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RAPID INFORMATION AND COMMUNICATION TECHNOLOGY ASSESSMENT TEAM (RTAT): ENABLING THE "HANDS AND FEET" TO WIN THE "HEARTS AND MINDS"

by

R. Travis Beeson

September 2014

Thesis Advisor:	Brian Steckler
Second Reader:	Bryan Hudgens

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Large-scale disasters severely damage local information and communication technology (ICT) infrastructure. This negatively impacts responders' ability to communicate and collaborate with one another. As a result, humanitarian assistance (HA) response organizations cannot maintain situational awareness and efforts remain disjointed and inefficient.

Out of the rubble of the Haiti earthquake, a cross-organizational collection of first responders created the Rapid ICT Assessment Team (RTAT) to conduct and share a holistic assessment of the ICT environment. However, RTAT has yet to solve the problem of efficiently and effectively collecting the ICT data and creating a shareable, common, ICT operational picture. Employing a campaign of experimentation (COE), this thesis analyzes RTAT with an Enterprise Architecture framework and Savvion process modeler and employs the Android based, mobile, spatial data collection applications Lighthouse and Open Data Kit (ODK) Collect to exploit the open source form builder ODK. RTAT founders, along with Bicol University and local volunteers, field tested the ODK forms with crowd sourcing techniques and when Typhoon Haiyan struck; they validated the organizational RTAT model and integrated assessments into the Pacific Disaster Center's (PDC) DisasterAWARE collaborative website.

This thesis highlights the disjointed rapid response ICT assessment community which lacks standard forms and unifying data standards. The COE validates using open source, spatial data collection tools and crowdsourcing techniques for even highly technical needs. However, the COE revealed programming logic limits of the ODK forms, and the imperfect back-end integration between RTAT and the PDC. Debates remain over the validity of qualitative, crowdsourced ICT assessments. Going forward, RTAT must refine its forms and lead the movement to harmonize HA community assessment data sets. Furthermore, future data collection tools must become operating system independent.

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RAPID INFORMATION AND COMMUNICATION TECHNOLOGY ASSESSMENT TEAM (RTAT): ENABLING THE "HANDS AND FEET" TO WIN THE "HEARTS AND MINDS"

R. Travis Beeson
Major, United States Marine Corps
B.S., The Ohio State University, 2000
M.S.B.A., Boston University, 2009

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requirements for the degree of

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from the

NAVAL POSTGRADUATE SCHOOL
September 2014

Author: R. Travis Beeson

Approved by: Brian Steckler
Thesis Advisor

Bryan Hudgens
Second Reader

Dan Boger
Chairman, Information Systems Department

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ABSTRACT

Large-scale disasters severely damage local information and communication technology (ICT) infrastructure. This negatively impacts responders' ability to communicate and collaborate with one another. As a result, humanitarian assistance (HA) response organizations cannot maintain situational awareness and efforts remain disjointed and inefficient.

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LIST OF ACRONYMS AND ABBREVIATIONS

APAN	All Partners Network Access
ASEAN	Association of Southeast Asian Nations
BU	Bicol University
C2	command and control
CMMI	capability maturity model integration
COD	common operational dataset
COM	chief of mission
COP	common operational picture
DART	Disaster Assistance Response Team
DCHA	U.S. Bureau for Democracy, Conflict, and Humanitarian Assistance
DHS	Department of Homeland Security
DOD	Department of Defense
DOS	Department of State
DRC	disaster relief coordinator
EPIC	Emergency Preparedness Integration Centre
ERC	emergency relief coordinator
FEMA	Federal Emergency Management Agency
FHA	foreign humanitarian assistance
GA	General Assembly
GPS	global positioning system
HA	humanitarian assistance
HADR	humanitarian assistance disaster relief
HC	humanitarian coordinator
HE	humanitarian event
HF	high frequency
IASC	Inter-Agency Standing Committee
ICRC	International Committee of the Red Cross
ICT	Information Communication and Telecommunication
JP	joint publication

KML	Keyhole Mark-up Language
MIRA	multi-cluster/sector initial rapid assessment
MySQL	My Structured Query Language
NATF	Needs Assessment Task Force
NGO	Nongovernmental organizations
NOMAD	HumanitariaN Operations Mobile Acquisition Of Data
NRF	National Response Framework
NRP	National Response Plan
NSC	National Security Council
OCHA	Office for the Coordination of Humanitarian Affairs
ODK	Open Data Kit
OFDA	Office of U.S. Foreign Disaster Assistance
OSA	Online Selection Assistance
PCC	Policy Coordination Council
PDC	Pacific Disaster Center
ROP	Republic of the Philippines
RC	regional coordinator
RTAT	Rapid Information Communication Telecommunication (ICT) Assessment Team
SMS	short messaging service
SQL	Structured Query Language
TSF	Télécoms Sans Frontières
UN	United Nations
UNDAC	United Nations Disaster Assessment and Coordination
UNCT	United Nations country team
UN-ETC	United Nations Emergency Telecommunication Cluster
UHF	ultra-high frequency
VHF	very high frequency
WFP	World Food Programme

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I. INTRODUCTION

Cataclysmic events such as the Indonesian tsunami in 2004 and hurricane Katrina in 2005 leave a wide and devastating wake of destruction. The horrific human suffering in these events is exacerbated by the inability of governmental and relief organizations to operate in a chaotic environment (Donahue & Tuohy, 2006). Specifically, their inability to collectively assess the situation, prioritize efforts, and effectively allocate/direct scarce resources (Donahue & Tuohy, 2006). Office for the Coordination of Humanitarian Affairs (Office for the Coordination of Humanitarian Affairs) (2014a) stated that unfortunately,

The humanitarian community's existing data-sharing practices usually involve one-to-one exchange of non-standardized spreadsheets or individual figures over email at irregular intervals. These ad-hoc methods can cause a significant delay between the collection of data and the formulation of that data into a common operational picture. In the worst case, information is simply not shared at all, leaving gaps in the understanding of the field situation.

This lack of shared information is due, in large part, to an ineffective or missing overarching collaboration organization and further compounded by severely damaged host nation communication infrastructure (Donahue & Tuohy, 2006; and Steckler, 2009). Most organizations "don't know what they don't know" when they arrive and, as a result, incorrectly equip themselves for the information and communication technology (ICT) environment (Steckler, 2009). Further, with the commoditization of smart devices and sensors, every organization is haphazardly collecting and sharing raw data in an unstructured manner. Kennerly & Mason (2008) described a growing concern that organizations are now "drowning in data, whilst thirsting for information."

Several organizations assess various aspects of the ICT infrastructure, but none collate the information into an ICT current operational picture or a complete understanding for decision making (Steckler, 2009). To fill the gaps and help make sense of the data noise, the Rapid ICT Assessment Team (RTAT) was created to conduct a

holistic assessment of the ICT environment and share this information in a coherent manner with other responding organizations. The problem of efficiently and effectively collecting the data, creating an ICT common operational picture and getting this information into the right hands, however, has yet to be solved.

A. PROBLEM STATEMENT

Understanding the information and communication technology (ICT) environment in a post disaster environment is difficult. Compounding this problem is the potential lack of host nation ICT infrastructure that could facilitate information collaboration between relief organizations. The Rapid ICT Assessment Team (RTAT) program was created to assess the ICT environment and give ICT prioritization recommendations. The current assessment form that uses Microsoft Excel spreadsheet, however, is not optimal for sharing ICT team findings in an efficient and expeditious manner to the rest of the humanitarian assistance (HA) response community (HARC).

Without an adequate assessment platform, RTATs will not be able to efficiently or effectively communicate the current disaster area ICT situation. As a result, HA response organizations may not have the required ICT tools and supporting infrastructure to respond adequately to the situation. Worse, they will not know what to bring to the disaster area to facilitate required collaboration and communication between the affected population, host nation officials and responders, international HA relief organizations, and US entities (DOD/DOS) further exasperating the dynamic and difficult problem of large scale disaster response.

This research will explore the use of mobile software applications on established existing networks, wireless meshed networks (WMNs), and exercise/real world hastily formed networks (HFNs) by RTAT members in an effort to bridge the gap and provide a more useful optimal ICT assessment tool for end users.

B. RESEARCH QUESTIONS

1. What are the limitations of the current Microsoft Excel based assessment form?

2. What are the costs and benefits of moving RTAT forms from a laptop based Microsoft Excel to a mobile data collection tool?
3. What are the best mobile data collection tool/ electronic form interface options available to RTAT?

C. PURPOSE STATEMENT

The purpose of this analysis is to research and create a mobile data collection tool and assessment form that can be used by the Rapid Information and Communication Technology (ICT) Assessment Teams (RTATs) in the field. This research/project will result in a more efficient and effective working mobile data collection platform that will have significantly greater capability than the current Microsoft (MS) Excel spreadsheet model. This improvement includes a working mobile spatial-data collection tool and backend aggregate server with links to an online collaboration website.

This research can be transferred to any DOD entity that has a need to transmit standardized reports from an off-the-grid, austere environment and allow those reports to be importable into a useful database that feeds a current operational picture (COP) website to enable a cohesive overview and, thereby, better decisions.

D. CONTRIBUTION

This project contributes to the understanding of how organizations make sense of chaotic environments by exploring possible improvements to rapidly collect and share accurate information to develop a current operational picture. This current operational picture leads to a shared understanding among participants and improved collaborative decisions.

Without an adequate assessment platform, RTATs will not be able to efficiently, or effectively, communicate the current ICT situation in the disaster area. In turn, Humanitarian Assistance Disaster Response (HADR) organizations may not have the expected ICT tools and supporting infrastructure to adequately respond to the situation. Worse, they will not know what to bring to the disaster area to facilitate required collaboration and communication between the affected population, host nation officials

and responders, international HA relief organizations and U.S. entities (DOD/DOS) further exasperating the dynamic and difficult problem of large scale disaster response.

II. LITERATURE REVIEW

The major topics for discussion in the literature review include: A. Information, B. U.S. Disaster Response, C. UN Disaster Response, D. Other Information and Communication Technology Non-Governmental Organizations, E. Rapid Information and Communication Technology (ICT) Assessment Team (RTAT), F. Categories of Post Disaster Assessment Data Sets, G. Current Post Disaster Assessment Forms, H. Enterprise Architecture Analysis, I. Savvion Business Process Management, J. Hastily Formed Network, K. Mobile Device Operating Systems, L. Mobile Data Collection Methods, and M. Available Mobile Electronic Form Interfaces.

A. INFORMATION

DOD (2006) stated, "There are two basic uses for information. The first is to help create situational awareness (SA) as the basis for a decision. The second is to direct and coordinate actions in the execution of the decision."

Kennerly & Mason (2008) reiterated this view stating the purpose of information is to make better decisions further positing that, "research evidence suggesting that better use of information can improve decision making." Unfortunately, Davenport, Harris, De Long & Jacobson (2000) brought to light that "one of the most enduring traits of the information age is that we have focused too much on mastering transaction data and not enough on turning it into information and knowledge that can lead to business results." Reaffirming this, Chopoorian, Witherell, Khalil and Ahmed (2001) found that "businesses currently analyze less than 7 percent of the data that they collect." Therefore, a focus on data collection is not enough; information must be processed into an actionable or usable form, and this process must add value to the organization within its market for it to thrive (Kennerly & Mason, 2008). Figure 1 shows the process of processing raw sensor data into actionable situational understanding for decisions.

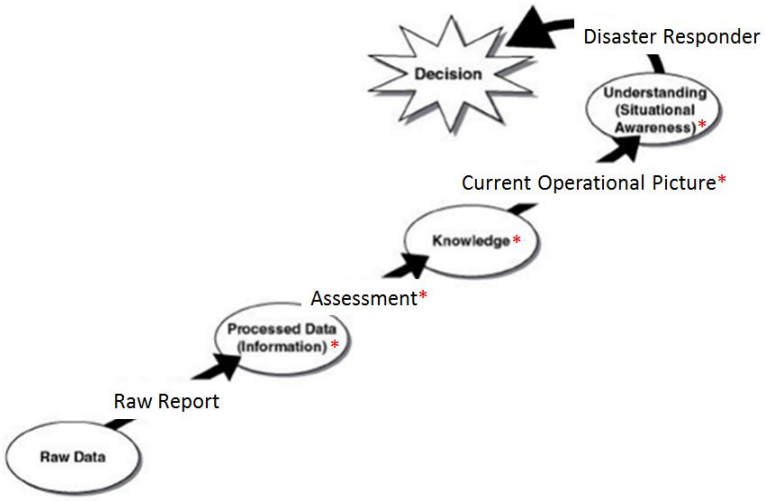

Figure 1. Process from Raw Data to Situational Understanding (after Headquarters, U.S. Marine Corps, 2002)

While the problem of collecting data is being solved through the proliferation of smart devices and sensors, the ability to turn this data into actionable information and situational awareness in a disaster zone is an on-going issue (Office for the Coordination of Humanitarian Affairs, 2014a). Asterisked within Figure 1, the Rapid Information and Communication Technology (ICT) Assessment Team (RTAT) seeks to interject at key points in the information process to enable and facilitate better decision making (Steckler, 2009). RTAT processes the raw data reports by conducting assessments and collating and promulgating this processed knowledge, along with recommended courses of action, via a shared current operational picture (COP) (Steckler, 2009).

1. Raw Data to Understanding

This section briefly outlines the process of taking raw data (Figure 1) and turning it into understandable data that adds value to HADR organizations. This thesis will use the collection of weather data to illustrate each stage.

a. Data

Merriam Webster (2014) defined data as:

> 1: factual information (as measurements or statistics) used as a basis for reasoning, discussion, or calculation. 2: information output by a sensing device or organ that includes both useful and irrelevant or redundant information and must be processed to be meaningful. 3: information in numerical form that can be digitally transmitted or processed.

Kennerly & Mason (2008) furthers the definition:

> The word data is the plural of Latin datum, past participle of dare, "to give," hence "something given." Thus in general, data consists of propositions that reflect reality. A large class of practically important propositions is measurements or observations of a variable. Such propositions may comprise numbers, words, or images.

Raw data in this context is a reported ICT outage or the omission of electronic reports in a disaster indicating an outage. Once raw data has been processed into a shared understanding, humanitarian Assistance (HA) workers, assuming they have the ability to communicate, can begin to deconflict and collaboratively organize and prioritize their efforts.

For illustration purposes, raw data are the numbers coming out of a sensor; in the weather example this would be the temperature, humidity, barometric pressure, and precipitation at a location at a specific time.

b. Processed Data (Information)

Kennerly and Mason (2008) described information in the following terms:

> The way the word information is used can refer to both "facts" in themselves and the transmission of the facts. The double notions of information as both facts and communication are also inherent in one of the foundations of information theory: cybernetics introduced by Norbert Wiener (1948).

Processed data would be the collection of weather data (such as temperature) for a period.

c. Knowledge

> Knowledge communicated concerning some particular fact, subject or event; of which one is apprised or told; intelligence, news.

> Information is the result of processing, manipulating and organizing data in a way that adds to the knowledge of the receiver. In other words, it is the context in which data is taken.

There are many epistemology and cognitive definitions for "knowledge;" simply put "knowledge is what is known" (Kennerly & Mason, 2008). Plato stated that knowledge is a subset of what is true and what is believed, Figure 2 (Kennerly & Mason 2008). For the purposes of this thesis, knowledge will be will be t defined as a refined set of facts that are pertinent to a narrow subset of the overall situation and can be acted upon in and of themselves.

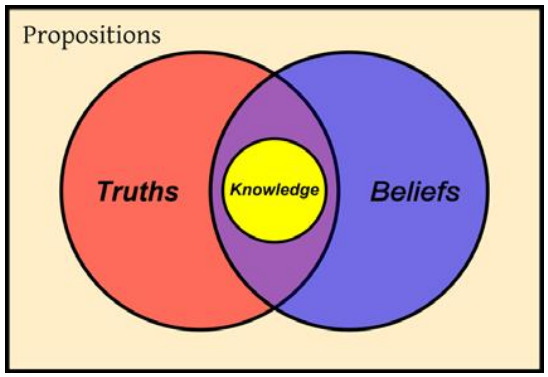

Figure 2. Plato's Knowledge is a Subset of What is Both True and Believed

Knowledge is organized into two categories: Explicit and tacit.

(1) Explicit knowledge

Explicit knowledge is easily codified and shared with others (Dienes & Perner, 1999). How to use a particular tool or do a specific process within an organization should be explicit knowledge.

(2) Tacit Knowledge

Tacit knowledge can be described as "head knowledge," that is knowledge that is trapped in one's head and not easily transferred to another (Headquarters, Department of the Army, 2012). This knowledge is gained through years of experience and gives rise to gut feelings and intuition. Tacit knowledge is knowledge that one may not know that they

know it (Dienes & Perner, 1999). Further, tacit knowledge "representations merely reflect the property of objects or events without predicating them of any particular entity" (Dienes & Perner, 1999). Making it difficult for an organization to identify the existence of tacit knowledge because the person who has it may not know they have it and it is difficult to associate this knowledge to an entity/object to codify it explicitly (Dienes & Perner, 1999). Unfortunately, a significant amount of knowledge for disaster response is currently tacit and difficult to transfer between people (Donahue & Tuohy, 2006). Worse, turnover and unpredictability of disaster location, i.e. rarely in the same local area twice, leaves much of the tacit knowledge gained and "lessons learned" to be relearned by the next group of responders at the next event (Donahue & Tuohy, 2006). Tacit knowledge examples may include cultural awareness, financial market understanding, and expert salesmanship.

Using the weather construct, knowing the average rainfall for an area or the fact that it is raining is tacit knowledge. Knowing the streets sometimes flood in Manila when it rains is tacit, until someone misses their flight or thinks to share the information.

d. Situational Understanding

Situational understanding combines both types of knowledge (tacit and explicit) to develop a complete mental picture of the situation allowing the development of a plan furthering decision making (Headquarters, U.S. Marine Corps, 2002).

Knowing to leave three hours early to get to the airport because the streets often flood, for example, shows situational understanding on a micro scale.

2. Relational Database

In order to organize, retain, and share explicit information, companies often look to information technology solutions. One such common solution is the use of relational databases.

According to Oracle, a leading database company,

> A database is a means of storing information in such a way that information can be retrieved from it. In simplest terms, a relational

> database is one that presents information in tables with rows and columns. A table is referred to as a relation in the sense that it is a collection of objects of the same type (rows). Data in a table can be related according to common keys or concepts, and the ability to retrieve related data from a table is the basis for the term relational database. (Oracle, 2014)

Telvent (2014) stated, "A database that contains only one table is called a flat database." Excel is an example of a flat database. To realize the true power of a relational database, however, one must learn how to tie multiple tables together to represent potentially complex relationships between the items stored therein (Yank, 2009, p. 71).

3. Spatial Data

A world leading mapping non-governmental organization (NGO), MapAction (2011), stated:

> Spatial data is any data that has a "where" component that can be recorded and mapped. Attributes can be any data about the specified place. So, by adding the coordinate data to an existing data set, you have created a spatial database—data that can be mapped.

Spatial-relational databases can be accessed and queried via entity attributes or location, as well as posted to a responder shared current operational picture map.

4. Data Collection

The United Nations (UN) Office for the Coordination of Humanitarian Affairs (Office for the Coordination of Humanitarian Affairs) (2013b) defined data collection "as the ongoing systematic collection of data (quantitative and/or qualitative) necessary for identifying and prioritizing needs for disaster relief assistance."

Jung (2011) defined mobile data collection (MDC) as "the targeted gathering of structured information using devices such as smartphones, PDAs, or tablets."

5. Microsoft Excel

Currently, the Rapid Information and Communication Technology (ICT) Assessment Team (RTAT) utilizes a Microsoft (MS) Excel spreadsheet to conduct its

assessment. To understand why they are seeking an alternative data collection method, one must understand the capabilities and limitations of their current MS Excel based solution.

Microsoft's (MS) Excel spreadsheet is prevalent throughout the HA response community and is widely adopted to track HA efforts (Office for the Coordination of Humanitarian Affairs, 2014a). Additional benefits of Excel include: wide adoption and use, pivot table functions to perform complex analysis, solver functions for optimization problems, auto fill features based on previous input, data visualization with various charts and graphs, exportability as a text file (tab or comma separated), Extensible Markup Language (XML) data and comma separated value (CSV) ((Microsoft [MS], 2014).

Unfortunately Excel has some serious drawbacks: has no skip logic, i.e. it can't walk a user through an assessment, requires MS Excel compatible program, and is limited on the number of fields. Additionally, a limitation exists as to the size and number of relations, views and their intermediate results, imposed by the maximal available number of worksheets, columns and rows in the spreadsheet system if one attempts to create a stand-alone Excel database (Tyszkiewicz, 2010). Finally, "the size of the data values (integers, strings, etc.) is also limited. The variety of data types in spreadsheets is also restricted when compared to database systems" (Tyszkiewicz, 2010).

