodafone reported that its mobile telephone network reached capacity at 10 a.m. on the day of the bombings, and it was forced to initiate emergency procedures to prioritize emergency calls. Other mobile phone networks also reported failures and BBC speculated that the telephone system had been shut down by security services to prevent the possibility of mobile phones being used to trigger bombs. It became clear later that the intermittent inavailability of both mobile and landline telephone systems was due only to excessive usage [50].

Victims trapped underground were able to take photos and video of their surroundings, though the lack of mobile phone coverage in the subway and a general failure of the telecommunication infrastructure to support emergency services meant that this information would only be later forwarded to police and broadcast through the media around the world. Still, local and national radio either suspended regular programming, or provided regular updates, whereas continuous, uninterrupted TV news coverage of the attacks was broadcast throughout the day, empowered by the use of mobile phone footage sent in by members of the public and live pictures from traffic CCTV cameras. Day-to-day technology played a major role in citizen journalism during this event [51].

2.2.3 April 16th 2007 – Virginia Tech Shooting

Students and professors of the Virginia Tech College lived moments of terror on April 16, 2007, when, over the course of two-and-a-half hours, a shooter killed 32 people and wounded 25 others, before committing suicide.

The campus police delayed issuing a campus-wide notification of the gunman, trying to prevent panic reactions, so students were only informed via e-mail at 9:26 a.m., more than two hours after the first shooting, thought at the time to be isolated. Not all students viewed this e-mail and many of those who saw it, did not grasp its sense of urgency. The report following the incident concluded that the Virginia Tech Police Department had erred in delaying a stronger, clearer, campus-wide initial alert and in not issuing a campus evacuation order, decisions that could have reduced the total death toll [52]. With no official information, students began to exchange messages amongst them with respect to the occurrence and afterwards used Facebook to learn and confirm the identities of those who had been killed and injured. Following the 2007 shootings, Virginia Tech created an alert system on its website, as well as text messages to warn students of danger.

The Virginia Tech and Blacksburg police departments responded quickly to the report of shootings, as did the Virginia Tech and Blacksburg rescue squads, and their responses were well coordinated. The emergency medical care onsite and at the hospitals was very effective, although providers from different agencies had some difficulty communicating with one another. The Virginia Tech massacre served as a trigger for re-examining gun purchase laws and issues concerning the balance between individual privacy and public safety concerns [53].

2.2.4 July 22nd 2011 – Norwegian Terrorist Attacks

On July 22nd 2011, a car bomb explosion in the government quarter in Oslo, outside the Prime Minister's office, caused the death of seven people, critically injured eighty-nine people and severely damaged several buildings, including the state broadcaster NRK and the Norwegian tabloid newspaper VG. Less than two hours later, the same perpetrator took the ferryboat to the island of Utøya, where youngsters were at a political retreat. Dressed as a police officer and with a false identification badge, he claimed to be performing a routine check following the bombing event in Oslo. Instead, he started to shoot indiscriminately. He gunned down 84 people and wounded 153 in the course of an hour and a half, before the Norwegian Police Service arrested him. This mass shooting is one of the worst in history and the deadliest terror day in Western Europe since the 2004 Madrid Train Bombings [54].

One minute after the bomb exploded, the police received the first message about the explosion and, two minutes later, the first police patrol reported it had arrived at the

scene. At the same time, the news agency NTB broadcast that the Prime Minister was unhurt and safe. Then, the police cleared the area searching for additional explosive devices and urged citizens to evacuate central Oslo over media outlets.

On the island, witnesses reported hiding in the undergrowth and in lavatories, communicating by text message to avoid giving their positions away to the gunman [55]. The messages also informed their relatives and friends not to phone, so that the ringing would not give away the location of those hiding from the gunman. Initially, as the besieged people from Utøya tried to call the emergency services, they were told to keep off the line unless they were calling about the Oslo bomb [56]. After the Utøya local police district learned about the shooting, the Oslo police were informed and the Norwegian central counter-terrorist unit *Beredskapstroppen* was dispatched to Utøya. However, the special force did not have a helicopter available that could take them straight to the island and had to drive to the ferry crossing and wait for a (recreational) boat to take them across [57]. Thus, the SWAT team arrived at the island 79 minutes after the reports that the shooting had begun. Paramedics did not arrive for another 10-15 minutes. The police also reported that the gunman called 112 at least twice to surrender, but continued killing people in between. The police tried to call him back but did not succeed [58].