B. U.S. DISASTER RESPONSE

Between 1980 and 2010, 640 disasters have occurred within the U.S. which accrued a staggering $18 trillion cost from damages and the loss of over 12,000 lives (PreventionWeb, n.d.). This section outlines how local, state, territorial, regional and federal governmental entities respond to disasters within the U.S. and its territories, with primary focus on the U.S. federal government.

The first analysis focuses on the U.S. federal government's response to disasters.

1. U.S. Federal Government Response to Disasters Within the U.S. and its Territories

The outdated United States (U.S.) *National Response Plan* (NRP), resulting from *Presidential Policy Directive Number 5* (PPD-5) in 2004, recognizes that planning, preparing for, and responding to natural and other disasters are primarily responsibilities of the individual states. This reflects the U.S. Constitutional perspective and results in a pull response assumption. Local authorities have the lead at the start, escalating to state level and then to federal level, if necessary and if requested, in the event of a disaster (Moffat, 2008).

The *Stafford Act* outlines the process by which state governors request this assistance from the federal government when the event becomes one of *national significance*. The President of the United States (POTUS) then has to decide whether the event of national significance merits designation as an *emergency* (releasing limited resources to the states), a *major disaster* (releasing much greater resources to the states) or a *catastrophe*. The first two of these result in a *pull* response; the states requesting and drawing down (pulling) from these federal resources as they see the event unfolding. The third category of *catastrophe* would have resulted in a proactive *push* of resources to the region, states and local level, irrespective of the states' requests (Moffat, 2008). The *Stafford Act* attempts to organize and capture all federal costs associated with the significant event. Its processes, however, can be cumbersome, slow and ill-suited to a dynamic situation where a rapid response, vice monetary accountability, is the gauge of success (Cannon, Beeson, Mitchell, Spencer, & Liguori, 2012).

Under the NRP, a comprehensive framework of response to significant event is established. At the federal level, the Homeland Security Operations Centre, the Federal Emergency Management Agency (FEMA), National Response Centre and the Interagency Incident Management Group jointly coordinate the response across government departments. The federal coordinating officer (FCO), a representative of the Secretary for Homeland Security, is authorized to lead a joint field office (JFO). This is a temporary federal facility established locally at the time of a disaster to coordinate the

local, state, and federal response. It consists of senior representatives from all agencies and responders involved and development of objectives, strategies, plans, and priorities (Moffat, 2008). The membership of this office is envisaged as growing and adapting over time as the incident escalates or diminishes (Moffat, 2008).

In summary, at pre-hurricane Katrina landfall, the NRP and *Stafford Act* delineated that states have the lead in handling natural disasters within their state and, with the exception of "catastrophic events," were required to request assistance from the federal government as necessary. FEMA is the lead federal command and control (C2) agency for handling "nationally significant" events (Meeds, 2006). Unfortunately as shown in Katrina, the entire system was set up in a strict, regimented, hierarchical system, which involved local, state, regional and federal entities respectively and was shown to be ill-suited and deficient for the dynamic task at hand (Cannon et al, 2012).

In response to the shortfalls experienced during hurricane Katrina, President Barack Obama signed Presidential Policy Directive 8 (PPD-8): *The National Preparedness System* (*NPS*) in 2011 (U.S. Department of Homeland Security, 2011). PPD-8 outlines the U.S. current approach to national preparedness (U.S. Department of Homeland Security, 2011). Hence, National Response Program (NRP) was changed to the *National Response Framework* (NRF) to reflect this change. The Department of Homeland Security (2013) further elaborated on this change:

> The National Response Framework (NRF) is an essential component of the National Preparedness: System mandated. PPD-8 is aimed at strengthening the security and resilience of the United States through systematic preparation for the threats that pose the greatest risk to the security of the Nation. PPD-8 defines five mission areas—Prevention, Protection, Mitigation, Response, and Recovery—and mandates the development of a series of policy and planning documents to explain and guide the Nation's collective approach to ensuring and enhancing national preparedness. The NRF sets the doctrine for how the Nation builds, sustains, and delivers the response core capabilities identified in the National Preparedness Goal (the Goal). The Goal establishes the capabilities and outcomes the nation must accomplish across all five mission areas to be secure and resilient.

This thesis will concentrate on the response mission.

Added to the federal response, the U.S. also has an established response to international disasters which is comprised of three parts: the U.S. Department of State response, the U.S. Department of Defense response, and the Interagency Coordination for Foreign Humanitarian Assistance. These will be examined in the following section.

2. U.S. Response to International Disasters

The Department of State (DOS) leads the U.S. response for international disasters, with USAID as its lead agency. Upon disaster striking, the ambassador or the

> Chief of Mission (COM) may send a disaster declaration cable outlining the extent of the damage, possible needs, and may recommend assistance in the form of funding, material, or technical assistance. When the President, Secretary of Defense (SecDef), and the Secretary of State have determined that a U.S. humanitarian response to a foreign disaster or crisis is required, the National Security Council (NSC) normally directs the Special Coordinator for International Disaster Assistance to convene an International Development and Humanitarian Assistance NSC Policy Coordination Committee (PCC) to review all pertinent information and recommend policy and specific actions. The PCC; which consists of senior DOS and DOD representatives, the COM, USAID representatives, and heads of other concerned agencies; concurrently develops a comprehensive strategy for emergency response and develops tasks for each key participant. (Department of Defense, 2014).

a. U.S. Department of State Response to Foreign Disasters

As stated, the U.S. Department of State (DOS) is the lead department for the U.S. response to foreign disasters (Department of Defense, 2011). The DOS has many agencies that work in concert to achieve the strategic goals or disaster preparedness and response. Two of these agencies are outlined below.

(1) Office of U.S. Foreign Disaster Assistance

The Office of U.S. Foreign Disaster Assistance (OFDA) is the lead office of USAID for immediate disaster relief. OFDA lies within the USAID Bureau for Democracy, Conflict, and Humanitarian Assistance (DCHA) (Department of Defense, 2011). OFDA is delegated the responsibility to "provide international disaster and humanitarian assistance and coordinate the USG response to declared disasters in foreign

countries" (Department of Defense, 2011). OFDA gets its authority from the Foreign Assistance Act of 1961, as amended, § 491-493 and from delegated Presidential Authority. In the performance of such tasks, OFDA "maintains stocks of emergency relief supplies in warehouses worldwide and has the logistical and operational capabilities to deliver them quickly" (Department of Defense, 2011).

(2) Disaster Assistance Response Team

OFDA has a responsibility to respond to disasters quickly and it uses to the Disaster Assistance Response Team (DART) to quickly assess the situation. DOD (2011) aptly summed DART,

> When disaster strikes, OFDA sends regional and technical experts to the affected country to identify and prioritize humanitarian needs. In the wake of a large-scale disaster, OFDA can deploy a Disaster Assistance Response Team (DART) to coordinate and manage an optimal U.S. Government response, while working closely with local officials, the international community, and relief agencies.

DART teams are the first responder eyes and ears of the OFDA.

The second tier of U.S. international disaster response is the Department of Defense.

b. U.S. Department of Defense Response to International Disasters

The U.S. government (USG) responds to "approximately 70–80 natural disasters across the globe each year. In approximately 10–15 percent of these disaster responses, the Department of Defense (DOD) lends support to the overall U.S. effort" (Department of Defense, 2011). In these instances, DOD acts in support to the Department of State (DOS) in concert with USAID efforts and in close coordination with the effected country and the international humanitarian assistance (HA) response community organizations (HARC) (Department of Defense, 2011). These HARC entities include other donor countries and participating international organizations and non-governmental organizations (NGOS), key NGOs will be discussed in greater detail later. The U.S. DOD role in foreign disasters is governed by the *Foreign Assistance Act* of 1961 under U.S. Code Title 22. DOD Directive 5100.46, *Foreign Disaster Relief*, "establishes policy and

provides for component participation in foreign disaster relief operations only after a determination is made by DOS that foreign disaster relief shall be provided" (Department of Defense, 2014). U.S. DOD Joint Publication (JP) *JP 3–29* calls these types of activities—Foreign Humanitarian Assistance (FHA) operations (Department of Defense, 2011). According to the DOD (2014),

> FHA consists of DOD activities, normally in support of the United States Agency for International Development (USAID) or the Department of State (DOS), conducted outside the United States, its territories, and possessions to relieve or reduce human suffering, disease, hunger, or privation. While, U.S. military forces are not the primary U.S. Government (USG) means of providing FHA, the foreign assistance they are tasked to provide is designed to supplement or complement the efforts of the host nation (HN).
>
> Typical DOD FHA operation missions include:
>
> - Relief missions: Missions that include prompt aid that can be used to alleviate the suffering of disaster victims (Department of Defense, 2014).
> - Dislocated civilian support missions: Provide assistance and protection for dislocated civilians (Department of Defense, 2014).
> - Security missions: "Establish and maintain conditions for the provision of FHA by organizations of the world relief community to include secure areas for storage of relief material, provide protection and armed escorts for convoys and personnel delivering emergency aid, protection of shelters for dislocated civilians, and security for multinational forces" (Department of Defense, 2014).
> - Technical assistance and support functions: "Advice and selected training, assessments, manpower, and equipment" (Department of Defense, 2014).
> - Foreign consequence management (FCM): DOD assistance to a "HN to mitigate the effects of a deliberate or inadvertent chemical, biological, radiological, nuclear, and high-yield explosives attack or event and to restore essential government services" (Department of Defense, 2014).

Coordination between the numerous FHA responding agencies can be overwhelming for new entrants. The third and final tier of U.S. international disaster response is the Interagency Coordination for Foreign Humanitarian Assistance; the diagram shown in the next section is helpful and outlines the organizational relationships between the U.S. DOS and U.S. DOD agencies.

c. The Interagency Coordination for Foreign Humanitarian Assistance

Under the President of the United States lay the various departments and agencies shown in Figure 3. During a disaster response, the affected country's Chief of Mission is the focal point of the U.S. effort. The Chief of Mission falls under the Department of State but has direct contact with the President of the United States. One should note that while *lines of coordination* to the Chief of Mission exist from the responding DOD Joint Task Force commander and the United States Agency for International Development (USAID), those organizations do not *work* for the Chief of Mission but for their parent organization, a minor detail that can lead to major consequences.

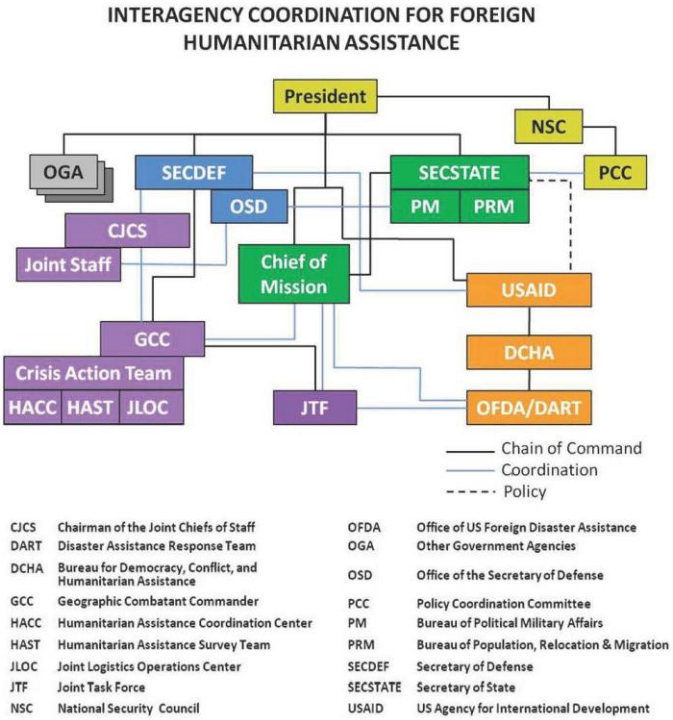

Figure 3. Interagency Coordination for Foreign Humanitarian Assistance (from DOD, 2011)

C. UNITED NATIONS DISASTER RESPONSE

The United States is but one player in a much larger humanitarian assistance (HA) response community (HARC). The United Nations (UN) has taken on a large role for coordinating international humanitarian event response and relief efforts. This section

outlines how the UN responds to large scale disasters and is comprised of four sections: UN Humanitarian events, UN resident coordinator, United Nations Emergency Relief Coordinator, United Nations Office for the Coordination of Humanitarian Affairs, and UN Emergency Telecommunication Cluster.

1. United Nations Humanitarian Events

UN characterizes its responses to human suffering and disasters as *humanitarian events* (Office for the Coordination of Humanitarian Affairs, 2013b). Humanitarian events are characterized into two broad categories of *natural disaster* and *complex emergency*.

a. Natural Disaster

Natural disaster occurs when a "disaster-affected country requests international assistance in coping with a natural disaster and requires additional international coordination resources" (Office for the Coordination of Humanitarian Affairs, 2013b).

b. Complex Emergency

Complex emergency is defined as "a humanitarian crisis in a country, region or society where there is total or considerable breakdown of authority resulting from internal or external conflict and which requires an international response that goes beyond the mandate or capacity of any single agency and/or the ongoing United Nations' country program" (Department of Defense, 2011). DOD (2011) further described complex emergencies as involving:

- Extensive violence or loss of life.
- Massive displacements of people.
- Widespread damage to societies and economies.
- The need for large-scale, multi-faceted humanitarian assistance.
- Hindrance or prevention of humanitarian assistance by political and military constraints.
- Security risks for humanitarian relief workers in some areas.

c. United Nations Level of Crises.

The UN further categorizes humanitarian events by level of crisis.

- Level 1 (L1) Emergency is "an emergency where the national and international resources in-country can handle the response and no outside assistance is needed" (Office for the Coordination of Humanitarian Affairs, 2013b).
- Level 2 (L2) Emergencies require "some support from neighboring countries, regional entities and possibly agency headquarters will be needed" (Office for the Coordination of Humanitarian Affairs, 2013b).
- Level 3 (L3) Emergency is "a major sudden-onset humanitarian crisis triggered by natural disasters or conflict that requires (UN) system-wide mobilization" (Office for the Coordination of Humanitarian Affairs, 2013b).

The affected country's resident coordinator or designated humanitarian coordinator (HC), with the permission of the effected nation and the help of a humanitarian Country Team (HCT), will request event tailored support from the UN Emergency Relief Coordinator (ERC) via the UN Regional Coordinator (RC) (Office for the Coordination of Humanitarian Affairs, 2013b). Normally requests are reserved for L3 Emergencies.

2. UN Resident Coordinator

The UN Office for the Coordination of Humanitarian Affairs (Office for the Coordination of Humanitarian Affairs) stated (2011),

> The overall coordination of United Nations activities falls primarily to the United Nations' (effected country's) Resident Coordinator (RC) in consultation with relevant United Nations agencies. The position equals the same rank as an Ambassador of a foreign state and is the designated Representative of the Secretary-General. The RC also leads the United Nations Country Team (UNCT). Office for the Coordination of Humanitarian Affairs, 2013b)

The RC is designated as or will designate a humanitarian coordinator (HC) to oversee a humanitarian event (natural disaster or complex emergency) (Office for the Coordination of Humanitarian Affairs, 2013b).

3. United Nations Emergency Relief Coordinator

The UN, in providing emergency assistance, is guided by General Assembly (GA) resolution 46/182, *Strengthening of the Coordination of Humanitarian Emergency Assistance of the United Nations*. The resolution, adopted 19 December 1991, strengthened the then existing position of the Disaster Relief Coordinator (DRC) to include both natural disasters and complex emergencies and renamed the position Emergency Relief Coordinator (ERC) (Office for the Coordination of Humanitarian Affairs, 2013). The ERC is an Undersecretary position within UN and reports directly to the Secretary of the UN on matters of emergency response (Office for the Coordination of Humanitarian Affairs, 2013b).

4. United Nations Office for the Coordination of Humanitarian Affairs

ERC utilizes the UN Office for the Coordination of Humanitarian Affairs (OCHA) to respond operationally to RC/HC and the affected nation's requests. DOD (2011) stated, "OCHA is the arm of the UN Secretariat that is responsible for bringing together humanitarian response participants to ensure a coherent response to disasters."

> In 1998, as part of the Secretary-General's program of reform, Department of Humanitarian Affairs was reorganized into the Office for the Coordination of Humanitarian Affairs (OCHA). Its mandate was expanded to include the coordination of humanitarian response, policy development and humanitarian advocacy. (Office for the Coordination of Humanitarian Affairs, 2014b).

a. United Nations Disaster Assessment Coordination Team

In 1993, the UN OCHA created the United Nations Disaster Assessment Coordination (UNDAC) organization to improve response to humanitarian events (Office for the Coordination of Humanitarian Affairs, 2014b). UNDAC has the primary mission to "help the United Nations and governments of disaster-affected countries during the first phase of a sudden-onset emergency" (Office for the Coordination of Humanitarian Affairs, 2014b). To clarify, the UNDAC lies within OCHA and has teams that can deploy within 12–48 hours of disaster striking in order to help the RC/HC coordinate the initial

disaster response (Office for the Coordination of Humanitarian Affairs, 2014b). The UNDAC can be likened to the USAID DART teams.

b. Inter-Agency Standing Committee

In an effort to delineate organizational responsibilities, coordinate international NGOs, and improve the operational responses to humanitarian events, the UN OCHA created the Inter-Agency Standing Committee (IASC) (Office for the Coordination of Humanitarian Affairs, 2013a).

> OCHA carries out its coordination function primarily through the IASC, which is chaired by the ERC. Participants include all humanitarian partners, from United Nations agencies, funds and programs, to the Red Cross movement and NGOs. The IASC ensures inter-agency decision-making in response to complex emergencies. These responses include needs assessments, consolidated appeals, field coordination arrangements and the development of humanitarian policies. (Office for the Coordination of Humanitarian Affairs, 2013a)

The IASC was established in June 1992 under the UN General Assembly (GA) Resolution 46/182 and affirmed in GA resolution 48/57 as the "primary mechanism for inter-agency coordination of humanitarian assistance" (Inter-Agency Standing Committee, 2011a). OCHA (2011) stated,

> IASC brings together international organizations working to provide humanitarian assistance to people in need as a result of natural disasters, conflict-related emergencies, global food crises and pandemics.
>
> The IASC is made of both members and standing invitees (see Figure 4).

IASC Members		IASC Standing Invitees	
	Food and Agriculture Organization (FAO)		International Committee of the Red Cross (ICRC)
	United Nations Development Programme (UNDP)		International Council of Voluntary Agencies (ICVA)
	United Nations Population Fund (UNFPA)		International Federation of Red Cross and Red Crescent Societies (IFRC)
	United Nations Human Settlements Programme (UNHABITAT)		American Council for Voluntary International Action (InterAction)
	United Nations High Commissioner for Refugees (UNHCR)		International Organization for Migration (IOM)
	United Nations Children's Fund (UNICEF)		Office of the High Commissioner for Human Rights (OHCHR)
	United Nations Office for Coordination of Humanitarian Affairs (OCHA)		Office of the Special Representative of the Secretary General on the Human Rights of Internally Displaced Persons (RSG on Human Rights of IDPs)
	World Food Programme (WFP)	SCHR	Steering Committee for Humanitarian Response (SCHR)
	World Health Organization (WHO)		World Bank (WB)

Figure 4. IASC Members and Standing Invitees (from Inter-Agency Standing Committee, 2011a)

The IASC is organized along functional lines called "clusters" (Office for the Coordination of Humanitarian Affairs, 2013a). Following the recommendations of an independent Humanitarian Response Review in 2005,

> The cluster approach was proposed as one way of addressing gaps and strengthening the effectiveness of humanitarian response through building partnerships. The cluster approach ensures clear leadership, predictability and accountability in international responses to humanitarian emergencies by clarifying the division of labor among organizations and better defining their roles and responsibilities within the different sectors of the response. It aims to make the international humanitarian community better organized and more accountable and professional, so that it can be a better partner for the affected people, host governments, local authorities, local civil society and resourcing partners. (Inter-Agency Standing Committee, 2012b)

Each cluster is headed by a cluster lead agency, see Figure 5. Intra-cluster information management (IM) is the responsibility of the Cluster Lead agency, inter-cluster IM is the responsibility of OCHA (Office for the Coordination of Humanitarian Affairs, 2011). This thesis will be primarily concerned with the UN Emergency Telecommunication Cluster (UN-ETC).

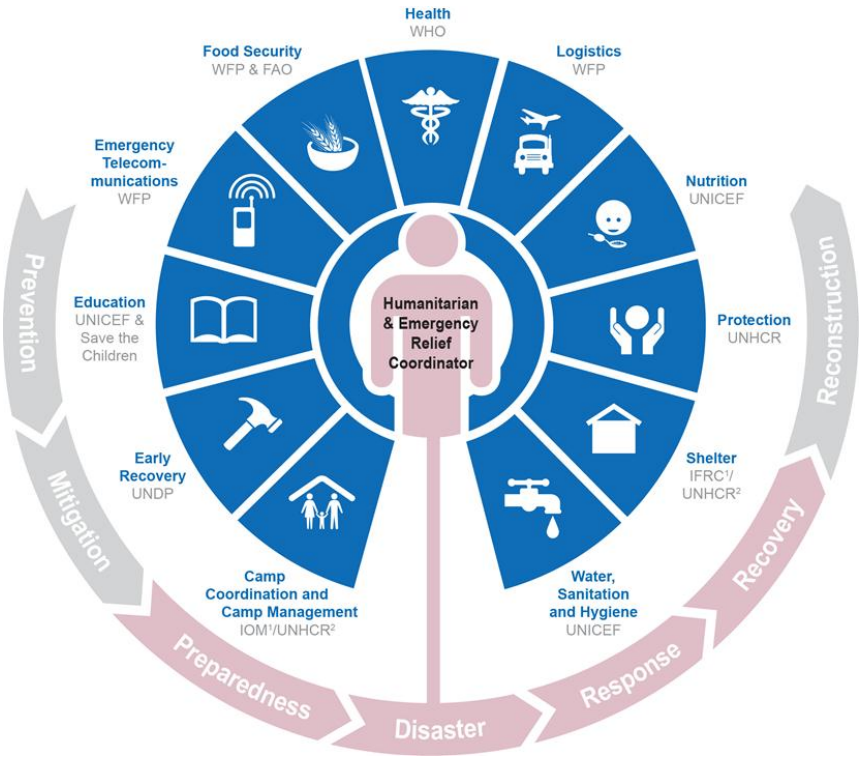

Figure 5. Inter-Agency Standing Cluster (from Inter-Agency Standing Committee 2012b)

5. UN Emergency Telecommunication Cluster

The cluster lead agency for the UN-ETC is the World Food Programme (WFP) (World Food Programme, 2013b). The WFP (2013b) stated, The UN "Emergency Telecommunications Cluster (UN-ETC) provides humanitarian workers with the communications services they need to operate effectively and efficiently, and to save lives." WFP (2013b) further stated, "The ETC is a network of organizations that work together to provide shared communications services in humanitarian emergencies."

The UN-ETC provides vital security communications' services and voice and Internet connectivity to assist humanitarian workers in their life-saving operations (World Food Programme, 2013b). The UN-ETC advertises that its first responders can deploy within 48 hours of a disaster to provide basic emergency services with service expansion for continued emergency relief within four weeks (World Food Programme, 2013b).

Specifically, the ETC provides humanitarian workers with information and communication technology (ICT) services to meet three broad goals (World Food Programme, 2013b):

- Enhance response and coordination among humanitarian organizations (World Food Programme, 2013b).
- Improve operational security environment for staff and assets (World Food Programme, 2013b).
- Facilitate decision making through timely access to critical information (World Food Programme, 2013b).

In order to help meet the immediate ICT needs of responders (within 48 hours), the UN-ETC utilizes the Fast Information Technology and Telecommunications Emergency and Support Team (FITTEST) , comprised of two elements.

a. Fast Information Technology and Telecommunications Emergency and Support Team

The Fast Information Technology and Telecommunications Emergency and Support Team (FITTEST) establishes information and communication systems and services where they have been disrupted by disasters (World Food Programme, 2013a).

b. Emergency Preparedness Integration Centre

In order to create a simple and consistent ICT solution, the UN-ETC has created Emergency Preparedness Integration Centre (EPIC) suite of information systems and applications. WFP (2011) stated,

> EPIC is an inter-agency innovation program to support improved disaster preparedness and enable faster, more cohesive emergency response. Initiated and led by the World Food Programme (WFP), EPIC is being developed for the humanitarian community, by the humanitarian community.

EPIC consists of the EPIC Portal information management platform, humanitarian assistance specific EPIC Apps, EPIC Unified Comms that enable field communication, EPIC Interaction that enables users to have the ability to interact with collected information, and EPIC Situation Room that allows for collective interaction and the

display of near real time information updates (World Food Programme, 2011). EPIC is the UN-ETC attempt at a single ICT solution to manage data information flow.

D. OTHER INFORMATION AND COMMUNICATION TECHNOLOGY NON-GOVERNMENTAL ORGANIZATIONS

There are countless international organizations committed to reducing the human suffering brought on by natural disasters and complex emergencies. Outlined below are five of the key players (and their subsets) that have information and communication technology (ICT) responsibilities pertinent to this thesis.

1. The International Federation of the Red Cross/Red Crescent

The International Federation of the Red Cross/Red Crescent (IFRC) consists of both the International Committee of Red Cross (Red Cross) and the International Committee of Red Crescent (Red Crescent). Most Westerners are more familiar with the Red Cross and most Middle Easterners are familiar with the Red Crescent. The International Federation of Red Cross and Red Crescent Societies (IFRCS) are headquartered in Geneva, Switzerland and "act as a secretariat for the national Red Cross and Red Crescent Societies, and assist in disaster management and response." The IFRC supports national societies in disaster situations (Department of Defense, 2011). The ICRC is a world-wide organization that was established in 1863 (Red Cross, n.d.). The mission of the ICRC to "provide humanitarian help for people affected by conflict and armed violence and to promote the laws that protect victims of war" (Red Cross, n.d.). The Red Cross is an independent and neutral organization; its mandates stem from the law of armed conflict Geneva conventions of 1949 (Red Cross, n.d.).

a. National Red Cross or Red Crescent Societies

DOD (2011) stated, "The 186 recognized national Red Cross or Red Crescent Societies are auxiliaries of their governments; national societies assist in both disasters and conflict situations." Members of these societies can be seen at refugee camps and disaster relief centers.

b. Red Cross/Red Crescent First Assessment and Coordination Team

First Assessment and Coordination Team (FACT) "members have technical expertise in relief, logistics, health, nutrition, public health and epidemiology, psychological support, water and sanitation, finance and administration, as well as language capabilities" (IFRC, 2014).

FACT can deploy within 12–24 hours, for 2 to 4 weeks, this allows operations to begin while longer-term support is mobilized (IFRC, 2014). FACT is similar to the DART or FITTEST teams but without the same capability.

2. NetHope

A NGO consortium, NetHope's mission is to "act as a catalyst for collaboration, bringing together the knowledge and power of 41 leading international humanitarian organizations so that the best information communication technology and practices can be used to serve people in the developing world" (NetHope, 2014a). NetHope enables standard ICT and help desk capabilities as well as economies of scale through its Shared Services program to the aforementioned humanitarian organizations under six fundamental values (NetHope, 2014a):

- Technology matters.
- Benefiting all benefits one.
- Learning through collaboration.
- Build for the field.
- Bias for action.
- Trust above all else.

NetHope works with the UN-ETC to collaborate and provide ICT services for its member organizations (NetHope, 2014a). NetHope works with its member NGO's in a manner similar to how World Food Programme (UN-ETC lead agency) provides ICT services for the other UN cluster agencies. Additionally, NetHope has its own "FITTEST" team that immediately responds to disasters to establish ICT services for its member organizations known as the Emergency Response Working Group (ERWG) (NetHope, 2014b).

3. TÉLÉCOMS SANS FRONTIÈRES

Telecoms Sans Frontieres (TSF) was formed in the crucible of both the Balkans crisis and in Kurdistan in the aftermath of the first Gulf War in the 1990's (Telecoms Sans Frontieres, 2013). TSF's mission is to provide information and communication technology (ICT) support to both emergency humanitarian events (HE) (natural disaster and complex emergency) and non-emergency support to affected people and HE responders. Non-emergency support comes in the form of general ICT support to the United Nations (UN) and more specifically telecoms assessments support to the UN Disaster Assessment and Coordination (UNDAC) (Telecoms Sans Frontieres, 2013). TSF was named a "first responder" of the Emergency Telecoms Cluster in 2006 (Telecoms Sans Frontieres, 2014). During such missions, TSF provides emergency ICT services in three broad categories:

a. Humanitarian Calling Operations

TSF provides three minute, satellite based, phone calls free of charge to any HE affected family. This allows people to pass critical information status and location to loved ones during a time of crisis (Telecoms Sans Frontieres, 2013).

b. First Responder Emergency Telecommunications Centers

Simultaneously, TSF specialists,

> Establish emergency telecom centers for emergency responders. The centers offer—at no charge—broadband Internet access, voice communications, fax lines and all the IT equipment needed for a field office. These centers enable emergency NGOs, the UN agencies, and local authorities to communicate right at the heart of a crisis. They also facilitate the coordination of aid efforts. First responders use TSF's telecommunications services to communicate vital information, stay connected with headquarters and other emergency responders in the country who are often spread across a wide geographic area. Information management and sharing has become critical for an effective humanitarian response. (Telecoms Sans Frontieres, 2013)

c. Information and Communication Technology Assessments

Finally, the TSF rapid response teams also assist local governments and emergency response coordinators to perform ICT assessments of damaged areas. TSF uses its ICT experience to assist organizations and the effected nation to reestablish commercial networks or planning to build the ICT support infrastructure needed for the recovery stage following an emergency (Telecoms Sans Frontieres, 2013).

4. Humanity Road

Founded in 2010, Humanity Road uses Internet volunteers and tools to monitor social media to help save lives and reduce suffering.

> Humanity Road delivers disaster preparedness and response information to the global mobile public before, during, and after a disaster. Humanity Road is a leader in the field of online disaster response, providing social media disaster training and participating in both civilian and military communications exercises worldwide. Humanity Road support aid agencies and first responders during natural disaster and relay urgent needs to those who can response. (Humanity Road, 2014)

Humanity Road concentrates on unstructured social media posts and tweets to conduct social network analysis (SNA) to obtain actionable information (Humanity Road, 2014). While SNA is outside this thesis's concentration, Humanity Road is technically a mobile data collection organization when users use their mobile devices to Tweet or post to their Facebook and are worth mentioning.

5. Humanitarian Data Exchange

One hindrance to data sharing, aggregation, and processing to situational awareness (see Figure 1) is the inability to fuse incompatible raw data sets. Incompatible data sets will be defined and further discussed in the next section. The Humanitarian Data Exchange (HDX) is an initiative within OCHA that seeks to solve this problem. The goal of HDX is "to make humanitarian data easy to find and use for analysis" (Office for the Coordination of Humanitarian Affairs, 2014a). This initiative attempts to link collected raw data from various entities and sensors into one collective humanitarian assistance

repository (Office for the Coordination of Humanitarian Affairs, 2014a). While still in the pilot stage, the HDX effort continues along three lines:

a. Repository

Sensors and data providers can upload their "raw data spreadsheets for others to find and use" into the HDX repository (Office for the Coordination of Humanitarian Affairs, 2014a).

b. Analytics

HDX analytics is "a database of high-value data that can be compared across countries and crises, with tools for analysis and visualization" (Office for the Coordination of Humanitarian Affairs, 2014).

c. Standards

HDX has created an open source data standard called the Humanitarian Exchange Language (HXL) (Office for the Coordination of Humanitarian Affairs, 2014a). The goal of HXL is to create standards to help share humanitarian data through the use of the above HDX Repository and HDX Analytic tools (Office for the Coordination of Humanitarian Affairs, 2014a).

E. RAPID INFORMATION AND COMMUNICATION TECHNOLOGY ASSESSMENT TEAM

The Rapid Information and Communication Technology (ICT) Assessment Team (RTAT) concept was started out of the rubble of the 2010 Haiti earthquake as a way to improve disaster response (Steckler, 2009). The need to quickly assess the ICT environment post disaster has been recognized in nearly every major disaster event where immediate efforts were less than optimal due to the inability of respondents to communicate, much less collaborate, with each other (Donahue & Tuohy, 2006). All of the ICT organizations listed in paragraphs B, C, and D of Chapter II Literature Review have some ICT assessment expertise and responsibilities; none are independent, however, of the competing responsibility to set up their parent organization's ICT infrastructure (Steckler, 2009). RTAT has the sole mission to assess the post disaster ICT environment

and share those assessment results on an ongoing basis to the rest of the humanitarian assistance (HA) response community. RTAT's independent lens allows them to make unbiased ICT recovery prioritization recommendations to the HA response community on a continual basis (Steckler 2009). However, RTAT is a fledgling organization that has not perfected its processes and is not fully integrated into the rest of the HA response community (Cannon et al., 2012). This thesis will become a first step towards that end.

"The Rapid Technology Assessment Teams (RTAT) concept seeks to provide a pool of multi-disciplinary experts who will rapidly deploy to the disaster zone to provide" a holistic assessment of the ICT environment (Steckler, 2012). "While there are existing disaster assessment teams from major organizations that deploy to such events, these teams primarily focus on sector specialty areas other than ICT and Information Sharing" (Steckler, 2012).

Additionally, RTAT is not looking to add more data noise but to enhance and complete the information process shown in Figure 1. That is, an end-to-end solution that automatively processes its assessment data into a shared collective understanding of the ICT environment for better decision (Steckler, 2012).

F. FOUR CATEGORIES OF POST DISASTER ASSESSMENT DATA SETS

Nearly all of the aforementioned organizations have some ICT assessment form to accompany their rapid response teams (DART, FITTEST, FACT, ERWG, etc.). Information on the ICT environment is vital in the initial phases to enable better communication and collaboration. The existence of the assessment is not enough, "the timeliness and quality of assessments help determine an effective humanitarian response" (Office for the Coordination of Humanitarian Affairs, 2014a). Additionally, "experience has shown that there are significant benefits to coordinating needs assessments and that doing so can help save more lives and restore more people's livelihoods" (Office for the Coordination of Humanitarian Affairs, 2014a). Finally, this information must be shared with the people who can make decisions and enact change for the better (Office for the Coordination of Humanitarian Affairs, 2014a). Unfortunately not all assessments, and their corresponding data sets, are compatible. The UN categorizes assessments by the

degree to which they can be integrated with one another and hence aggregated into a collective common operational picture or understanding.

1. Coordinated Assessments

The UN describes *coordinated* assessments as,

> Those which are planned and carried out in partnership with other humanitarian actors, with the results shared for the benefit of the broader humanitarian community to identify the needs of the affected population of a humanitarian crisis. Such assessments range from inter and intra cluster/sector joint assessments to single agency assessments that are harmonized. (Inter-Agency Standing Committee 2011b)

Unless RTAT is absorbed by the UN-ETC, its assessments cannot be characterized as coordinated.

2. Harmonized Assessment

Harmonized assessments are conducted by external UN entities, but their assessment data set structures allow for their integration. The Humanitarian Data Exchange (HDX) initiative discussed earlier strives to put more data sets into this category.

> Data collection processing and analysis is undertaken separately, however the data is sufficiently comparable (due to the use of common operational datasets, key indicators, and geographical and temporal synchronization) to be compiled into a single database, and to serve as the subject of a shared analysis. (Inter-Agency Standing Committee, 2011b).

RTAT is striving to ensure data collected falls within this category.

3. Joint Assessment

Joint assessment is the aggregation or combining of multiple cluster reports into a single assessment.

The IASC (2011b) defined joint assessments as the "data collection, processing and analysis form one single process among agencies within and between clusters/sectors. This leads to a single report. This is sometimes also referred to as a

‘common assessment’” (Inter-Agency Standing Committee, 2011b). The Multi-Cluster/Sector Initial Rapid Assessment report, discussed in detail later, is an example of a joint assessment.

RTAT wants its collected data to be included in the UN-ETC ICT common operational picture.

4. Uncoordinated Assessments

In contrast to the above assessments, *uncoordinated* assessments are those in which “data sets are not interoperable, and the results cannot be used to inform the overall analysis” (Inter-Agency Standing Committee, 2011b). RTAT’s previous Excel assessment form fell into this category.

G. THREE CURRENT POST DISASTER ASSESSMENT FORMS

The literature reviewed revealed that nearly all of the aforementioned organizations have some sort of ICT assessment form or questions that pertain to the ability to communicate information. Unfortunately, these forms are not harmonized (integrated) with one another (Office for the Coordination of Humanitarian Affairs, 2014a). The current forms discussed below, however, were an important starting point for the RTAT ICT assessment form development and, as such, should be discussed.

1. United States Agency for International Development

United States Agency for International Development’s (USAID’s) *Field Operations Guide for Disaster Assessment and Response* Appendix II Assessments includes Section 12. Infrastructure, Subsection a. Communication with an itemized assessment checklist that has some similar items to Appendices G-J to include (United States Agency for International Development, 2005, p. II-54–II-57). Its areas include communication and electric power.

a. Communication

- Describe where the system's facilities are located.
- Determine the broadcast/reception area or zone of influence (e.g., towns serviced by the system).
- Identify the organization/firm responsible for operation and maintenance of the system.
- Is there a disaster response plan with identification of priority facilities, material supply, and priority screening of messages?
- Obtain technical information, such as:
    - Broadcast power.
    - Operating frequencies, call signs.
    - Relay/transmission points.
    - Hours of operation.
    - Standby power sources.
    - Mobile capability.
    - Repair/maintenance facilities, including capabilities of manufacturer's local agent.
- Language of transmission.
- Identify key personnel (owners, management, operations, and maintenance).
- Determine the degree of integration of military and civilian communications networks.
- Note the source(s) of the above information.
- Determine which communications facilities exist that are operable or easily repaired and could be used to pass on assessment information and assist in coordination of lifesaving responses.
- Identify the type of system assessed:
    - Radio.
    - Private ownership.
    - Commercial.
    - Broadcast.
    - Two-way.
    - Amateur.

    - Citizens band.
    - Public systems.
    - Police.
    - Armed forces.
    - Government agencies. (Which ministries have communications facilities?)
    - Telephone.
    - Cable and wireless.
    - Television.
    - Newspaper.
    - Other.
- Describe specific reasons why a system is not operating.
- Unavailability of:
    - Personnel.
    - Power.
    - Fuel.
    - Access to facilities.
- Damage to system:
    - Broadcast/transmission equipment.
    - Antennae.
    - Buildings.
    - Transmission lines.
    - Relay facilities.
    - Power source.
    - Other.
- Note source(s) of the above information.
- Outline options for restoring minimum essential services.
- Identify local/regional suppliers of communications equipment and materials available for repair. Check cost and availability.
- Determine the local/regional availability of technical services available for repair.

b. Electric Power

- Describe the power system, including:
  - Base load facility.
  - Peaking facility.
  - Number of units.
  - Fuel source.
  - Plant controls.
  - Output capability (specify voltage and cycle).
  - Mobile plants.
  - Other standby capability.
  - Switching facilities.
  - Transmission facilities.
  - Distribution facilities (number of substations).
  - Interconnections.
- Inventory auxiliary equipment that may be available locally (e.g., from construction companies).
- Determine why power is not available (i.e., at what point the system has been damaged).
- Ascertain the condition of generating units.
- Check the integrity of the fuel system.
- Determine whether towers, lines, and/or grounding lines are down.
- Assess the condition of substations.
- Outline the impact of power loss on key facilities, such as hospitals and water pumping stations.
- Describe the options for restoring minimum essential services.
- Ascertain whether load shedding and/or switching to another grid can restore minimal services.
- Identify local/regional suppliers of equipment and materials.
- Check the cost and availability.
- Determine the local/regional availability of technical services available for repair.

2. United Nations Assessments

This section includes four subsections: a. Assessment Phases, b. Situational Analysis, c. MIRA, and d. Disaster Assessment Coordination.

a. United Nations Assessment Phases

- Phase 1, the initial 72 hours: Initial assessments—Situational Analysis
- Phase 2, weeks 1–2: Rapid assessments.
- Phase 3, weeks 3–4: In-depth assessments.
- Phase 4, week 5 onwards: In-depth assessments, including recovery needs (Inter-Agency Standing Committee, 2011b).

Table 1 outlines the UN assessment reports due within each phase. RTAT works within phases zero (coordination and baseline) through phase two (weeks one and two post disaster).