Meanwhile, media helicopters were filming the killings from the air, long before the arrival of armed anti-terror police officers, more than an hour after the shooting started. Long before any emergency services came to assistance, local residents in little motorboats and fishing dinghies sailed out to rescue the survivors who were pulled out bleeding from the water and picked up from hiding places in the bushes and behind rocks around the island's shoreline [59].

During the unfolding of the attacks, security and emergency services were paralyzed with communication disruption. While the district police used an old analogue radio system, the elite SWAT unit, dispatched to assault the island, and paramedics had switched to a new secure digital network. Police commanders had to contact different units via email and fax, as the mobile network was down [60].

Soon after the attacks, the Norwegian media, headed by the Norwegian national broadcaster NRK, identified the suspect and reported that police were investigating the shooter's Internet activity with respect to political and religious beliefs. Social media - Twitter and Google+ - served as the main information providers for the survivors and their families. Both traditional and online media reflect that the Norwegian security and emergency services were heavily criticized [61] for their slow reaction time response to the Utøya island shooting. Because of the shortage of transport capacity, they relied on a military helicopter that was stationed at 60 km distance and a police surveillance helicopter whose crew was on vacation. Engine failure also delayed the arrival of one commando police boat [62]. Moreover, the concentration of response units in Oslo contributed to the delayed response to the Utøya massacre, raising questions of whether the security and emergency services were prepared to handle a dual attack. The Norwegian intelligence services were also under fire, for they had the suspect on a security service watch list, after he ordered chemicals online from Poland, in March, but did not continue to monitor his activities, which might have prevented the massacre [63].

2.3 SOCIAL TURMOIL AND UPHEAVALS

2.3.1 January 2003 China SARS Epidemic

An epidemic of severe acute respiratory syndrome (SARS) began in the Chinese municipality of Foshan, Guangdong Province, in November 2002. In the first four months of 2003, this became an emerging crisis with a total of 8,422 known infected SARS cases and 916 confirmed human deaths. Within weeks, SARS spread from Hong Kong and rapidly infected individuals in 37 countries around the World.

Little information was provided by official sources, giving rise to peer-to-peer communications (SMS text messaging) that, discretely and without repercussion, sought and provided information about the physical locations of apparent SARS victims. Over the long span of the SARS outbreak, 120 million text messages were sent, some disseminating opinions, rumors and even humorous content [64]. Citizens knew about the SARS before the mainstream media and before the Chinese Government reported it privately to the World Health Organization (WHO) on February 11th, 2002.

After April 20th, when the Chinese Government publicly acknowledged the existence of SARS and it became obvious they had been concealing the vastness of the outbreak, citizens used their mobile phones and text messaging to share their apprehension and concerns regarding the Chinese Government's behavior. Ultimately, the Chinese Government restricted the use of online and mobile technologies to keep control of the situation, applying a censorship policy called the Golden Shield that uses 2800 facilities across China to monitor and restrict SMS messages on the Internet and sent via personal mobile communication devices (citizens were even arrested because of the content they post online or send through a text message) [65].

2.3.2 2011 Middle East Upheavals

In December 2010, a mass protest in Tunisia led to the ouster of the country's autocratic ruler. It was the first successful mass uprising against an Arab leader in years. Fueled by the successful protests in Tunis, political unrest and change swept North Africa and the Middle East, in what has become known as "the Arab Spring". Pro-democracy and anti-government protests began in Egypt and spread to Jordan, Yemen, Syria, Algeria, Morocco and Libya, where after a 42-year rule, Muammar Kadhafi was defeated by rebel troops.

Social networking platforms were among the tools of change [66] as much of the organization of these popular protests was done on Facebook, Twitter and YouTube, despite the governments' blocking efforts. Network monitoring site BGPmon found that 88 percent of Egyptian networks had become unreachable, with many Egyptian internet service providers no longer offering connectivity [67]. There is a growing number of Middle East users of available social networking tools, especially after March 2009, when Facebook adopted an Arabic language interface [68] and attained 35 percent of the UAE population and 49 percent of Qatar's resident base. The growth of social media in the Middle East and the shift in user trends has played a major role in citizens' mobilization and empowerment, marking the winds of change in the 2011 Middle East upheavals.