	PREPAREDNESS	SAVING AND SUSTAINING LIVES AND RE-ESTABLISHING ESSENTIAL SERVICES		SAVING LIVELIHOODS AND RE-ESTABLISHING ESSENTIAL SERVICES	
TIMING	**PHASE 0** Before	**PHASE 1** 72 hours	**PHASE 2** Week 1-2	**PHASE 3** Week 3+	**PHASE 4** Second month +
RECOMMENDED TYPE OF COORDINATED ASSESSMENT	Coordinated Assessment Preparedness	Initial Assessment for Preliminary Scenario Definition	Multi Cluster/Sector Rapid Assessment	Single Cluster/ Sector Coordinated In-depth Assessments, harmonized across Clusters/Sectors (any single agency assessments should be coordinated by Cluster/Sector Coordinators)	Continued Single Cluster/ Sector Coordinated In-depth Assessments, with (early) Recovery considerations, harmonized across Clusters/Sectors (any single agency assessments are coordinated by Cluster/Sector Coordinators)
		MIRA (Multi-cluster Initial and Rapid Assessment)		Continued Inter-Cluster/Sector Assessment Coordination	
ASSESSMENT TYPE & PURPOSE	Coordinated assessment preparedness planning and gathering pre-crisis data	Initial Assessment to • Estimate scale & severity of the impact of the event • Locate affected populations • Inform initial response decisions • Inform Phase-2 rapid assessments	Rapid assessment to • Inform initial planning of humanitarian response, highlighting priority actions • Define focus for follow-on in-depth assessments • Establish the baseline for monitoring	In-Depth Assessment to: • Analyze situation and trends • Adjust ongoing response • Inform detailed planning for humanitarian relief/early recovery, • Establish baseline for operational and strategic / performance monitoring	In-Depth Assessment to: • Situation and trend analysis • Inform phasing out of the life sustaining activities • Inform detailed planning for humanitarian relief and (early) recovery • Feed into performance monitoring
METHODOLOGY FOR DATA COLLECTION	• Prepare and agree on assessment formats, indicators and tools • Organize preparedness trainings and if possible simulations • Establish procedures & responsibilities. • Prepare Common Operat'l Datasets (CODs), P-Codes, and Key Humanitarian Indicators • Gather Baseline data • Fact sheets and lessons learned disasters	• Mostly secondary data: pre-crisis information, surveys and reports prior to the event, fact sheets. • Primary data: initial reports from the field, media flyovers, satellite imagery. Direct observation from quick visits to field (if feasible). Information from still functioning monitoring and reporting systems • Use Initial CODs	• Secondary data; various sources • Primary data as in phase 1, complemented by site visits purposively selected, conducting community / key informant interviews • Unit of measurement for site visits is Community (e.g. village, camp or neighborhoods), or Institutions (e.g. schools, health facilities). • Use simple agreed form with key questions • Use Expanded CODs and Key Humanitarian Indicators	• Secondary data; various sources • Use harmonized sector/cluster specific tools • Primary data as in phase 2, but now site visits through purposive and representative sampling methods (using more detailed sectoral surveys questionnaires). • New data from (re)-established monitoring systems • Unit of measurement as in phase 2, but now also household & individual. • Use Comprehensive CODs, Key & comprehensive humanitarian indicators	• Sources and Methods as in Phase 3 • For recovery assessment use additional guidance for recovery assessment (Damage and Loss Assessment and sectoral PDNA guidance) • In case of complex emergencies; conflict analysis
INFORM FUNDING PROPOSALS	• Proposals for preparedness	• Allocation of preliminary emergency funding • Initial Flash Appeal • First response proposals	• Emergency response proposals • Revision of Flash Appeal (occurs within one month of Initial Flash Appeal)	• Revised emergency response proposals. • National Recovery and Reconstruction Plan	• Nat'l Recovery & Reconstruction Plan • Consolidated appeal. • Inputs for the Post Disaster Needs Assessment
OUTPUTS	• Assessment preparedness plan agreed by HCT • Compiled pre-crisis data • Humanitarian Dashboard	• Preliminary Scenario Definition (within 3 days) • Humanitarian Dashboard	• MIRA Report (within 14 days) • Humanitarian Dashboard	• Sector/Cluster Reports • Humanitarian Dashboard	• Sector/Cluster Reports • PDNA & Recovery Framework • Humanitarian Dashboard

Table 1. IASC Phase Assessment Reports (from Inter-Agency Standing Committee, 2011b)

b. UN Situational Analysis (Phases 1–2)

A Situational Analysis (SA) report provides,

> An initial overview of the situation, priority humanitarian needs and information gaps. It informs the Strategic Statement and the initial decision-making about scale and resource allocation. The SA should be updated regularly, until the next phase of the assessment is complete. (Office for the Coordination of Humanitarian Affairs, 2013b).

This report is typically conducted by the earliest responders such as the UNDAC teams and FITTEST within the UN-ETC sector (Office for the Coordination of Humanitarian AffairsOffice for the Coordination of Humanitarian Affairs, 2013b). Situational Analysis assessment includes the following (Office for the Coordination of Humanitarian AffairsOffice for the Coordination of Humanitarian Affairs, 2013b):

- Drivers of the crisis and underlying factors
- Scope of the crisis and humanitarian profile
- Status of populations living in affected areas
- National capacities and response
- International capacities and response
- Humanitarian access
- Coverage and gaps
- Priority needs

c. Multi-Cluster Initial Rapid Assessment

The UN Multi-Cluster Initial Rapid Assessment (MIRA) is an assessment product of the UN's Inter-Agency Standing Committee (IASC) and is completed by the IASC's Needs Assessment Task Force (NATF) (Inter-Agency Standing Committee, 2012). MIRA is joint assessment of the IASC clusters and is designed to,

> Identify strategic humanitarian priorities during the first weeks following an emergency. The main benefit of the MIRA is the elaboration, from the onset of the crisis, of a concerted operational picture based on the best information available from primary and secondary sources. This picture is expressed through two key products: a preliminary scenario definition, issued 72 hours after the disaster's onset, and a MIRA Report, released after 2 weeks. (Inter-Agency Standing Committee, 2012).

MIRA assesses crises along eight axes (Office for the Coordination of Humanitarian AffairsOffice for the Coordination of Humanitarian Affairs, 2013b):

- Drivers of the crisis and underlying factors.
- Scope of the crisis and humanitarian profile.
- Status of populations living in affected areas.
- National capacities and response.
- International capacities and response.
- Humanitarian access.
- Coverage and gaps.
- Priority needs.

Unfortunately, MIRA is a broad overarching assessment that does not yield the specific detail to meet all the needs of the RTAT stakeholders.

d. United Nations Disaster Assessment Coordination Team Assessments

UN Disaster Assessment Coordination (UNDAC) teams deploy within 48 hours of disaster and they contain sector experts from each of the clusters. Therefore, UNDAC teams are a primary means for Phase 1 Situational Analysis assessments and have a large supporting role in future MIRA reports (Office for the Coordination of Humanitarian Affairss, 2013b). Additionally, UNDAC teams have a "primary responsibility to assist the government of an affected country in its decision making through the identification and prioritization of needs for international disaster relief assistance" (Office for the Coordination of Humanitarian Affairs, 2013b). "UNDAC teams must develop an adequate and efficient structure and flow of information to disseminate the analysis of emergency needs to national authorities and other disaster responders in a timely manner" (Office for the Coordination of Humanitarian Affairs, 2013b). RTAT looks to help facilitate the ICT portion of this information flow.

UNDAC reports include the following (Office for the Coordination of Humanitarian Affairs, 2013b):

- Summary (highlights and key issues).
- Situation (general description of the situation, response and recent incidents).

- Coordination overview:
  - Overall coordination mechanisms in place, both national and international.
  - Summary of meeting times and frequency.
  - Constraints in coordination.
- Operational considerations:
  - Relief entry point.
  - Logistical constraints in relief delivery.
  - Relief delivery issues (e.g., customs information).
  - Special administrative concerns.
  - Security issues.
- Urban search and rescue (USAR) activities (only applicable in USAR phase):
  - Number of teams, name and sending area/country.
  - Differentiation between national and international response.
  - Areas covered/not covered.
- Cluster overview:
  - List of operation clusters.
  - Overview of coordination within clusters.
  - Specific details for each operational cluster under new headings.
  - Clearly identified national response in each cluster.
  - List of relief provided or in the pipeline for each cluster.
- National response:
  - Other national response not covered in the cluster section.
- Bi-lateral response:
  - In-kind contributions.
  - Cash contributions.
- Other:
  - Other issues of interest not applicable in the above mentioned headings.

- General context of the situation.
- Attached maps and lists where applicable, or included in the report itself.

The FITTEST teams reside within the UN-Emergency Telecommunication Cluster (UN-ETC). FITTEST teams are the primary means of assessing ICT infrastructure in the early phases. FITTEST teams have the added responsibility to establish infrastructure to facilitate emergency inter and intra UN agency communication. RTAT looks to assist FITTEST teams by conducting ICT assessment while they concentrate on establishing communication means (Steckler, 2009).

No explicit ICT assessment checklist was found in either the Situational Analysis or MIRA report. Nor could a standalone ICT checklist for either the UNDAC or FITTEST teams be located. One question was located within the Logistics checklist of Annex Z of *UNDAC Handbook* (2013b) in regards to logistical communication.

No explicit ICT assessment checklist was found in either the Situational Analysis or MIRA report. Nor could a standalone ICT checklist for either the UNDAC or FITTEST teams be located. However, one question was found within the Logistics checklist of Annex Z of *UNDAC Handbook* (2013b) in regards to logistical communication:

> "Communications: Do telephone and/or radio systems exist? What is their reliability/usefulness? Is there cell phone coverage? If yes; what system, i.e., roaming or procurement of scratch cards?" (Office for the Coordination of Humanitarian Affairs, 2013b).

The World Food Programme, UN-ETC lead agency, also has a section on ICT assessment within their *Field Operations Pocketbook*.

3. World Food Programme Emergency Field Operations Pocketbook

Section 11.4 Information and Communication Technology (ICT) of World Food Programme's (WFP's) Emergency *Field Operations Pocketbook* stated that responders should monitor various items, to include (World Food Programme, 2002, p. 280–281):

- Telephones:
    - Normal phones: coverage and reliability of the network; whether all offices are connected.
    - Mobile phones: coverage and reliability of the network(s); which offices/staff are using them
    - Satellite phones: whether each office has one; as of security phase 2, the security focal point and the CD should each have a satellite phone
    - in their residence
    - Faxes: which offices have fax machines and are able to send/receive
- Radios:
    - WFP/UN radio room(s): the location(s) and hours of operation.
    - HF/VHF radios: which offices, vehicles and individuals have them?
    - VHF base stations and repeaters: locations.
    - Lightning protection: whether all radio equipment with external antennas is protected.
    - Local technical support: availability and quality of service; availability of spare parts.
- IT Environment:
    - The numbers of functioning desktops, laptops, printers; whether there is a local area network (LAN).
    - E-mail services: whether offices have 'Notes' connectivity and deepfield mailing (DFMS)
    - Anti-virus software; Whether installed on all computers; the regularity of updating
    - Local technical support: availability and quality of service; availability of spare parts
- Electric power:
    - The local power grid: hours that power is available; its reliability and stability
    - Whether UPS stabilizers are installed to protect equipment
    - Back-up capacity: generators, solar panels, batteries

Table 2 is a synopsis of WFP's minimum communication requirements based on phases, as indicated above, based on the phases of relief above.

Minimum Security Telecommunication Support by Security Phase

- The standards indicated below are minimum standards. Local security and operational conditions might require offices to deploy more telecommunications equipment than foreseen in these minimum standards.

PHASE 0					
Country offices	**Field offices**	**Vehicles**	**Staff**	**Procedures**	**TC staffing/ stocks**
One satellite telephone per country office		*For each country:* one key vehicle equipped with HF, VHF and GPS	Handheld radio for every head of section/ department	Monthly radio checks for all staff with hand-held radios	
One UN or WFP repeater covering the town area			Each head of section/ department is properly trained in the use of telecommunications equipment	Monthly HF radio check	
PHASE 1 - AS PHASE 0, PLUS:					
A VHF security channel established in each operational area	A VHF security repeater channel is established in each operational area	*For each field office:* one key vehicle equipped with HF, VHF and GPS		Technical maintenance programme in place	Contingency telecommunications stocks as required for maintenance and potential move to phase 2/3
Established HF communications channel with dedicated network control for operations outside the VHF range All HF radios use selcall scanning	Established HF communications channel with dedicated network control for operations outside the VHF range All HF radios use selcall scanning			Installed backup power systems for repeaters and base radios Standard operating procedures established for radio room	
One UN or WFP operational radio room capable of 24h/7d				Vehicle tracking notes departure and arrival of each vehicle Weekly VHF Radio Check Daily HF Radio Check between bases	

- 'Key vehicles' are the vehicles necessary for field operations, or for operations outside of the town/area perimeter, or the vehicles required for a full staff evacuation (on the basis of 4 people per vehicle), whatever the greatest number.

PHASE 2 & 3 – AS PHASE 1, PLUS:					
Country offices	**Field offices**	**Vehicles**	**Staff**	**Procedures**	**TC staffing/ stocks**
One UN or WFP radio room is operational 24h/7d	Access to 24h/7d communications monitoring (satellite telephone or other	All vehicles equipped with VHF	Hand-held VHF radio provided to all staff members working outside the office	Vehicle tracking notes the departure and arrival of each vehicle and checks the position every 30 minutes	Country-specific radio network maintenance facility (phase 3)
Satellite telephone for the CD and security focal point	Satellite telephone in each office	All key vehicles equipped with HF using selcall scanning	Staff trained in the use of GPS, HF and VHF, and selcalls	Use of HF selcalls is mandatory	Contingency telecommunications stocks as required for maintenance and potential move to phase 4/5
For each country: a pool of two GPS units is available (stand-alone or combined with HF radio)	*For each field office:* one GPS unit is available (stand-alone or combined with HF radio)			As of phase III: daily VHF radio check for all hand-held users	As of phase 3, dedicated radio operators in each field office
	As of phase 3: radio room has dedicated staff during working hours				
PHASE 4 & 5 – AS PHASES 1, 2 AND 3, PLUS:					
		For each office: at least two key vehicles available, each equipped with VHF and HF radio		Communications limited to traffic essential to the mission	
		In phase 5, at least two passengers per car have a hand-held radio			

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Table 2. World Food Programme Communication Requirements by Phase (from WFP, 2002, pp. 282–283)

H. ENTERPRISE ARCHITECTURE ANALYSIS

According to the capability maturity model integration (CMMI) model, system requirements analysis must be done before designing a solution (Huang & Lien, 2012). The Enterprise Architecture Analysis marks the starting point for the discovery stage of the COE. Appendix B includes a detailed enterprise architecture assessment for RTAT; however, definitions and highlights are included in this section.

1. Enterprise Architecture

Ross, Weill and Robertson (2006) defined Enterprise Architecture as,

> The organizing logic for business processes and IT infrastructure, reflecting the integration and standardization requirements of the company's operating model. The enterprise architecture provides a long-term view of a company's processes, systems, and technologies so that individual projects can build capabilities—not just fulfill immediate needs. Companies go through four stages in learning how to take an enterprise architecture approach to designing business processes: Business Silos, Standardized Technology, Optimized Core, and Business Modularity [see Figure 6]. As a company advances through the stages, its foundation for execution takes on increased strategic importance. (p.9)

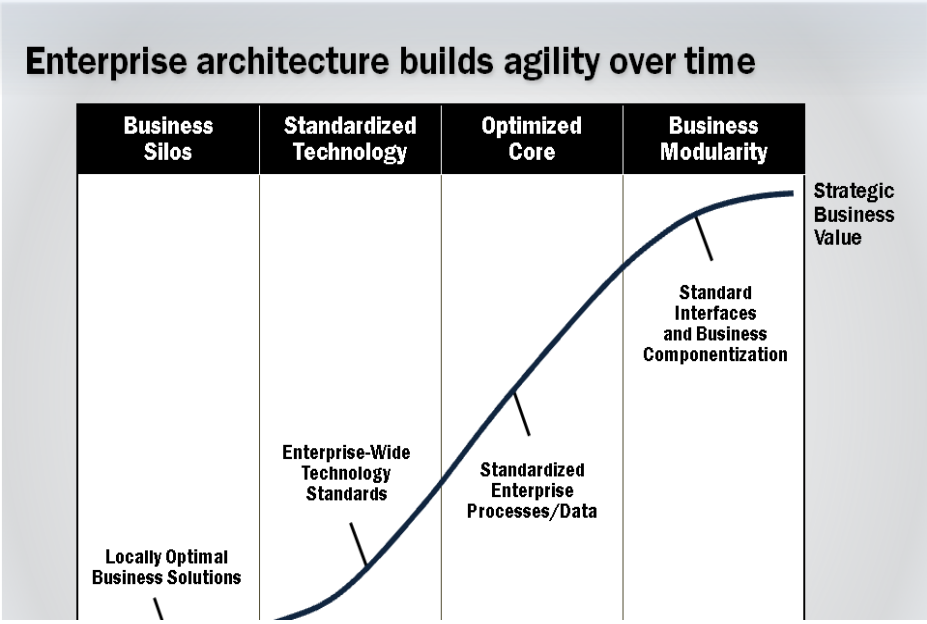

Figure 6. Four Stages of Enterprise Architecture Maturity (from Ross et al., 2006, p. 72)

Summarily, the RTAT "enterprise" is defined as the people, equipment and processes associated with the collection, storage and promulgation of pre and post disaster ICT data collection (Beeson, 2013).

2. Operating Model

Ross et al. (2006) stated, "The operating model is the necessary level of business process integration and standardization for delivering goods and services to customers" (p. 8). Figure 7 breaks up the different operating models to be discussed in a 2 X 2 matrix based on the levels of business process integration and process standardization between units in an organization.

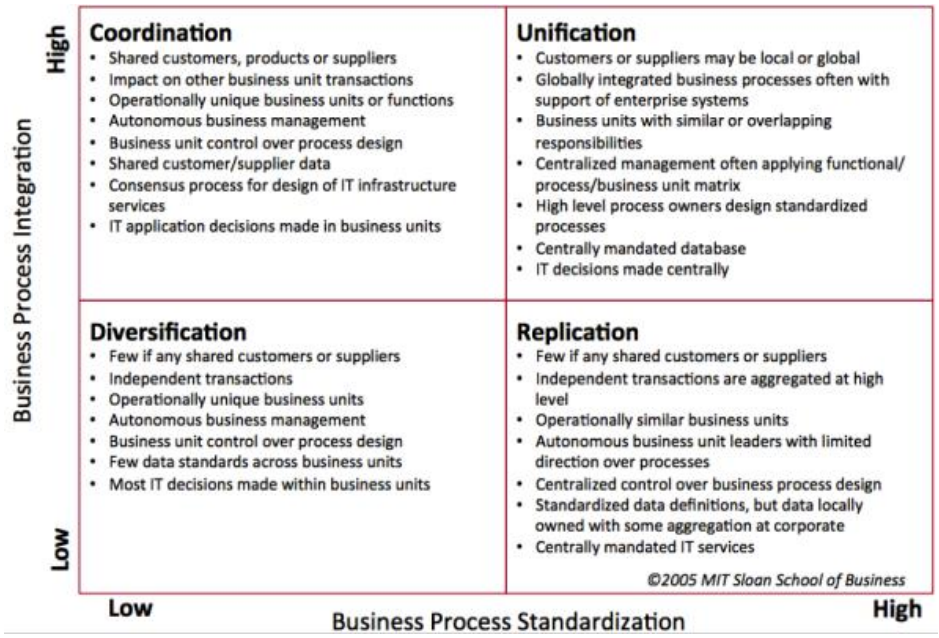

Figure 7. Four Operating Models with Description (from Ross et al., 2006, p. 39)

RTAT is trying to improve standardization within the organization and within the forms, as well as become more integrated with other HA organizations thereby increasing its organizational agility, see Figure 8 for this shift (Beeson, 2013).

a. Standardization

With the use of standardized capabilities (gear), the developed mobile data collection tool (standard data forms) and standardized training (how qualitative questions within the forms are assessed), RTAT hopes to improve, standardize, and add value to its assessments with the HA community.

b. Integration

Integration is defined as the ability of stakeholders (Pacific Disaster Center) to seamlessly import and display RTAT collected assessment data in a value added, intuitive, easily understood manner to the end-use customer (UN-ETC and other NGOs).

RTAT seeks to increase the standardization of its processes from a diversified to a replication organization, see Figure 8 for this movement.

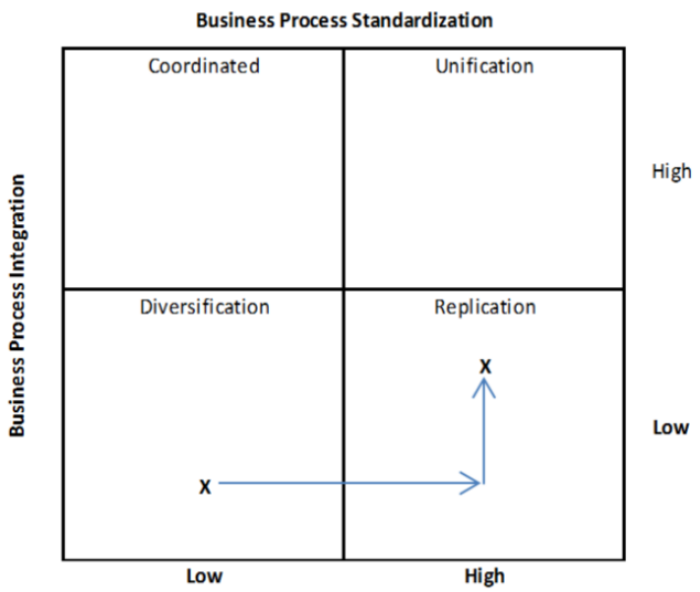

Figure 8. Shift from Diversification to Replication Operating Model (after Ross et al., 2006, p. 39)

a. Agility

Agility is the ability to get assessment information in the hands of those who need it and the ability to re-task as required within the ICT assessment realm. Agility includes

time training assessors, speed and accuracy of assessment, speed and ability to send assessment information to end users, and the ability to modify forms quickly as need arises.

RTAT currently uses a Microsoft (MS) Excel spreadsheet that is manually updated by subject matter expert (SME) assessors and emailed to other team members and organizations. RTAT has agreed upon the questions to ask and the items to assess, but they have not agreed to their associated standard answer/assessment metrics. The current MS Excel spreadsheet method does not expeditiously collate the raw data and export processed information. To obtain actionable information from RTAT, an individual must collect all of the spreadsheets and individually review each one. This is a painstakingly, time consuming process that does not work when time equates to lives lost.

In response, RTAT is looking into alternatives that will better meet the current and future data collection, processing, and sense-making needs. In the process, RTAT has discovered that it needs to change its operating model to remain relevant (Beeson, 2013). To enable this operating model change, RTAT is seeking an IT solution that will foster standardization while enabling integration.

This developed IT solution must enable RTAT to efficiently collect and distribute baseline/post-disaster ICT information in (near) real time. (Near) real time is situational dependent but should be less than 1 hour from collection by RTAT to receipt by the end-use customer (UN-ETC/NGO). Potential IT solutions will be discussed later; all available options, however, require a data connection to work. This is problematic because the ICT infrastructure is typically in ill-repair in a post disaster scenario. HA organizations have been experimenting with and developing Hastily Formed Network (HFN) concepts and technologies to cope with this problem. Before exploring the technologies, RTAT wanted to examine its processes. Savvion process modeler was chosen to do this.

I. SAVVION BUSINESS PROCESS MANAGEMENT

Savvion is a comprehensive, model-based business process management (BPM) system that empowers a user to build and simulate business process alternatives (Aurea,

n.d.). Savvion (2006) has identified that, "The first step in improving a business processes is to articulate precisely where bottlenecks exist, and the most efficient way to do that is by simulating existing processes using business process modeling software."

Based on input, Savvion calculates the cost (time and or monetary) of the created business process map (Figure 6). This enables a quantitative comparison of alternatives. Savvion delivers real-time, context-relevant insight into critical business operations and tools to change business rules and logic (Aurea, 2014). Savvion was used to simulate and improve the RTAT assessment business processes; detailed results are included in Chapter III and in Appendix C. Figure 9 shows a screen capture of the RTAT old "as is" assessment business process using Savvion.

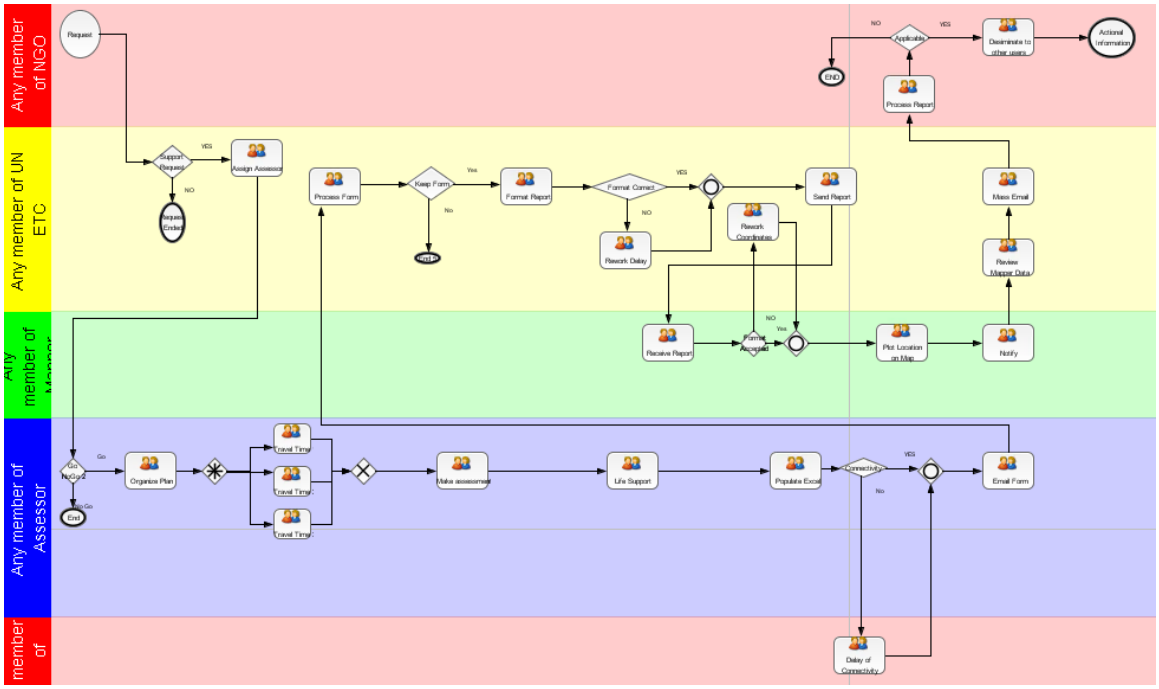

Figure 9. Savvion RTAT Old "As Is" Business Process (from Beeson, Gladem, & Gonzalez, 2014)

Starting in the top left portion of Figure 9, a member of a responding NGO needing information requests the UN-ETC to conduct an ICT assessment at a particular site or region of interest. UN-ETC requests support from RTAT who assigns one of three available teams to support. The team conducts the assessment using the outdated Excel

spreadsheet and manually inputs GPS coordinates via an external device. Completed assessments are emailed to the UN-ETC for quality assurance and map plotting. Errors and ambiguity are sent back to the RTAT for correction and or clarification. Once reviewed and plotted by the UN-ETC, results are shared with the requesting NGO via email dissemination. Review and rework are the largest sources of delay, outside of RTAT travel to the assessment site. Manual, point-to-point email is the least desirable form of information sharing; if collaboration, and a collective shared understanding of the operational environ is desired (Office for the Coordination of Humanitarian Affairs, 2014a).

J. HASTILY FORMED NETWORK

All RTAT means of forwarding the ICT assessment require an Internet connection. This section will discuss how RTAT can leverage hastily formed network organizations, gear and procedures to obtain an Internet connection within a disaster zone.

1. Wireless Mesh Network

Wireless mesh networks is the term used to describe the ability of devices to automatically connect to other networks within a network. Akyildiz, Wang & Wang (2005) explained,

> Wireless Mesh Networks (WMN) offers an inexpensive, quickly deployable, stable and fault tolerant solution for wireless coverage, requiring zero maintenance. The WMN based on (IEEE standard) 802.11(s) is most popular due to easily available and inexpensive radios. There are currently many implementations of wireless mesh networks based on 802.11(b,g,n) hardware. All of these (solutions) run some proprietary mesh protocol at the network layer.

Furthermore, WMNs provide:

> [n]etwork access for both mesh and conventional clients. The integration of WMNs with other networks such as the Internet, cellular, IEEE 802.11(b,g,n), IEEE 802.15 (WIMAX), IEEE 802.16, sensor networks, etc., can be accomplished through the gateway and bridging functions in

> the mesh routers. Mesh clients can be either stationary or mobile, and can form a client mesh network among themselves and with mesh routers. (Akyildiz et al., 2005).

Any individual or organization with a Wi-Fi device (laptop, phone, etc.) within range, on the move or stationary, can access the WMN and the support and/or reach back capability that it offers. WMNs can quickly and cheaply replace failed host nation infrastructure and are a key enabling component to hastily formed networks.

2. Hastily Formed Network

Hastily formed network (HFN) is a type of hyper-network that is

> (a) put together quickly in response to an emergency, crisis, or urgent situation (b) from a collection of entities who have expertise or local responsibility to help but have not worked together before (c) and who accept no higher decision-making authority. (Denning & Hayes-Roth, 2006).

The lack of a recognized, over-arching authority may further compound the ad hoc/complex nature of disaster relief. Like "networks" and "hyper networks" defined above, HFNs are a composition of both the organizational make up and their equipment.

a. Hastily Formed Network Organization

HFN's are neither a hierarchy nor flat organization, but an ecosystem or a federation of organizations with a shared purpose (Denning & Hayes-Roth, 2006). HFNs may be made up of a loose federation of hierarchical organizations, but success depends on their ability to create a collective "network" that shares more in common with 'edge' organizations, as defined later by Alberts and Hayes (2003). Denning (2000) further described a HFN as "the newest form of a hyper-network, having the special characteristic that the participants have little time to learn and adapt before producing results" (Denning, 2000). According to Denning (2000),

> An HFN has five elements: it is (1) a network of people established rapidly (2) from different communities (3) working together in a shared conversation space (4) in which they plan, commit to, and execute actions, to (5) fulfill a large, urgent mission.

Furthermore, "HFNs must employ organizational forms compatible with the nature of the organizational challenges at that level. Decentralized decision making and a focused sharing of high value situation information should be base principles" (Denning, 2000). Successful HFN organizational forms are more similar to "Edge" organizations as described in Alberts and Hayes's (2003) classic book, *Power to the Edge* than hierarchical organization typical of the military or most host nation governments. Alberts and Hayes (2003) described entities on an organizations edge as those on the "tip of the spear," on the edge of the empire, and or in direct contact with the customer. People on the edge have the most up to date, local, situational awareness and should be empowered with the right information, tools, equipment and authority to enact rapid decisions and change. Alberts and Hayes (2003) described this process in *Power to the Edge*. Edge organizations are empowered with the ability to smart pull of resources and information (Alberts & Hayes, 2005, p. 119). Suppliers in edge organizations must post information and available assets and resources for the consumers to pull (Alberts & Hayes, 2003, p. 119). This is similar to a Craig's List or eBay posting format that efficiently links resources to needs and suppliers with consumers.

b. Hastily Formed Network Equipment

Denning (2000) asserted, "The heart of the (HFN) network is the communication system… and the ways they (participants) interact within it. We call this the 'conversation space' of the HFN." Denning (2000) continues that conversation space is made of three key aspects: "(1) a medium of communication among (2) a set of players (3) who have agreed on a set of interaction rules." The physical equipment systems vary greatly from humanitarian event (HE) to event. Some are brought by nongovernmental organizations for specific tasks, but, by definition, the HFN quickly becomes a compendium of ad hoc meshed networks brought to bear by the collective. Figure 10 shows the various puzzle pieces (systems, procedures, etc.) required for an HFN and includes power systems, as well as cellular, Internet, radio, and communication means (Steckler, 2009).

The RTAT collection tool will leverage HFN technologies.

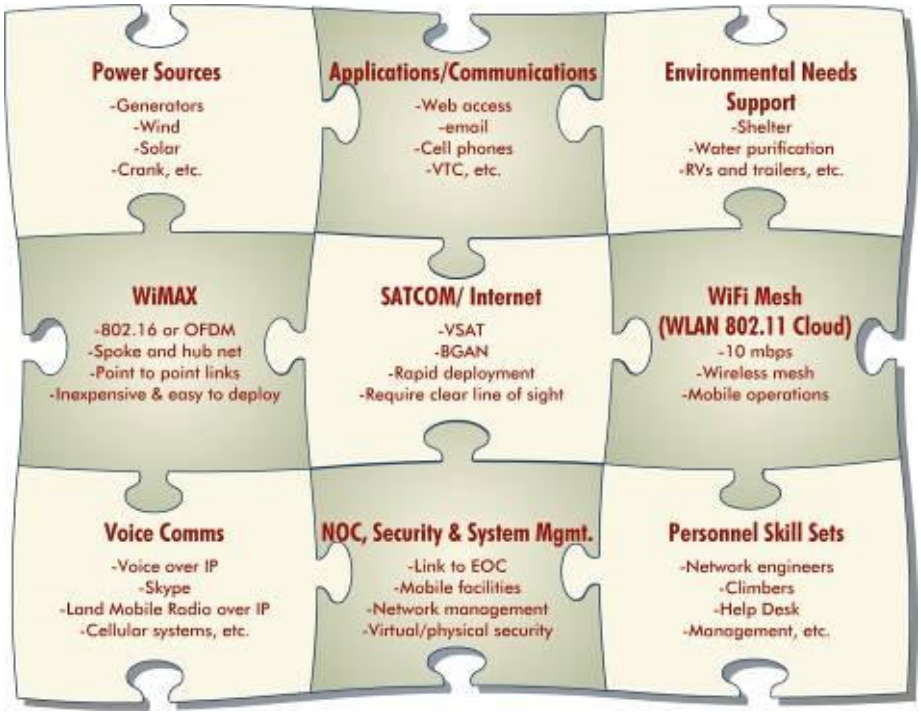

Figure 10. Hastily Formed Network (HFN) Puzzle Pieces (from Steckler, 2009)

K. MOBILE DEVICE OPERATING SYSTEMS

Several competing operating systems in the mobile (smart) device arena currently exist. Competitors include: Microsoft Windows Mobile, Symbian Operating System (OS), Research In Motion Blackberry OS, Apple iPhone OS (iOS) and the Android™ OS. Currently, iOS and Android make up 94 percent of this market, justifying further study.

1. iPhone Operating System

iPhone Operating System (iOS) was created for Apple's iPhone in 2007 in response to Windows Mobile, Palm OS, Symbian, and BlackBerry (Verge Staff, 2014). Apple revolutionized the smart phone market through its innovative use of the capacitive touch screen. Apple removed all but five physical buttons and perfected its touch screen to allow multi-touch commands such as "pinch-to-zoom and inertial scrolling to make apps feel more natural and immediate" (Verge Staff, 2014). Additionally, Apple integrated iOS into its Apple ecosystem that included iTunes and the Apple Appstore; this combined with its ultra-usability propelled iOS to the forefront of the smart phone

market (Verge Staff, 2014). Unfortunately, iOS is available only on Apple products and the Appstore has a more rigorous vetting process for the creation of third party applications than other competing operating systems and has inadvertently limited the mobile data collection applications as a result.

2. Android Operating System

The Open Handset Alliance (OHA) Android™ initiative was created as a way to cost effectively develop a mobile device operating system. While Google is the lead entity of the OHA, there are a total of 84 technology and mobile companies contributing. These entities include: Acer, ASUS, HTC, Huawei, LG, Kyocera, Motorola, Samsung, Sony and ZTE to name but a few (Open Handset Alliance, 2014). OHA created Android as an open source operating system to promote the smart phone market and get the most out of emerging cell phone technologies. According to Reed (2014), Android makes up approximately 46 percent of smart device operating systems; however, research has shown that market share estimates vary slightly by source and time frame (Figure 11). What is clear is that Android has been increasing its market share over the years, especially in developing nations and is poised to take over the smart phone market in 2014 (Levine 2014). Currently, Android phone shipments make up approximately 85 percent of smart phone market, but that could change with the scheduled release of the iPhone 6 in fall 2014 (Levine, 2014).

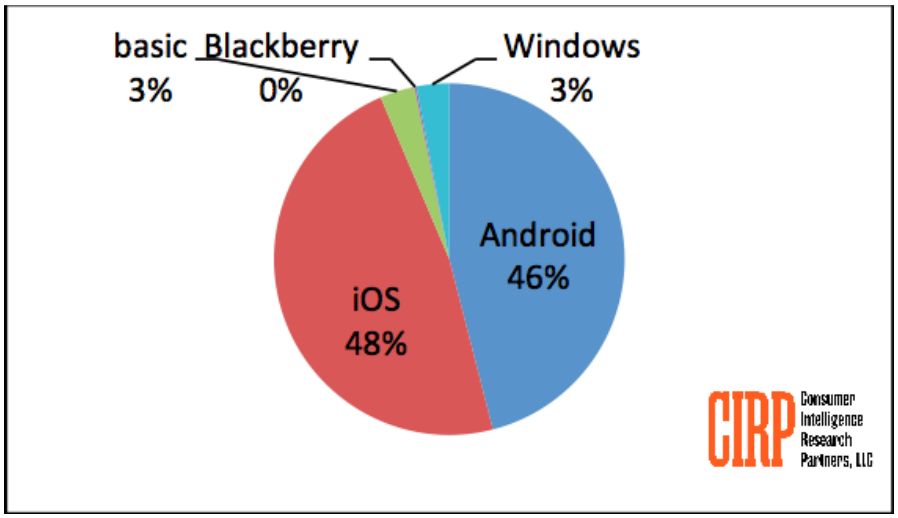

Figure 11. Mobile Device Operating System Market Share (from Reed, 2014)

Android allows a user to download applications (app(s)) that interface with certain capabilities organic to the device. These capabilities include: Camera (video and still), microphone, GPS, network (cellular and Wi-Fi), touch screen capacitance, accelerometer, memory, and the device's computing power. Any user can create their own Android compatible application (Lighthouse is one such example) using the OHA standards, or the user can simply download the appropriate application from an app store such as GooglePlay or Amazon (Open Handset Alliance, 2014). The One Platform Foundation (OnePF) tracks over 30 popular app stores and found that GooglePlay makes up about 1/3 of the market with approximately 2.5 billion downloads/month (One Platform Foundation, 2014). In comparison, the next largest competitor is Tencent at 300 million/month and Amazon accounts for comparatively low 25 million downloads (One Platform Foundation, 2014). Comparatively, iOS users download approximately 1.56 billion applications from Apple's App Store every month (Levine, 2014).

L. MOBILE DATA COLLECTION METHODS

Historically, data collection methods in undeveloped areas or disaster zones have been lacking and reliant upon paper forms in interview or checklist assessment format. Unfortunately, the paper forms require additional processing to collate their associated information into a data base for further refinement that enables logical and cogent

delineation of needs and decisions. With the advent of laptops and Personal Digital Assistants (PDA), some forms have been migrated to electronic format. The formats can be integrated into data base formats, but their forms require extensive programming or understanding of the software to do so. Additionally, these forms typically could not update information in (near) real-time. With the "proliferation of smartphones, low cost mobile connectivity with good coverage and availability of several data collection applications that can work around the connectivity concerns, pen-paper surveys are now being replaced by mobile based data collection applications" (Gupta, Thapar, Singh, Srinivasan & Vardhan, 2013).

Mobile phone data collection options fall into three main methodologies, Electronic Form Interface, Short Messaging Service (SMS) + Cue Card Interface, and Voice Interface (Patnaik, Brunskill, & Thies, 2013). The strengths and weaknesses for each are outlined in Figure 12.