The work of Merlyna Lim describes the relative importance of social media in Egypt's upheaval [69]. The Egyptian society was able to participate in social media because of the *reach* of the relevant media. In Egypt, youngsters had access to the Internet

and, increasingly, over time, to Facebook and other social media. As technology evolved from chat through the sharing of image, social media creates communities, enabling information sharing, mobilization and coordination of action, all executed as part of online networks. Lim's work enables an understanding of how the dynamics between citizens and social media evolved in the years leading to the 2011 Egypt upheaval.

2.3.2.1 January 2011 – Egypt Upheaval

In January 2011, pro-democracy and anti-government protests began in Egypt with social media playing a supportive role. A segment of the population held deep social grievances and perceived that what was wrong should be rectified.

In 2004, Kefaya, a social movement whose name translates as "Enough", launched Egypt's first independent digital newspaper, using a website to share information, coordinate activities and host discussion *fora*, in spite of not having neither physical headquarters nor a permanent meeting place. As Kefaya blossomed, blogging became much more prevalent and relevant in Egypt, replacing fora and allowing free ranging discussions of strategies and tactics as well as information countering state-controlled media reporting. Blogging also expanded participation in these discussions. Kefaya gradually declined as a result of the inability to spread its message beyond Cairo's intellectual community, though the dialogue was continued by a few persistent bloggers, who were often harshly punished. They brought focus to the message, posting pictures and videos of beatings and torture. The enhanced reach of social media, now adding images to the text content, sharpened the messages and made it easier for people to relate to the stories told.

By 2008, a new group called The April 6th Youth Movement emerged in a leadership role. Their name came from a general strike called by the Egyptian labor movement as part of its efforts to reestablish its role in society. Because social media technology had broadened, Facebook, Twitter, YouTube, and Flickr were added to the well-established tools of e-mail, text and blogs. These new media enabled the creation of an extremely important meme[3] – a Facebook Group called *We are all Khaled Said*. The subject was a 28 year-old Egyptian who had been seized by the Egyptian police at an Internet café in Alexandria and beaten to death in the street. Images of his facial injuries were circulated along with stories about his death. This dramatic element arose within a broad and deep set of related online activities leading up to the culminating protest built on January 25th 2011 demonstrations that spelled the beginning of the end for the Mubarak regime. By that time, the full set of online tools were being employed to mobilize, coordinate and publicize dissent across the country.

2.3.3 August 2011 – England Riots

As a consequence of Mark Duggan's killing by the police in Tottenham, a peaceful protest was organized on August 6th and quickly deteriorated into violent confrontations between Metropolitan Police and rioters. These disturbances continued and spread to other locations, including Birmingham, Liverpool, Bristol and Manchester, characterized by torching vehicles and buildings and widespread looting. A total of five people died and more than 1,600 arrests were made.

Twitter was initially reported as the prime means of communication for rioters but later BBC and The Guardian identified Blackberry Messenger as having been heavily used to coordinate activities such as looting and to avoid authorities [70]. These rumors led Research In Motion, the company that manufactures BlackBerry

smartphones, to issue a statement of its willingness and availability to cooperate with law enforcement and regulatory authorities and track users who incited violence [71]. Public criticism has emerged with respect to the police's inefficiency in monitoring social networking. Still, a number of arrests have been made in the United Kingdom for posting Facebook and Twitter messages inciting to criminal behaviors [72]. Also authorities have used social media themselves to identify criminals, posting photographs on Flickr and scanning the Web for photographs of rioters' faces [73].

Social media have also been quite relevant to the citizen's journalism trend. The hyper-local site The West Londoner offered a live blog of the riots that achieved one million views in just 24 hours, because of its ability to provide immediate updates, with no speculation or rumor [74]. After the riots, social media was also instrumental to correct inaccurate information, to assist on debris cleaning and to disseminate messages of hope and commiseration [75].

3 CONDITIONS NECESSARY FOR CONNECT AND COLLABORATE SUCCESS

Ranging from natural disasters to terrorist activities and to social turmoil, the case studies presented above are well-documented accounts of the current state-of-the-art in the use and impact of social media technology in emergency and crisis situations and associated response efforts throughout the world. As we study these illustrative examples, the significant influence social media are exerting on traditional command and control models in underdeveloped and degraded environments becomes evident. The social media presence is prompting those systems to adopt need-to-share principles and *connect and collaborate* approaches.

It is useful to identify the conditions that must be in place to enable and encourage the successful use of social media technology as a privileged instrument for connecting and collaborating, for improving traditional command and control models so that they involve citizens and inter-agency participation and ultimately contribute to enhanced situational awareness, self-synchronization and effectiveness.