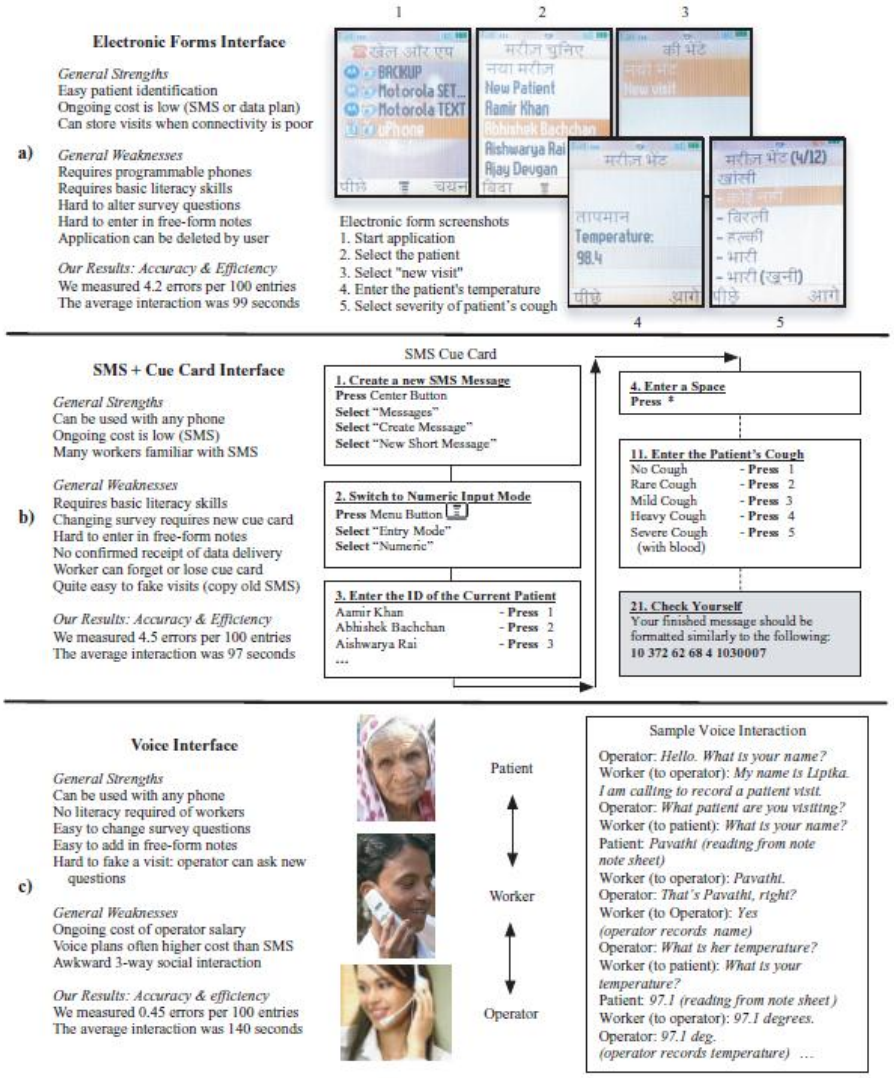

Figure 12. Mobile Phone Data Collection Methods (from Patnaik et al., 2013)

1. Electronic Form Interface

The term "electronic forms" denotes "any external application that can be placed on a phone and that automatically guides the user how to enter data, through the use of text, menus or other tools" (Patnaik et al., 2013). The term "developed electronic form interface" is interchangeable with mobile data collection tool/platform, RTAT tool, or by its associated application Lighthouse or Open Data Kit (ODK) Collect, to be discussed later.

2. Short Messaging Service + Cue Card

Patnaik et al. (2013) referred to Short Messaging Service (SMS) as "data collection systems that involve information entered by a structured text message: in particular we assume that the information is entered by following a small cue sheet with a flowchart that directs the collector how to enter the data." This method assumes a SMS (text) service works in the area being assessed.

3. Voice Interface

Voice interface relies upon a voice connection and an interviewer to collect information. Gupta et al. (2013) found that voice interface is the most accurate of the three methods when answers are relayed to a live person or by voice mail. They require only a basic phone. Questions and answers can be modified or explored further and the education level and training of the interviewer is the lowest of the methods (Gupta et al., 2013). Unfortunately, the method relies upon a working phone network that may not be available in a post disaster environment. Further, voice takes up more bandwidth than SMS, and small data transmissions leading to interruptions in calls and voice services are typically more expensive than SMS services in developing regions. For these reasons, Voice Interface was not further considered for RTAT.

M. AVAILABLE MOBILE ELECTRONIC FORM INTERFACES

NOMAD (n.d.-a and b) and MobileActive (2013) have extensive listings of available Mobile Data Collection Platforms; below is an overview of pertinent platforms.

Chapter III includes an extensive discussion as to how the final platform was selected. The basic mobile data collection tool requirements include:

- Small form factor.
- Ruggedized.
- Android compatible.
- Free to develop and use.
- Ability to make and tailor forms quickly and easily.
- KML file exportable (importable into a database).

- GPS location enabled
- Able to take and include photos.
- Skip logic pattern supportable (able to ask/skip questions based previous answers).
- Not restricted to SMS (text message) only.
- Forms must be stored on the device until they can be opportunistically uploaded when a data connection is available.

1. The HumanitariaN Operations Mobile Acquisition of Data

The HumanitariaN Operations Mobile Acquisition of Data (NOMAD) is a non-governmental organization (NGO) project that "links organizations with the latest information management tools to more easily collect, analyze and manage data" (HumanitariaN Operations Mobile Acquisition Of Data, 2012). NOMAD utilizes its Online Selection Assistant (OSA) to connect organizations with one of 39 established mobile data collection (MDC) solutions (HumanitariaN Operations Mobile Acquisition Of Data, 2014). Participants are asked a series of questions regarding their requirements and the OSA returns viable options for further research, test and evaluation. According to NOMAD (2014), established MDC tools include:

> Acquee, COMMANDmobile, CommCare, CommTrack, CSPro, CyberTracker, DevInfo, do Forms, droidSURVEY, Enketo Smart Paper, EpiCollect, FrontlineSMS, Fulcrum, GeoChat, GeoPoll, Humanitarian Data Toolkit, Imogene, iSURVEY, KoBo, Last Mile Mobile Solution, Magpi, Majella Insight, Mobenzi Researcher, Nokia Data Gathering system, Oasis Mobile, Open Data Kit, openXdata, Pendragon, Poimapper, PSI Mobile—Fusion, RapidSMS, RDMS, Smap, SoukTel, Telerivet, ViewWorld, Voxiva, and Wepi.

One notable popular disaster information management solution is Ushahidi's CrowdMap. Ushahidi is a Kenyan based initiative and its CrowdMap differs from the listed mobile data collection tools in that it uses a "crowd-sourced data aggregation paradigm... Data aggregators collect unstructured data found as posts to services such as Twitter, Facebook, email, and SMS, and they mine this data for information (Jung, 2011). In contrast,

> Mobile data collection systems run designed surveys which collect specific information from a target audience. The audience can be either organizational staff trained to conduct surveys/assessment or the target population being studied can be surveyed directly via their personal mobile devices. In either case, the specific questions and structured responses can be important to rapidly collecting information deemed essential to an emergency response. (Jung, 2011).

Developers of the aforementioned established tools are allowed to update their tool's information within the OSA to ensure the latest information. The results for free, Android operating systems, with Keyhole Markup Language (KML) output options are outlined in the next sections.

2. Android Options

Android is a product of the Open Handset Alliance (OHA), led by Google (Open Handset Alliance, 2014). Android currently makes up approximately 46 percent of smart device operating systems and has been slowly increasing its market share (Reed, 2014). The following sections briefly discuss the Android compatible mobile data collection (MDC) tool applications that HumanitariaN Operations Mobile Acquisition Of Data (NOMAD) suggested for further research by the NOMAD Online Selection Assistant (OSA) program. Full OSA results are available from the author upon request.

a. Open Data Kit

According to Brunette, Sundt, Dell, Chaudhri, Breit, and Borriello (2013),

> Open Data Kit (ODK) is an open-source, modular toolkit that enables organizations to build application specific information services for use in resource-constrained environments. ODK is one of the leading data collection solutions available and has been deployed by a wide variety of organizations in dozens of countries around the world.

ODK has a robust community of practice and Google group forum located at https://groups.google.com/forum/#!forum/opendatakit-developers. In addition, Developmental support is available for a fee if required. ODK is a suite of systems that include the following tools:

- Build: ODK Build enables users to generate forms using a drag-and-drop form designer. Build is implemented as an HTML5 web-based application and targets the common use case of a simple form" (ODK, 2014).
- Collect: ODK Collect is a "powerful phone-based replacement for your paper forms. Collect is built on the Android platform and can collect a variety of form data types: text, location, photos, video, audio, and barcodes" (ODK, 2014).
- Aggregate: ODK Aggregate "provides a ready to deploy online repository to store, view and export collected data. Aggregate can run on Google's reliable and free infrastructure as well as on local servers backed by MySQL and PostgreSQL" (ODK, 2014).
- Form Uploader: ODK Form Uploader facilitates the uploading of a blank form and its media files to ODK Aggregate (ODK, 2014).
- Briefcase: ODK Briefcase is "the best way to transfer data from Collect and Aggregate" (ODK, 2014).
- Validate: ODK Validate "ensures that you have an OpenRosa compliant XForm—one that will also work with all the ODK tools" (ODK, 2014).
- XLS2XForm: ODK XLS2XForm allows XForms to be designed using MS Excel (ODK, 2014).

b. Lighthouse Application

The Naval Postgraduate School's (NPS) Common Operational Research Environment (CORE) lab developed Lighthouse. Lighthouse leverages the above ODK technologies (ODK Build forms and ODK Aggregate) to collect, aggregate and display spatial data on a common operational picture (COP) display. This data can then be further analyzed using social network analysis (SNA) tools to develop a better understanding of the commonalities and groupings of events and data sets. In the context of the DOD, Morganthaler and Summers (2011) defined SNA as "a type of applied art where social science and mathematics are integrated to flesh out the strategic options within both the kinetic and non-kinetic approaches of a counterinsurgency campaign" (p. 10). These tools have been used by the CORE lab with success in Iraq, Afghanistan, and Thailand to combat improvised explosive device (IED) threats and to better understand insurgent cells (Bumatay, & Graeber, 2014). While SNA is out the scope of this thesis, these tools can be used to link cellular providers with tower locations, determine hardest hit disaster

areas, and even piece together the structures/areas that remain the most resilient for later research. Ushahidi, mentioned above, is a SNA tool.

Unfortunately, Lighthouse only works for Android operating system based devices and thus will not work for 54 percent of smart device users (Reed, 2014). Further, Lighthouse is not available in the GooglePlay store making distribution and installation of the application difficult. Lighthouse, however, is supported by the NPS CORE lab staff and they were instrumental in the development of the early RTAT forms. Unfortunately, due to budget restraints and operational commitments, updates to the Lighthouse application have not kept pace with feature developments of the ODK Forms. Further Lighthouse developments have been halted in favor of the development of a Hypertext Mark Up Language 5 (HTML5) based solution that is operating system independent and will work on both Google's Android and Apple's iOS.

A direct competitor to Lighthouse is Open Data Kit (ODK Collect).

c. Open Data Kit Collect

Like Lighthouse, "ODK Collect is a mobile platform that renders complex application logic and supports the manipulation of data types that include text, location, images, audio, video, and bar-codes" (Hartung, Anokwa, Brunette, Lerer, Tseng, & Borriello, 2010).

ODK Collect is available on the GooglePlay store and works with the created ODK Build forms and can be synched to the CORE lab's ODK aggregate server, just like Lighthouse. ODK Collect solves the distribution and update problems of Lighthouse. ODK has an extensive wiki and online community of practice, but their level of support does not match that of the CORE lab's walk-in face to face help when it comes to form building.

Like Lighthouse,

> ODK Collect renders forms into a sequence of input prompts that apply form logic, entry constraints, and repeating sub-structures. Users work through the prompts and can save the submission at any point. Finalized submissions can be sent to (and new forms downloaded from) a server. Currently, ODK Collect uses the Android platform, supports a wide

> variety of prompts (text, number, location, multimedia, barcodes), and works well without network connectivity. (Open Data Kit Collect, 2014)

d. Field Information Support Tool

As Longley (2010) explained,

> The Field Information Support Tool (FIST) is a field data-collection system using commercial-off-the-shelf (COTS) smartphones, customized software, and a robust information management backend known as FusionPortal with a deployable sensor fusion system known as FusionView that enables information to flow from the point of capture to an analyst in near real-time regardless of location or physical proximity.

FIST is free for a Naval Postgraduate student to develop, RTAT would be expected to pay, however, for ongoing future support. FIST became a pay for service option when it expanded the Lighthouse data collection capability into a more robust social network analysis platform.

e. CyberTracker

According to NOMAD (n.d.-a),

> CyberTracker is a downloadable solution for mobile data collection that can be implemented on PalmOS, PocketPC, Windows Mobile or Android. The CyberTracker designer enables the creation of graphical collection forms, originally targeted at non-literate animal trackers. No coding is required and it automatically generates the required database schema in MS (Microsoft) Access. CyberTracker exports data in 14 formats including ESRI Shape file. CyberTracker can send data from mobile device or smartphone to remote FTP (File Transfer Protocol) site.

CyberTracker Consists of a Desktop Windows Application to design sequences to use in the mobile application, a Mobile Application (see Figure 13) to capture data and another Desktop Windows application to query, visualize, and export the data using Microsoft (MS) Access (CyberTracker, 2014).

Figure 13. CyberTracker in use (from CyberTracker, 2014)

Forms are customizable, but there is no ability to use skip logic (CyberTracker, 2014). Photos can be manually added to the database only after the form has been uploaded thus necessitating a two-step processes (CyberTracker, 2014). The requirement to manually attach a photo after upload in the database and physically attach the device to a laptop/desktop to manually download a assessment file to the computer for export gives the tool low marks for usability. Additionally, Cybertracker has no way of synching downloaded assessments or resuming a download should the link between the computer and the server be disconnected. The supportability of CyberTracker is minimal with no established community of practice or wiki.

f. Humanitarian Data Toolkit

NOMAD (n.d.-a) stated,

> The Humanitarian Data Toolkit (HDT), developed by Internews and Modi Research Group at Columbia University, is a ruggedized, self-contained data collection toolkit that makes it possible to conduct rapid mobile and paper based data collection and analysis in an off-line and off-grid environment. The HDT consists of a laptop running a local instance of the Formhub data collection software, a scanner, Wi-Fi network and phones that fit in a carry-on sized Pelican case and an additional portable solar panel / battery that are able to reliably power the toolkit when electricity is

> not possible. Powering the HDT is Formhub, an open source mobile data collection platform, bamboo, a data analytics service, both developed by the Modi Research Group, and Captricity service that rapidly converts paper forms into structured data. In the HDT, these tools are integrated together make it possible to author a survey offline in Excel, collect data using Android phones/tablets, offline enabled webforms and paper forms, with all data managed in a central place where they can be quickly analyzed in almost a real-time basis allowing responders to make quick, evidence-based decisions on how best to intervene.

Unfortunately, this system does not meet the small form factor (laptop, scanner, solar panel, etc.) requirements of the on-the-go assessor model and was not considered further (Figure 14).

Figure 14. Humanitarian Data Toolkit (Humanitarian Data Toolkit, 2014)

3. iPhone Options

The NOMAD OSA program was used to narrow the Apple iOS compliant mobile data collection tool options, with the following results: Fulcrum, GeoChat, Majella and ViewWorld. All three were iOS compliant, but all three required payment for their use in the scale required by RTAT (HumanitariaN Operations Mobile Acquisition Of Data, n.d.-b). Full OSA results are available upon request.

a. Fulcrum

Fulcrum allows a user to "create, deploy, and manage field data collection apps for iPhone, iPad, and Android" (MobileActive, 2010). Fulcrum includes a web-based

drag-and-drop app designer for creating customized survey forms to control the data captured from the field. Fulcrum has offline mobile support but there is a charge for its services (MobileActive, 2010). As of August 6, 2014, plans go from $29/month for one user to $749/month for 50 users (Fulcrum, n.d.).

b. GeoChat

GeoChat is,

> A collaboration tool that allows users to chat, report, and get alerts on their phone that can be represented on a map. It facilitates a slightly different communication paradigm based on collaboration rather than one way data collection. Geochat is an open source solution that supports GeoRSS, KML and http API's on any mobile device. (HumanitariaN Operations Mobile Acquisition Of Data, n.d.-b)

GeoChat is an interesting way to track personnel and simple data points; the system, however, was not supported like the Open Data Kit community, and it is better suited to track personnel with simple data messages such as: "I'm here," "I'm going to __," or "Send Help!"

c. Majella

"Majella Insight is a complete Mobile Data Collection and Integration System" (HumanitariaN Operations Mobile Acquisition Of Data, n.d.-b). Majella provides a "secure cloud application and the ability to collect and integrate data on both a web and mobile mapping application" CSV, XML, KML and PDF export formats (HumanitariaN Operations Mobile Acquisition of Data, n.d.-b).

d. ViewWorld

ViewWorld is a plug and play mobile data collection platform hosted in the cloud, designed for organizations collection data in harsh conditions" (HumanitariaN Operations Mobile Acquisition Of Data, n.d.-b). ViewWorld is an end-to-end solution that allows a user to create a form, collect data, and view the data on a web console (HumanitariaN Operations Mobile Acquisition Of Data, n.d.-b). Results can be exported to the web, social media, or on line map (HumanitariaN Operations Mobile Acquisition Of Data,

n.d.-b). Data can also be manipulated on ViewWorld's dashboard with simple visual analytics such as graphs and pie charts (HumanitariaN Operations Mobile Acquisition Of Data, n.d.-b). ViewWorld's API facilitates data exportation into various data formats (HumanitariaN Operations Mobile Acquisition Of Data, n.d.-b).

e. ***Data***Keep

A Formhub/Open Data Kit based application is available in the Apple appstore called DataKeep. Released in March 2014, DataKeep version 1.01 is a free XForm format compatible application. Like ODK Collect, DataKeep allows forms to be retrieved from and returned to any setup server, Formhub or ODK Aggregate for example. Unfortunately, this application does not support all XForm features like ODK Collect and does not work with developed RTAT forms (iTunes App Store). The application, therefore, would not work with established servers. This application may become a viable option once all ODK Form features are incorporated into DataKeep.

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III. RESEARCH METHOD

This chapter documents a campaign of experimentation to develop an improved mobile data collection tool for the Rapid Information and Communication Technology (ICT) Assessment Team (RTAT) organization and mission. This chapter will explain what a campaign of experimentation is and what was done at each stage of the campaign to research, develop, test, analyze and ultimately demonstrate a viable RTAT solution.

A. CAMPAIGN OF EXPERIMENTATION

Alberts and Hayes (2002) stated that the objectives of experimentation are "to develop and refine innovative concepts of operation and to coevolve mission capability packages to turn these concepts into real operational capabilities. One experiment cannot possibly achieve this objective. Rather, it will take a well-orchestrated experimentation campaign consisting of a series of related activities to accomplish this" (p. 16). Alberts and Hayes (2002) further described the linking of several related experiment, discovery, hypothesis and /or demonstration experiments, in a systematic and coherent manner to achieve a much larger end state goal as an "experimentation campaign" (p. 25). Alberts and Hayes (2002) explained that an experimentation campaign is,

> A series of related activities that explore and mature knowledge about a concept of interest…experimentation campaigns use the different types of experiments in a logical way to move from an idea or concept to some demonstrated military capability. Hence, experimentation campaigns are organized ways of testing innovations that allow refinement and support increased understanding over time. (p. 25).

Simply put, "Campaigns of experimentation explore and mature knowledge about a subject" (Hudgens & Bordetsky, 2009). Elaborating further on campaigns of experimentations, Alberts and Hayes (2002) stated,

> Campaigns (of experimentation) are designed to provide comprehensive insight across a set of related issues. The focus of campaign planning is to ensure that each important aspect of force capability is addressed and that no critical issues are overlooked. As a result, the various axes of the experimentation campaign employ a range of conditions and methods for investigating different types of issues. The fundamental planning question

> for an experimentation campaign is: 'Are we addressing all of the important aspects of the problem?' (p.45)

Alberts and Hayes (2005) characterized COE experimentation activities within three categories: discovery, hypothesis and demonstration (pp. 72–76).

1. Discovery Experiments

Alberts and Hayes (2002) defined discovery experiments as those experiments that "involve introducing novel systems, concepts, organizational structures, technologies, or other elements to a setting where their use can be observed and catalogued" (p. 9). Further, "discovery experiments are designed to generate new ideas or ways of doing things. They seek to create opportunities for individuals and organizations to 'think outside the box' and thus to stimulate creativity" (Alberts & Hayes, 2005, p. 73). The result, product, or output of a discovery experiment "is a promising idea or approach (Alberts & Hayes, 2005, p. 73).

2. Hypothesis Testing

Alberts and Hayes (2002) stated, "hypothesis testing experiments are the classic type used by scholars to advance knowledge by seeking to falsify specific hypotheses (specifically if then statements) or discover their limiting conditions" (p. 22). Alberts and Hayes (2005) continue that,

> Depending on the nature of the hypotheses tested, this type of experiment provides 'proof' that a theory, idea, or approach is valid; establishes its value under specific conditions; establishes the exceptions and limits of its application or utility; and establishes a degree of credibility. (p. 75).

3. Demonstration Experiments

Alberts and Hayes (2005) explained demonstration experiments as a, "venue in which known truth is recreated…They are used to show potential customers that some innovation can, under carefully orchestrated conditions, improve efficiency, effectiveness, or speed" (p. 75).

B. RAPID INFORMATION COMMUNICATION TECHNOLOGY ASSESSMENT TEAM CAMPAIGN OF EXPERIMENTATION

Following Alberts and Hayes's (2002, 2005) campaign of experimentation model outlined above, this section describes a campaign of experimentation to research, explore and mature mobile data collection technology and methodology. The specific goal for this COE is a working mobile data collection tool for the RTAT organization and mission.

Alberts and Hayes (2005) stated, "campaigns of experimentation (COE) should generally move along an axis that takes them from discovery experiments to preliminary hypotheses experiments, to refined hypotheses experiments, and finally, when the state of knowledge is mature enough to support serious policy and acquisition decisions, to demonstration experiments" (p. 77). Naturally, COE flows in three stages from the discovery stage and investigation phase to the demonstration stage. Below is a listing of the actions taken during the RTAT COE within each stage. Details for each action follow in sections within each stage heading.

1. The Discovery Stage

- Research and literature review
- Enterprise architecture analysis
- Mobile data collection tool prototyping
- Mobile data collection tool analysis of alternatives

2. Investigative Stage

- Savvion process modeling
- Legazpi City field experiment

3. Demonstration Stage

- Typhoon Haiyan field deployment
- Joint Interagency Field Exercise (JIFX) 2014–4

C. THE DISCOVERY STAGE

The discovery stage is marked by research and discovery experiments which "are meant to provide the inspirational spark that gives life to a new piece of knowledge or a disruptive innovation—a spark that would otherwise not occur or occur at some unknown time in the future" (Alberts & Hayes 2005, p. 78).

The research purpose for the discovery stage was to assess current RTAT data collection methods, organization and processes and to explore possible alternatives that might better serve the RTAT organization.

It was discovered early in this stage that the current MS Excel assessment solution needed to be replaced (Beeson, 2013). At the conclusion of the discovery stage, RTAT selected Android based smart phones and Open Data Kit (ODK) for form development and integration and RTAT had a working prototype assessment form for experimentation in the Investigative Stage. Actions taken during the Discovery Stage included:

1. Research and Literature Review

Research related to the humanitarian assistance (HA) response community (HARC), formal and informal organizations, as well as various related topics are included in the literature review.

2. Enterprise Architecture Assessment

The author conducted an enterprise architecture analysis of RTAT to understand the organization, what it does, and what it wants to accomplish; this is outlined in greater detail in Appendix B. Strategic outputs of the assessment include: RTAT mission statement, stakeholder analysis, operating model, and operating model change recommendations; the COE and its developed RTAT solution must meet the strategic vision of this assessment. Stakeholders judge the success and failure of the RTAT solution.

a. Organization Mission

The mission of RTAT is: "Conduct and promulgate baseline and post-disaster Information Communication Technology (ICT) infrastructure assessments, in order to facilitate host nation and international disaster relief efforts" (Steckler, 2012). "Facilitate" includes the management and dissemination of a shared common operational picture and ICT recovery prioritization recommendations (Beeson, 2013).

b. Stakeholder Analysis

Several stakeholder organizations are associated with RTAT which include: United Nations (UN) Emergency Telecommunication Cluster (UN-ETC), Association of Southeast Asian Nations (ASEAN), Pacific Disaster Center (PDC), U.S. Pacific Command, the Naval Postgraduate School, as well as other HA governmental and non-governmental organizations (NGO) (Steckler, 2012).

c. Operating Model Analysis

As discussed in the literature review, RTAT must move from a *Diversification* model with low process integration between teams and with stakeholders and low standardization of processes to a *Replication* operating model with integration minimally with Pacific Disaster Center and standard processes enabled by an enterprise wide mobile data collection tool solution. Figure 15 is an adaption from Ross, Weill, & Robertson's (2006) *Enterprise Architecture as a Strategy* "characteristics of four operating models" and graphical depicts this proposed change (p. 29). Further explanation can be found in Appendix B.

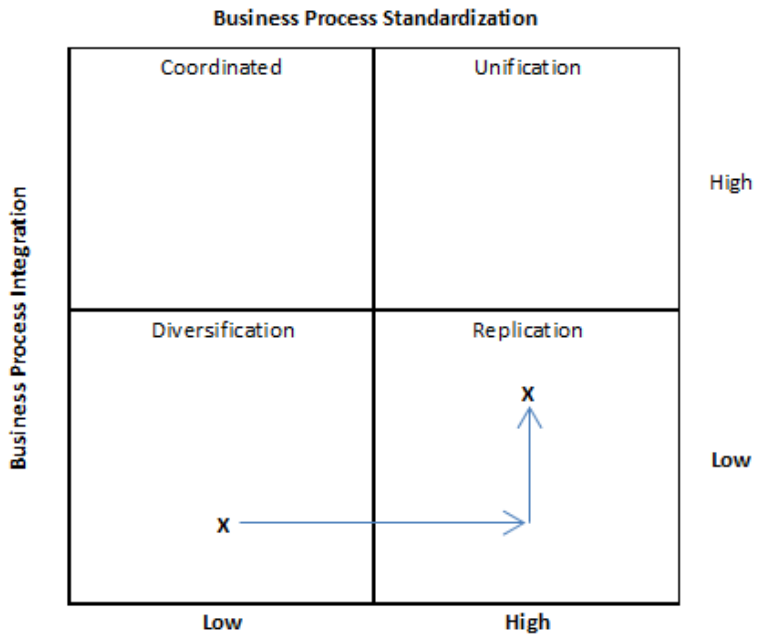

Figure 15. RTAT Recommended Change in Operating Model (after Ross et al., 2006, p. 29)

d. Enterprise Architecture Assessment Conclusions and Recommendations

Standardizing and refining the assessment forms in a query-able format is the top priority of the RTAT architects. This enables the forms to be programmed into an envisioned mobile data collection tool solution (Beeson, 2013).

Concurrently, RTAT must integrate their data with Pacific Disaster Center to take advantage of their DisasterAWARE website information dissemination capabilities.

Team training, and standardization of "go-kits" is a low priority recommendation, but some training must be conducted to test the various versions of the RTAT assessment tool for validity and refinement (Beeson, 2013).

3. Mobile Data Collection Tool Prototyping

It was concluded early in the project that concluded that a MS Excel form modification would not meet the requirements of the enterprise architecture assessment recommendations nor leverage available technologies, see Appendix B for greater

explanation. As a consequence, the author created individual ODK Collect prototype assessment forms for each ICT category, based on Appendices G–J. The author used an iterative, spiral development strategy to prototype and refine these assessment forms. The author used the spiral development strategy because not all requirements for the form and mobile data collection tool were established from the outset; and new requirements emerged through the course of the COE (Hawthorne & Lush, 2002). Further, a spiral development strategy provides,

> [t]he opportunity for interaction between the user, tester, and developer. In this process, the requirements are refined through experimentation and risk management, there is continuous feedback, and the user is provided the best possible capability within the increment. Each increment may include a number of spirals. (Hawthorne & Lush, 2002)

This strategy forces interaction feedback early and often from RTAT teams. The multiple prototype tests also lines up the multiple experiments required in the COE thesis strategy. See Figure 16 for a spiral development diagram, note the use of multiple prototypes and tests to flesh out the requirements and develop the product. Prototype 1, 2, etc. of Figure 16 could be replaced by the various experiments (Legazpi City, Typhoon Haiyan, etc.) for RTAT tool development, or the various RTAT form versions (e.g., rtat_mobile_assessment_philippines_130924, v4, v5) found in the "RTAT Assessment Form Development" section below.

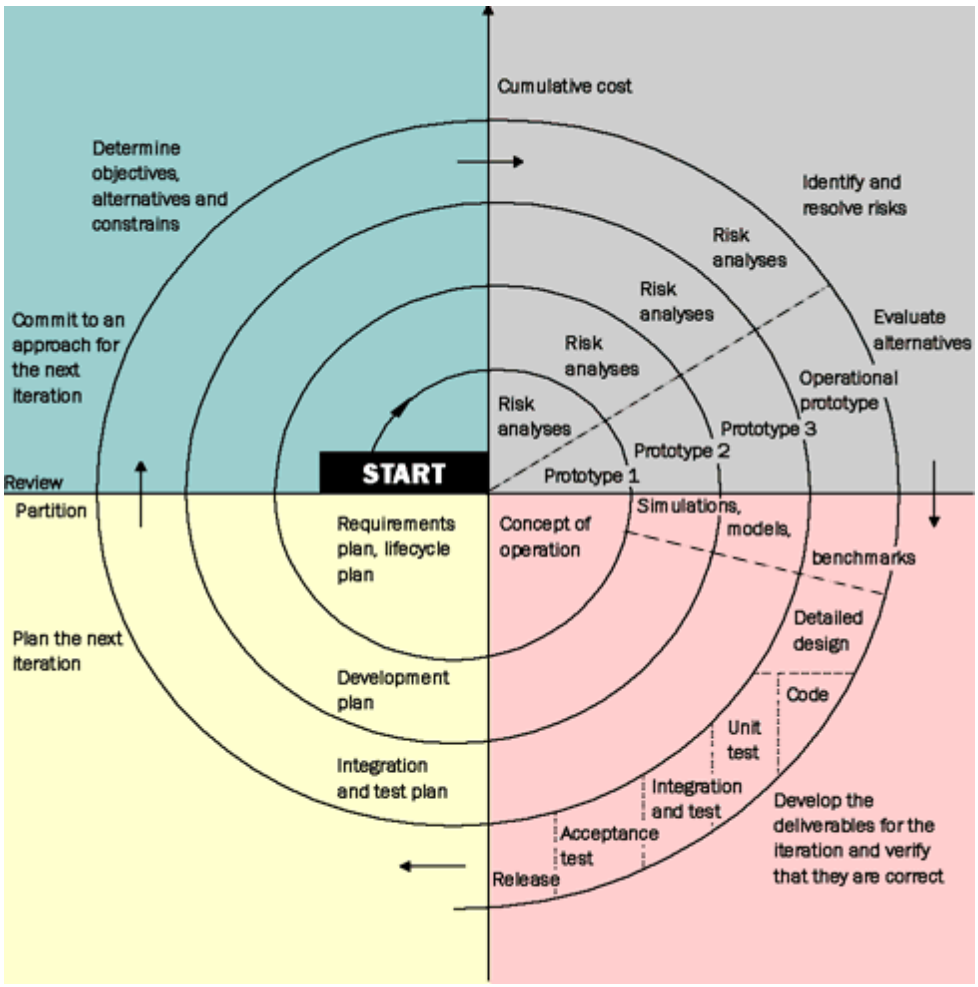

Figure 16. Spiral Development Diagram (from Osmundson, 2014)

The "Mobile Data Collection Tool Analysis of Alternatives" and "RTAT Assessment Form Development" sections found below give more information on form development. The lack of RTAT development funding was the single most significant factor for tool development (B. Steckler, personal communication, September 3, 2014). According to Brian Steckler, RTAT plans to charge zero dollars for its services hence any solution must be free to develop and operate (personal communication, September 3, 2014).

4. Mobile Data Collection Tool Analysis of Alternatives

The author attempted to modify the then current MS Excel RTAT assessment form spreadsheets found in Appendices G-J to improve their *practicality*. Practicality

here means a intuitive, user friendly interface and data is integrated easily into the larger humanitarian assistance community. All initial attempts failed to convert the Appendices G-J into a relational database.

This initial failure suggested that current processes were outdated, and that the campaign of experimentation should move to the hypothesis testing phase, to investigate whether a mobile device (i.e., a smart phone) solution might prove better.

In response, the author spoke informally with several people working with various aspects of disaster response, researched via the various academic papers, Internet search engines related to disaster response and smart device application (app) stores for potential alternatives to MS Excel. Various applications were downloaded from the app stores for first impressions. The analysis of alternatives included the use of the HumanitariaN Operations Mobile Acquisition of Data (NOMAD) Online Selection Assistant (OSA) to both expand and narrow the field of potential mobile data collection tool options. More information on NOMAD and the OSA can be found in Appendices E, F and Jung's (2011) *Mobile Data Collection Systems a review of the current state of the field research report*. NOMAD and the analysis of application alternatives will be explored later.

a. Requirements

Rapid Information and Communication Technology (ICT) Assessment Team (RTAT) mobile data collection requirements include: Small form factor, rugged, free to develop and use (no formal budget), ability to make and tailor forms quickly and easily, KML file exportable (importable into a database), GPS location enabled, ability to include photos, skip logic pattern supportable (able to ask/skip questions based previous answers), not restricted to SMS (text message) only, and ability for forms to be stored on the device until they can be opportunistically (when data connection is available) uploaded.

b. Selected Operating System: Android

After analyzing the capabilities and limitations of the various operating systems, Google's Android OS was down-selected during the analysis of alternatives for development for several reasons.

- **Compatible device availability:** Availability of free Android based Samsung S2/S3 and Google Nexus devices within Naval Postgraduate School's Hastily Formed Network (HFN) Lab and Common Operational Research Environment (CORE) lab enabled form development and testing. This was the single largest factor in this decision.
- **Support**: Recent research, development and use of the CORE Lab's Android based data collection tool Lighthouse enabled better direct development support.
- **Android market share**: Research in the literature review found that Android's market share has been steadily increasing over iOS in recent years especially in developing countries where the tool would most likely be employed.
- **Free data collection platforms**: Availability of free mobile data collection platforms such as ODK Collect and Lighthouse enabled form development without financial cost. Cost was the single largest deciding factor.

c. Selecting the Data Collection Application: Lighthouse and ODK Collect

The researcher utilized the HumanitariaN Operations Mobile Acquisition of Data (NOMAD) OSA feature to help narrow the field of options. NOMAD (n.d.-a and b) contained a detailed list of questions asked, results, and detailed comparison between valid application options. Three RTAT requirements narrowed the field to the final three contenders: Open Data Kit, CyberTracker and Humanitarian Data Toolkit (HDT).

- **Android operating system**: The operating system requirement narrowed the field to 33 options. This requirement stems from the availability of Android operating systems available and the lack of project funding to purchase unlocked iPhones.
- **Keyhole Markup Language (KML) export file format**: This requirement narrowed the field to 10 options. KML is one of the file formats supported by the Pacific Disaster Center (PDC) to import spatial data sets for display on its DisasterAWARE website (personal communication with T. Bosse August 11, 2014). This website link is critical for the attainment of RTAT's end state goal

of a shared ICT environment situational understanding via a current operational picture (COP) visual display.

- **Cost (free)**: As discussed in the previous section, this requirement narrowed the field to the final three (B. Steckler, personal communication, September 3, 2014).

As discussed in the literature review, the Humanitarian Data Toolkit was not selected due to its form factor size, which includes a laptop, scanner and printer, as well as a handheld device, see Figure 14.

CyberTracker did not have the community support comparable to ODK Collect and the forms that could be created could not incorporate the complex skip logic of "If any ___ selected then ___" or "If any but ___ selected then___." CyberTracker has form development support available for purchase, but this violated the third requirement above.

As a consequence the Open Data Kit suite of tools was down selected for RTAT form and mobile data collection tool development and will be further discussed below.

The discovery stage hypothesis became: an ODK based solution would better meet the needs of RTAT and would enable desired organizational operating model changes.

5. RTAT Assessment Form Development

To test the above hypothesis, ODK forms needed to be created.

RTAT forms are intended to be the principle data collection drivers of a data to situational understanding processing chain. The aim of this RTAT assessment interjection chain is to help the humanitarian aid leaders make better decisions. As Kennerly & Mason (2008) aptly stated,

> If decision making is to be informed by information (the developed RTAT forms) then clearly it is important what data is available (collected). Not only does the availability of data enable a decision to be made, but in many circumstances data can indicate when a decision needs to be made.

Therefore it is vitally important to get the RTAT assessment/data collection forms correct.

As stated earlier, RTAT originally used an excel spreadsheet to conduct its ICT assessments. This method relied heavily upon assessor's professional judgment to assess non-standardized markings within the MS Excel spreadsheet (Steckler, 2009 and 2012). Email was the original method to disseminate findings (Steckler, 2009 and 2012). These spreadsheets were not set up with established entity or attribute relationships and therefore could not be exported into a query-able, relational database. According to OCHA (2014a), unstructured Excel documents are poor means of communicating time critical humanitarian assistance data due to their poor ability to be imported into shared databases. Further, email is a poor means of data transfer due to its singular point-to-point characteristic in an environment with frequent personnel turnover (Office for the Coordination of Humanitarian Affairs 2014a). This research supports the original and refined discovery stage hypotheses.

Additionally, RTAT looks to add spatial data attribute information to the assessment so that it can be imported into an easily understood current operational picture (COP) map that could then be rapidly promulgated to HA responders (Beeson, 2013). ODK collected data can be exported into a myriad of formats (to include KML) and could therefore be importable into Pacific Disaster Center (Open Data Kit Collect, 2014).

A quick re-examination of currently available ICT centered disaster response surveys in the Literature Review found that the various reputable, established humanitarian assistance organizations, specifically USAID, UNDAC, UN-ETC, FITTEST and WFP, all lack the level of fidelity desired by RTAT and its customers (Steckler 2009, 2012). This confirms RTAT's pre-thesis decision to develop its own ICT centric disaster assessment forms based on what forms were available at the time and what the collective RTAT member disaster experience deemed necessary (Steckler, 2012). The original RTAT MS Excel forms can be found in Appendices G-J.

As stated earlier, the author iteratively refined the RTAT forms were during each campaign stage. For simplicity, a discussion on all form changes are consolidated in this section. More information on the various stage events can be found in their respective sections.

The RTAT forms were built using the Open Data Kit (ODK) XLS2XForm, the resultant EXtensible Markup Language (XML) forms were then compiled and checked for errors with ODK Validate. Forms were uploaded to the Naval Postgraduate School's (NPS) Common Operational Research Environment (CORE) lab managed ODK Aggregate server via ODK Form Uploader. Once on the CORE lab's ODK Aggregate server, the forms could be accessed (downloaded), filled out and submitted via ODK Collect or the CORE Lab's Lighthouse application on an Android based smart device.

One initial thought by the author was to make a separate form for each of the services outlined in Appendices G-J, but the researcher quickly realized that one form could be created that included all of the services with the use of ODK's skip logic feature. Table 1 is the breakdown of "service" and "sub-service" as discussed throughout the rest of this section. They were taken directly from Appendices G-J.

Service	Sub-Service
Electrical Power	Generator
Terrestrial Services	Copper Line Fiber Optic DSL Cable T-1
Cellular Services	Voice Data-2g-4g Long-Term Evolution (LTE) Text/Short Messaging Service (SMS)
Wi-Fi (Wireless Fidelity)	Voice Data
Satellite	Voice Data
Radio	UHF VHF HF
Broadcast	Television Radio

Table 3. Service and Sub-Service Table (after Appendix D-G)

The major form capabilities/changes are outlined below using the following time periods: beginning through Legazpi City field experiment, post Legazpi City through Typhoon Haiyan (October-December 2013), post Typhoon Haiyan to today (December 2013-September 2014). Names of the forms are taken verbatim from the ODKAggregate website. All forms were tested using Samsung S2/S4 and the Google Nexus smart phones using Lighthouse exclusively until RTAT Assessment v4. Thereafter forms were tested with both Lighthouse and ODK Collect.

a. Beginning Through Legazpi City Field Experiment

This period of form development starts at the author's involvement in the RTAT mobile data collection tool development and ends at the conclusion of the Legazpi City field experiment. This occurred from the beginning of June 2013 through the first week of October 2013.

(1) rtat_mobile_assessment_philippines_130924

This represents the first ODK form tested within the campaign of experimentation. This version was used to show the art of the possible to RTAT members at the Legazpi City experiment. Capabilities included: GPS location, video and audio recording as well as standard form questions and simple skip logic. Below is a more detailed review of the form version. User feedback was taken from RTAT conducted after action discussions and a nightly "hot wash" meeting attended by the author (author's notes, available upon request).

rtat_mobile_assessment_philippines_130924 had one overall status marked for the location (working, operational with some degradation, highly degraded, broken, or disconnected from the infrastructure/electrical grid etc.) (see Figure 17). Unfortunately, only one service could be assessed per form, i.e. a tower with both cellular and broadcast television service antennae would require two separate assessments.