Early work on the Internet and Network Enabled Capabilities is significant here. The tenets of Network Enabled Capabilities have proven to be robust over time and across social media applications. A network connection is an absolute requirement, allowing the sharing of information and enabling the community to improve the content of the information, by correcting errors, exchanging alternative views and perceptions, and (often) identifying the sources of information, enabling others to judge motive and intent. Information sharing also allows collaboration or discussion of what the information means, as well as improving awareness and empowering the development of a shared situational awareness. Given shared situational awareness, participants in social media have yet another opportunity to collaborate in discussing what may and should be done, both individually and as a social group. This appears to permit them to act in concert (i.e., self-synchronization). The cases reviewed illustrate that these actions, whether supporting first responders or relief workers or deciding when and where to carry out protests, impact the ability of a group to achieve its desired goals.

The flat and open nature of social media is one of the major concerns of government agencies/organizations as they lose information control and fear potential negative consequences, including the further endangerment of citizens' safety. Information, being it correct, incorrect or in form of rumors, affect the public's perception of the situation or behavior. Therefore, actions such as FEMA's rumor control policies

(albeit rumor management would be better suited) and FDNY's monitoring of social media to detect and correct misinformation are of paramount importance.

However, social media are not a panacea. Because they essentially occur in the information, cognitive and social domains, they have limits in the physical domain, for network reach may be affected due to situations in which communications infrastructure and systems are damaged or disrupted, delaying or impeding information sharing. Moreover, physical requirements for action must also be considered: during the Norwegian terrorist attacks, the limits of transportation (e.g., lack of helicopter availability and the breakdown of the small boat carrying first responders) delayed rescue activities that were clearly urgent. Hence, based on the case studies' analysis, we identify the following conditions for success: **Interoperability**, **Reach**, **Richness**, **Quality of Interaction**, **Trust** and **Privacy Data Protection**.

INTEROPERABILITY

Effective social media require technical, semantic and social interoperability. Technical interoperability refers to the simple ability of the devices in use to connect directly. For example, a mobile phone can *Tweet* if it has Internet access and accesses the Twitter webpage. Semantic interoperability refers to the ability to understand the message received. In Haiti, pleas for help in the Kreyol language were not understood by the English or French-speaking responders and volunteers and required translation. Groups of volunteers emerged to process translations and expedite rescue services. This is an excellent example of self-synchronization: disparate organizations and individuals taking actions that proved effective in resolving a challenging situation. Social interoperability means a willingness to exchange information and work together. In Egypt, blogs proved to be linkages that cut across the political and religious divides that had prevented recognition of common perceptions, common interests and the potential for mutually supporting actions.

REACH

The Information Age, characterized by the ubiquity of the Internet and online technologies, resulted in always-connected individuals with active consumer/producer behaviors. The May 2012 *Latest Social Media Statistics* [11] clearly state the overwhelming numbers that corroborate the growing trend on the adoption and use of social media platforms. Some of those figures are presented in Table 1.

Twitter	Facebook	Google+	YouTube	Mobile
500 Million accounts 40+ Billion tweets 175 Million tweets a day 11 new topics (*hashtag*) created every second	850+ million members 31% check in once a day Avg of 20 min per day 2.7 billion likes per day 100 billion connections 20 million apps installed daily 250 million photos daily 425 million access via mobile	90+ million users g+ button is served 5 billion times a day g+ users: 44% of users are single 29% female / 71% male 20% are students Average of 6 minutes on site	4 billion videos viewed every day - 1 trillion in 2011 24 hours of video uploaded, every 24 secs 2.9 billion hours a month on the site, 326,294 years 800 million users per month Auto speech recognition translates video and captions in 43 languages	5.9 Billion subscribers 8 Trillion SMS messages sent in 2011 11+ Billion apps downloaded, 1 in 4 never used again The number of mobile searches quadrupled in the last year 8.49% of global web site hits come from mobile

Table 1 – Social Media Statistics (May 2012)

In developed societies, where there is heavy internet penetration and broad access to smartphones, social media provide citizens and organizations important services in situations of emergency, crisis or degraded operational environments. These services accommodate warning broadcast, alert services and coordination of operations to generate essential information when traditional communications systems fail (see the Japanese Earthquake case study). Even in developing countries, there are significant social media dynamics, as observed in the Haiti Earthquake and the Indian Ocean Tsunami case studies (*ad hoc* communications networks were rapidly deployed to enable local connectivity and assist rescue operations), but also in Middle East countries (social media platforms enabled social mobilization and active informed citizenship).

Reach, however, does not mean that media are always readily available. Capacity may be limited by failures, system overload or deliberate prioritization and restrictions by authorities or service providers. Limits can also arise from risk assessments. The Madrid bombing decision to shut down cell phone services fearing they might be used to trigger explosive devices is an example, as is the initial refusal of the Norwegian emergency call center operators to put through emergency calls from the island because the downtown bombing was perceived as the crucial event. Albeit the Internet and telecommunications sectors have successfully achieved interoperability across disparate devices, technologies and location, more conservative sectors (e.g., security and defense communities) are still limited by non-interoperable, proprietary technologies and/or stringent security requirements. In many of the case studies, the private sector and open source communities provided key platforms to assist C2 in underdeveloped and degraded operational environments: Haiti's DigiCel provided a free SMS service to anyone with a mobile phone (a fee would have restricted participation and negatively impact reach) and Ushahidi's information was used by US deployed forces.

RICHNESS

Richness (the quality of content) is also a pertinent condition for success. The evolution of social media from text and chat to voice, imagery and video has made a big difference in social media utility and impact. Services have become routinized in responding to disasters – people finders, photo posting and digital mapping updated with the most recent information all emerged as a consequence of improving technology and creative use of emerging capabilities. The power of social media has expanded as its users learn to create memes – verbal and visual images that take on a life of their own and come to epitomize a social group, cause or pattern of action. Improved richness is attained as new social media tools (Facebook, Twitter, YouTube, Flickr) become more and more popular and enhance their own potential impact. The selection of which communication channel is best often depends on the actual situation. In circumstances where connectivity is sparse or unreliable, or where making sounds is unadvised, basic text messaging may be the best, most effective choice[4]: it was the choice for Haitians trapped in rubble and for the youngsters in the Utøya island that wanted to alert relatives and authorities but did not want to give away their hiding place. Another issue is to know how to best get your message across to the audience. Different cultural backgrounds influence how citizens understand messages and deal with their content. Institutional messages are often disregarded: the email sent to students by the Virgina Tech management on the shootings day was not seen by all students and most of the students who read it did not grasp its urgency.

QUALITY OF INTERACTION

The quality of interaction in social media has also grown over time. Texts and voice chat remain vital, but the improved dialogue empowered by online fora, blogs and town meetings allow rich bi-directional participation by interested citizens across the globe. Today, it is relatively trivial to set up near real-time one-to-one, one-to-many and many-to-many online communications and collaboration platforms, allowing the formation of highly focused *communities of interest*, exchanging *rich* content in the *right* format with very high *signal-to-noise* ratio. As a result, participants are engaged in high quality interactions, retrieving a real added value that encourages them to explore further these new online information avenues.

TRUST

Perhaps the most crucial condition required for the success of social media in underdeveloped or degraded environments, trust is also among the most subtle and difficult to attain. In order for individuals and groups to act in concert, they must trust the information they receive, the source(s) of that information and the integrity of the medium through which they have obtained it. Even the willingness to participate in online social media communities and networks requires trust that the act of participation will not be punished or misused, either from peers or from authorities tracking the activity.

Trust in social media and the information it contains is one of the major contributors to differences in perception and participation across generations. Parents often caution their children not to assume what they see on the Internet or social media is genuine. Many participants prefer to use pseudonyms rather than their true identities, both to avoid exposure to those who might disagree with them or, in some cases, to hide from the authorities either because their activities are criminal or the authorities may choose to censor content or punish participation. In specific online communities, individuals who express unpopular views are “shouted down” by others who believe they are incorrect. Tools and techniques to *anonymize* activities have become commonplace and can render locating the origin of a post difficult and impractical for all but the most skilled technicians.

However, in case after case, the record is clear that large numbers of citizens have chosen to participate in activities mobilized and coordinated through social media platforms whether because they seek to belong, or because they value the opportunity to have a voice and be heard, or even because they appreciate the auto-corrective misinformation mechanisms that social media provide, adopters of social networking are a growing worldwide community. Likewise, organizations are increasingly aware that social media are adequate platforms to know rumors and correct them – illustrative examples in this paper refer to FEMA's recently created area for "rumor control" and FDNY's rumor management actions during the NY Sandy Hurricane.

PRIVACY DATA PROTECTION

Since its inception, cyberspace remains a relatively unregulated space with respect to data protection and privacy rights - a situation only exacerbated by its global reach and the corresponding lack of certainty as to relevant applicable legal frameworks. The Internet, and social media in particular, are no exceptions. Many of the issues involve the handling and mining of personal information, illicit uses of private data (e.g. identity theft), a perceived lack of accountability, the disclosure of data to third parties (without the consent or awareness of those concerned), and data ownership

rights. These concerns are the main factors obstructing the generalized adoption of existing and available social media as part of governmental official tools to disseminate and exchange information with citizens. In Western European countries, laws on the sharing of personal data are quite stringent: as observed in the London case study, agencies and families were not informed of victims' identities and statuses since, in the absence of the consent of those concerned, such data processing is prohibited by the UK's Data Protection Act.

Citizens have tended to ignore or accept the risks involved in the exposure of their personal information though social media since, especially in crisis situations, such platforms offer practical tools addressing their problems (e.g. Google CrisisResponse includes a PeopleFinder database in which anyone can register missing people and access existing records - thus apparently with little concern for the UK's Data Protection Act or similar legal instruments in other countries). Nonetheless, recent legal disputes have arisen regarding the *right to be forgotten* or the right to rectify and erase one's own information. The importance of this right – as well as the challenge of respecting it in crisis situations – has been emphasized by the EC Vice-President and Commissioner for Justice and Fundamental Rights, Viviane Reding [77]. In crisis situations the balance between the greater public good and the respect for individual liberty, dignity and autonomy is very much open for discussion. Indeed, data protection legislation is evolving, with social media users demanding more transparency from social media providers regarding how their data is handled, stored and shared, and who retains ownership of, and responsibility for it. The legal and ethical implications of posting and sharing information online as well as the potential for the misuse of various online social media tools, including geolocation applications, techniques of information parsing and data mining, and the protection of civil rights and freedoms are fundamental issues to be debated as digital citizenship is increasingly fostered.

4 APPROACHES

The relevance of social media influence in the security context is acknowledged by nations and their institutions. This new, challenging arena poses significant questions and hurdles to public safety and security organizations, characterized for the difficulty in handling decentralized, open and bi-directional flows of information. To better understand how to adopt social media tools in organizations' processes and operations, several investigation and experimentation activities have been undertaken. Next, we briefly describe two approaches with different engagement levels that are emerging from those activities.

Namely:

(1) the iSAR+ Approach, a recent research and development project funded by the European Commission on the use of social media in emergencies and crisis; and

(2) the US FEMA Social Media Initiative, comprising the several social media tools this governmental agency has been developing for years.

The main attributes of both approaches are summarized in Table 2.

Both approaches add to already proven and accepted communication mechanisms (i.e., traditional media and current online presence) bringing about new possibilities for social media platforms and networks.

FEMA already exhibits a well-advanced position in social media state-of-the-practice by incorporating these online platforms as an integral part of its official organizational

processes and channels of communication with the public. iSAR+ is a recent initiative that aims to build a social media enabled capability within the next three years. FEMA already includes new digital services such as SMS broadcasting service, whereas iSAR+ intends to develop more functions, including a mobile application for citizens and an online portal.

Although the US presents a fielded emergency response system and Europe is now starting to build a common crisis and emergency system, both approaches highlight the strong emphasis and interest in adopting and using social media to the benefit of C2 success in underdeveloped and degraded operational environments.

European iSAR+ Approach	US FEMA Approach
Considers traditional tools	
Emergency service: 112 and reverse-112. Media broadcast services (TV and radio).	Emergency service: 911 and Reverse 911. Media broadcast services (TV and radio).
Considers online presence	
Internet Presence (webpages and RSS). Email subscription services (currently implemented by a few nations).	Internet Presence (webpages and RSS). Email subscription services (fully implemented). Alert system (Wireless Emergency Alert - WEA).
Considers new communications and social media channels	
No support for image and video (automatic image and video analysis will be developed). iSAR+ Mobile Applications (multiple apps will allow news, notifications, map-info and SOS-call/message). iSAR+ Social Networks Presence (e.g., Facebook, Twitter, YouTube). Social media monitoring (soft monitoring on an *ad hoc* and manual basis, foreseen machine data mining and processing). SMS-broadcasting (not yet implemented). iSAR+ Social Network and Information Portal (following EU legislation and data privacy recommendations).	No image and video analysis (support via social networks). FEMA Mobile Application (news, notifications, map-info, tutorials/help). FEMA Social Networks Presence and *official* accounts (e.g., Facebook, Twitter, YouTube). Social media monitoring - recently a rumor control section was established. SMS-broadcasting (implemented in several states).

Table 2 - Social Media Approaches in Europe and in the US

5 CONCLUSIONS

This paper explores how the new digital arena of social media increasingly influences the *connecting and collaboration* of citizens and organizations in underdeveloped and degraded operational environments, as found in emergency and crisis situations.

The case studies involving natural disasters, terrorist activities and social upheavals, account for the current state-of-the-art in the use and impact of social media technology in emergency and crisis situations and their associated response efforts throughout the World. They corroborate the profound influence of social media in society, forcing traditional C2 model organizations to adapt to an Information Age reality. That reality includes an informed, active and digitally empowered audience

demanding authorities to present enhanced network-enabled connection and collaboration capabilities, able to handle freedom of expression, source anonymity, decentralized flows of information, sharing of information, shared situation awareness and the emergence of self-synchronization, all of which enhance Effectiveness, especially in underdeveloped and degraded operational environments.

Specific success conditions have to be in place in order to enable and encourage the use of social media technology to improve traditional C2 models by involving citizens, and achieve enhanced situational awareness, self-synchronization and effectiveness. Aware of the power and flexibility of social media tools, both governments and citizens explore this new world and present their adoption mechanisms to the Connect and Collaborate paradigm.

Our effort in this paper to better understand the relevance, influence and role of social media in security-related events in underdeveloped and degraded environments enables the emergence of particularly important conclusions:

- Social media have become ubiquitous in a wide variety of important security-related situations, including but not limited to disaster warning and response, social upheavals, and responses to terrorist activity. Their impact is only limited by the reach of social media technology and platforms (when and where they are available) and the creativity of the involved citizens and organizations.
- Over time, government institutions, international organizations and NGOs have become aware of and more comfortable with the use of social media, framed in a relatively informal way to inform, conduct rumor management (involving countering, control, validate/falsify rumors and misinformation), develop situational awareness and collaborate in coordinated activities, from evacuations to volunteering. Increasingly, governments use social media as an integral part of crisis management operations, including prevention, preparation, response and recovery phases. Thus, Robert Ottenhoff, president and CEO of the Center for Disaster Philanthropy, observed that since Hurricane Katrina social media has gotten better at alerting more people how to prepare for a storm of Sandy's magnitude: “The communities in affected areas of Sandy were prepositioned. States were all pretty well organized and declared disaster areas quickly, sometimes days before the worst of it. Social media played a big role in that.” [76]
- Social media providers, including major players such as Google, broadband providers like Digicel, and those controlling rich social media tools like Facebook and Twitter, have proven to be willing partners in crucial situations, pushing information and providing platforms for the coordination of information. Social media *intermodality* or overlapping of various social media networks facilitates this sharing.
- As a consequence of the shared experience of governments, international organizations, NGOs, media and individuals, open source platforms have created and adopted templates and processes to generate rapid, flexible common responses as situations evolve.
- Social media are tools, not panacea. They can be used for good, evil or mixed motives. However, in the case studies reviewed, they often proved to be an important reinforcement to community response. Social media utility and value have been enhanced as their reach, richness and quality of interaction have grown.
- Trust underlies all successful social media activity – trust in the information, in the information channel and in the source of the information. Efforts to earn and

maintain trust are crucial to on-going success. Social media users have become alert to the use of social media for misinformation and have been able to mount corrective campaigns.

- Data privacy aspects are still a concern in cyberspace, and social media in particular, for its international nature remains outside of country-specific legal framework.
- Information sharing is a trigger activity, enabling improved information quality, creating shared situational awareness, valuing collaboration and promoting self-synchronization.

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8 ENDNOTES

[1] "Connect and collaborate" is a term used by Thomas L. Friedman in "The World Is Flat" (2005).

[2] Decisions are an organisational product rather than and individual one and the whole organisation upholds them as own decisions.

[3] A meme is an idea, behavior or style that has the potential to spread across society. This term was created by Richard Dawkins in *The Selfish Gene* (1989).

[4] SMS requires less infrastructure capacity than a voice call and can be processed asynchronously. Therefore, SMS are effective communication means even in conditions of great demand.