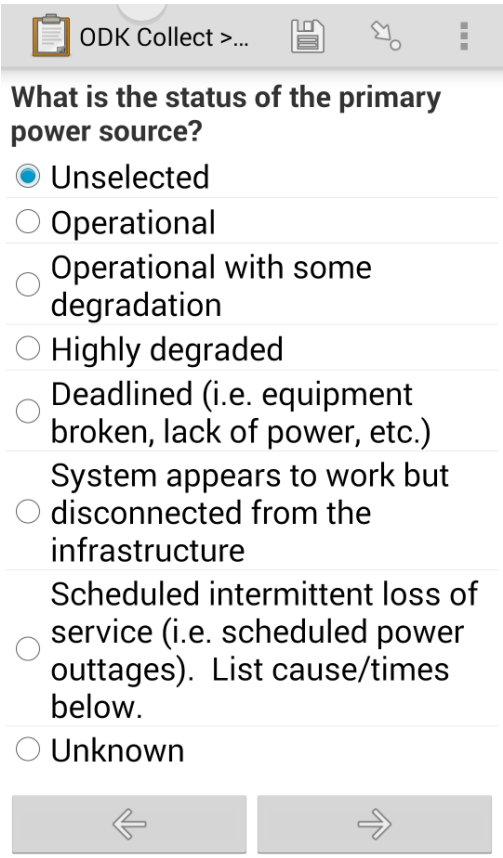

Figure 17. RTAT Assessment Status Option Screenshot

Other specific questions included: type of assessment (training, test, baseline, post disaster), GPS or fill in location (Latitude / Longitude or Military Grid Reference System), lengthy address and point of contact telephone number input. Lengthy status drop down menus were included throughout the assessment. Examples include required, primary, secondary, and tertiary "Cause of the issue?," "What's the issue?," and "What's needed to fix" the issue options. There were very detailed power questions (voltage, cycle, phase, Hz, etc.), to include what power assets are on location (generator, inverter, uninterrupted power supply, etc.). Towards the end of the form there was the option to take a photo or record a video audio message.

The following issues/recommended fixes were taken from the author's after action notes generated during the various hot washes and can be furnished upon request.

All questions in the form were required; the assessor had to mark an input before moving on to the next question. So if volcano ash were the only cause of the damage at the location, the assessor still had to pause to mark secondary and tertiary damage causes. While minor, this issue was multiplied throughout the form and led to user irritation especially if conducting the assessment in a rain storm.

Another take away was that too many unknowable or impertinent questions to the environment were required. For example, the *phase of alternating electrical power* (1, 2 or 3) would need to be answered for an assessment on a broken UHF antenna. Many of the first responder volunteers had no idea what phase meant and guessed or left it as *unknown*. The RTAT subject matter experts (SME) dropped this and many other *irrelevant* questions in later form versions.

While the lengthy drop down menus worked well for a relational database (i.e. Tell me all the locations assessed with "2 phase power"), they did not work well for speed if the question did not fit the situation. One could argue that many of these irrelevant questions did not add value to the assessment or meet the RTAT assessment intent. Additionally, many of the questions were deemed redundant, such as the primary, secondary, and tertiary causes of damage.

The point of contact telephone number stopped short of the required number of digits for a foreign telephone number, i.e. the integer field was too small. Finally, assessments with video recordings could not be uploaded to the NPS servers. It was concluded at the time that the size of the assessment file was too big to be accepted by the CORE Lab's ODK Aggregate server. However, this was not investigated further. The option to take multiple photos was deemed acceptable by the RTAT SMEs.

The overall impression is that the assessment was too slow and cumbersome. Additionally, users wanted the ability to "slew" their GPS location on a map to an "unreachable" location; unfortunately, this is not possible with ODK. Users wanted the ability to mark up the taken picture; unfortunately, this was not possible using Lighthouse. Finally, users wanted the ability to assess more than one service at the location.

(2) rtat_mobile_assessment_philippines_130925

This is the same as rtat_mobile_assessment_philippines_130924, except the number of required fields was reduced. Secondary and tertiary causes of issues and a number of electrical data questions were made optional to speed up the process. Address field was pre-filled to some extent for Legazpi City; telephone number was shortened and prefilled for the Republic of the Philippines; the ability to record a video was dropped and replaced with the ability to take multiple photos at a location. Users reemphasized their desire to assess multiple services at one location. Testing of this form was conducted largely in the rain with flash flooding throughout the area. As a consequence, teams wanted the GPS and photo at the very beginning of the form so that the assessor could take refuge while filling out the rest of the form or move on to the next assessment location.

b. Post Legazpi City Through Typhoon Haiyan

The goal of this stage was to create a form that could be crowdsourced by novice users and assess multiple (sub-) services differently at one location. The time period covers roughly the second week in November 2013 to the second week in December 2013 and is punctuated by the deployment of two RTAT waves to Tacloban City, the Republic of the Philippines (ROP) in response to Typhoon Haiyan relief efforts.

(1) rtat_mobile_assessment_philippines_131110

The assessor could only give one overall assessment for the location (Figure 17), but the assessor could check multiple services and sub-services to be included in the assessment (Table 1). There remained no ability to assess sub-services individually and the one overarching assessment inferred the same status for the other services checked. For example, this form could not state that cellular text was *operational* but that the radio broadcast service was *dead lined* (see Figure 12). It could only state that something at the site was assessed *dead lined* (see Figure 12) and that cellular text and broadcast radio services were assessed. This leads to ambiguity and forces the assessor to make multiple assessments at the location if more than one status exists at that location (see Figure 18 for a screenshot from the Lighthouse application). Electrical power was assessed

separately from the rest of the form, however, and operational status of power could differ from the services being assessed. This form marks a turning point in assessing multiple services at a given location.

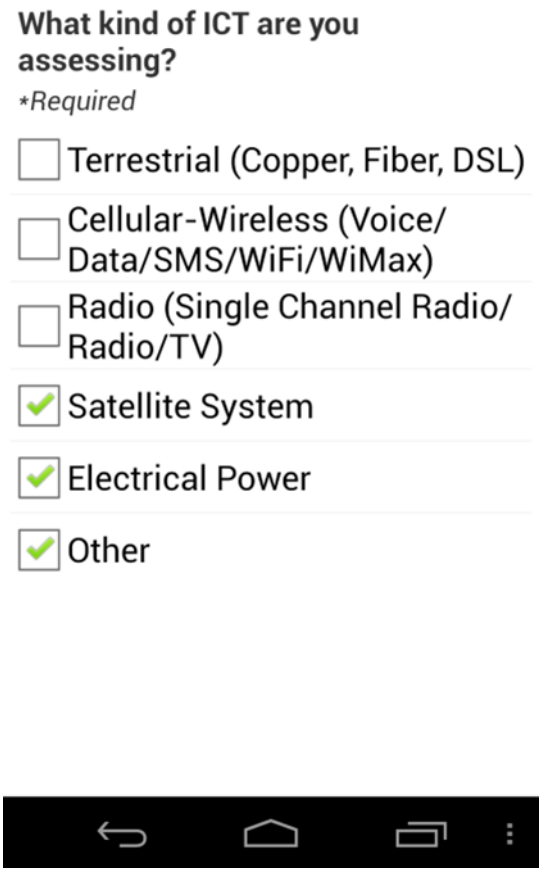

Figure 18. Lighthouse ICT Services Being Assessed at a Location

Telephone number was changed from an integer variable input to a text variable to skirt the input size limitation.

This form replaced the primary, secondary, and tertiary causes of damage with *what's the issue?* and *what's needed to fix the issue?* open text fields. While less searchable via a data base program, this vastly simplified the form and reduced user survey fatigue.

Unfortunately the photo remained at the end of the form, and, as stated, the ability to give different operational status marks to the various sub-services was still not programmed into this version.

(2) haiyan_rtat

This version cleaned up some typographical errors found in rtat_mobile_assessment_philippines_131110 and was used during initial testing in the Republic of the Philippines (ROP) during the first RTAT wave while waiting for team members to assemble in Manila. This form was not intended to be utilized by RTAT volunteers; however, it was accidentally left on some of the phones during the turnover between the first and second RTAT waves and was subsequently used by some of the volunteers in the second wave to conduct assessments. This led to integration issues during the data consolidation and submission to Pacific Disaster Center. (See section on Typhoon Haiyan below for more detail.)

(3) Haiyan Post Disaster

This change incorporated some of the requested changes that had not been incorporated into previous versions. For example, the photo was finally placed at the very beginning of the survey immediately followed by the location input (GPS).

This form was created with the intention of using crowdsourcing techniques, and the assessor name and point of contact info dropped due to privacy concerns.

Figure 18 question remained with some notable improvements. Skip logic was introduced into the form. The assessor was taken only to the services being assessed and asked what is the operational status of the assessed services checked in the Figure 18 question. Subsequent radial menus were shown asking which subservices are working and which sub-services are not working.

This change gave much better fidelity to the data collected. An end user could now, for example, get the overall operational status of the cellular service and know that voice and text sub-services were working, but that 2g, 3g, and 4g data sub-services were not, see Figure 19.

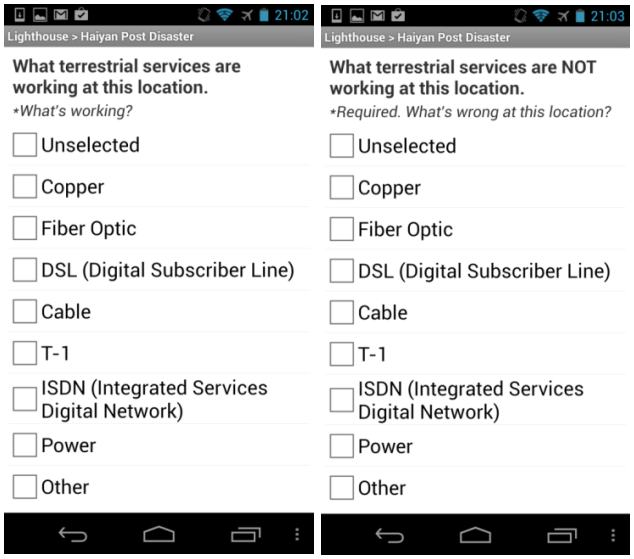

Figure 19. Terrestrial Sub-Services

The form was a little disjointed, reflective of the rapid revision done on location at the Typhoon Haiyan relief effort staging area, but an assessor could now assess multiple (sub-) services differently at a given location. The form was a success during Typhoon Haiyan's demonstration testing and validated that RTAT could crowdsource a simplified RTAT assessment form utilizing ODK tools and the CORE lab's Lighthouse application. Further, this form was the first to be integrated into PDC's DisasterAWARE situational awareness web portal. (See Figure 20 for results.)

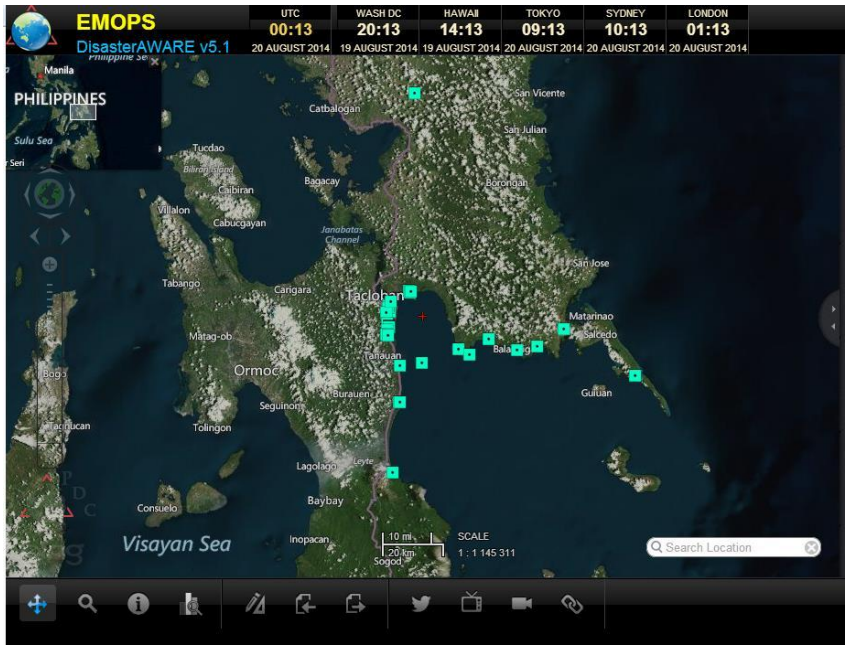

Figure 20. Screenshot of DisasterAWARE with RTAT Data (from Pacific Disaster Center, n.d.)

c. Post Typhoon Haiyan to Today

Unfortunately, getting *Haiyan Post Disaster* assessment form data onto the DisasterAWARE web portal was an arduous and manually intensive task that took more than one week to accomplish. Further, the results on the DisasterAWARE web portal do not intuitively convey assessment information with the default turquoise assessment icons (see Figure 20). Therefore, the goal during this stage was to finalize the form so PDC could integrate data seamlessly into DisasterAWARE. Additionally, subsequent forms were needed to create a single data field that PDC could use in order to match an appropriate icon to the assessment data (i.e. green icon for a working ICT service). This would intuitively convey information and situational understanding to stakeholders and end-customers visiting the DisasterAWARE web portal.

(1) RTAT Assessment v4

This form smoothed out the "disjointedness" of the *Haiyan Post Disaster* form and marked a naming convention turning point for the RTAT forms.

Unfortunately, an assessor must go through each subservice regardless of if there is an issue or not. For example, radio ICT service is marked *operational,* but the user has to manually check which radio sub-services are *working* and which subservices are *not working.*

(2) RTAT Assessment v5

RTAT Assessment v5 incorporated logic to avoid non-assessed subservices and fixed issues of a single attribute for each service versus an attribute assigned for each sub-service. This effort required an extensive XML code rewrite and surpassed the capabilities of ODK XLS_Form builder.

(3) RTAT Assessment v6

This version of the form (v6) is the current RTAT ICT assessment form at the time of thesis completion. It includes a *type of location* added for PDC and other cosmetic fixes from v5. V6 is the last form anticipated to be built on the ODK platform. Subsequent forms will be built using HTML5 so that they can be utilized on any smart device regardless of operating system. Below is an outline of the form. A full training brief is included in Appendix I.

- Admin info
  - Assessor info
  - Location point of contact info
  - Location info (GPS)
- Photo (multiple)
- What services are you assessing?
- Electrical, Terrestrial, Cellular, Satellite, and or Radio service:
  - “What’s working?”
  - “What’s broken?”
  - “What’s needed to fix the issue?”
- Final remarks

D. HYPOTHESIS TESTING

This stage in the campaign is marked by hypothesis testing. Hypothesis testing experiments "build on explanatory knowledge to create predictive knowledge" (Alberts & Hayes 2005, p. 81).

1. Legazpi City Field Experiment

From above, the hypothesis for the Legazpi City field experiment was that: an ODK based solution would better meet the needs of RTAT and would enable desired organizational operating model changes. Further, people with first responder or ICT backgrounds could be quickly trained to conduct RTAT assessments using the ODK/Lighthouse solution.

RTAT conducted baseline ICT infrastructure assessments in Legazpi City, Republic of the Philippines (ROP) from 21–26 September 2014 (Chang, 2013), ironically just a couple of months before Typhoon Haiyan. Utilizing the created mobile data collection tool from the Discovery Stage, RTAT members from around the world met with local leaders, volunteers, and first responders in an effort to conduct baseline assessments throughout the Albay Province. As a note taker in attendance at the "hot wash" feedback sessions at the end of each day, the author was able to rapidly prototype form improvements for the next day's use. According to DHS (n.d.) a hot wash is an informal conversation where participants,

> [s]hare their perspectives on key strengths and areas for improvement. Hot washes are important because they mark the transition from actual exercise play to the evaluation phase where lessons learned and corrective actions are documented. It is important to conduct the hot wash at the end of the exercise while all participants are still present and the day's discussions are still fresh in their minds.

The result from the Legazpi City experiment was a validated mobile data collection tool that consisted of a vastly improved ODK based assessment form, Lighthouse electronic form interface application and Android powered Samsung S3 and S4 phones.

This field experiment confirmed that an ODK based mobile data collection solution would better meet the needs of RTAT and was a step forward in the desired organizational operating model changes. See Chapter IV for the analysis supporting this conclusion.

According to the official Marine Forces Pacific official Quick Look after action report (Appndix L), the Legazpi City experiment effort consisted of,

> 81 participants coming from 42 different entities including those from academia, industry, UN, NGO, U.S. government, military, and law enforcement as well as Philippines national, regional and local leadership and other government agencies. U.S. participants made up about 20 percent of the people for the overall event. Defense related entities (U.S. and Philippines) made up about 15 percent of the total entities.

Fewer than 10 of the participants were RTAT members, most of whom had not seen the created RTAT assessment forms or the Lighthouse application prior to the event.

a. Format

Formal training with practical application was followed by real world use of the tool and a feedback session at the conclusion of each day.

Iterative changes were made to the form and tested the following day. This pattern was repeated for September 24, 25, and 26. Feedback from the 26th was included in the Typhoon Haiyan version.

Figure 21. Legazpi City Hot Wash Feedback Session (from Chang, 2013)

b. Training

The author trained the RTAT members and volunteers in a "hands on" classroom setting using a brief similar to Appendix I followed by a practical application session. Participants were able to download the Lighthouse application on their own Android compatible device or use a RTAT team provided Samsung S3 phone for the hands on practical application session.

c. Execution

Participants were divided into 6 vans and assigned to a specific Barangay (local governance district) to meet the local leadership (Barangay Captain) and conduct baseline ICT assessments in the area. Barangay is "the smallest administrative division in the Philippines and is the native Filipino term for a village, district or ward...the term often refers to an inner city neighborhood, a suburb or a suburban neighborhood" (Barangay, 2014). Teams taught the Barangay Captains how to use the tool, and the teams along with the local leadership conducted as many ICT assessments of the local areas as time permitted.

Teams were given a Broadband Global Area Network (BGAN) satellite system to get access to the live Internet to upload the forms to the ODK Aggregate server in real time. Team leads were given unlocked Samsung S4 phones and furnished with local

subscriber identity module (SIM) cards with unlimited data for the duration of the exercise and other team members could alternatively upload the forms by tethering a connection to the Internet via the S4 device.

d. Results

The following is a synopsis of what worked and what did not work during the exercise. The results were taken from hot wash after action discussions and from the after action report found in Appendix J (Chang, 2013).

(1) What Worked?

This experiment validated the RTAT mobile data collection tool which consisted of an Android device, ODK forms, and Lighthouse application. Specific form questions were debated, but the utility and convenience of the Lighthouse applications were undeniable.

The experiment validated a train-the-trainer model. Participants were able to teach local volunteers how to use the device with less than two hours of training. Users were able to easily and intuitively navigate the form. Even Barangay Captains with no experience with touch screen devices were able to quickly pick up on how to use the tool with just one use of the device. It was discovered that RTAT Subject Matter Experts (SMEs) could train others to conduct the assessments, thus multiplying their capability.

RTAT teams were able to use the forms to successfully conduct scores of RTAT ICT assessments in various field conditions. These forms could be uploaded to the NPS CORE Lab ODK Aggregate server in Monterey, CA via BGAN satellite communication or via the local Smart Communications (cellular service provider). Figure 22 is a display of one of the day's data collection results.

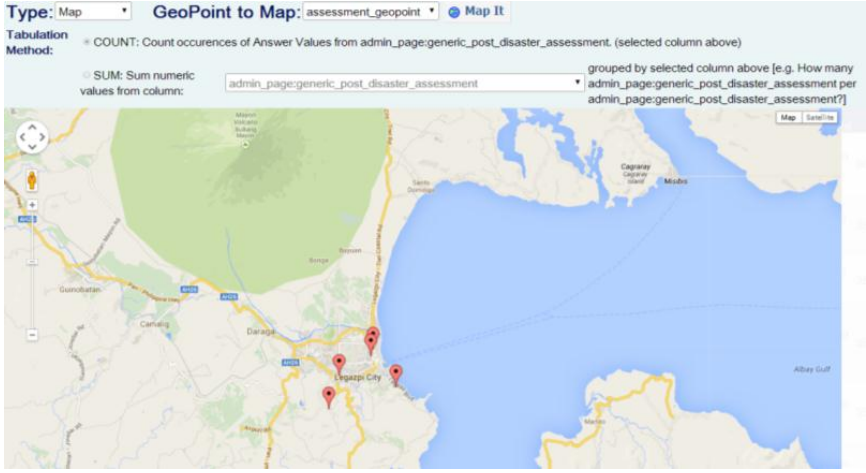

Figure 22. ODK Aggregate Map Visualization for Surveys Conducted September 24, 2013 (from Chang, 2013)

(2) What Did Not Work?

While the ODK Aggregate map function did a good job of indicating an assessment was conducted, the end user could not easily read the assessment values in this view. Further variable names and values were not always intuitively understandable. Care was taken in the creation of variable names; questions often remained, however, if only looking at the ODK Aggregate output. A database should be created that can import the data and export standardized reports. Figure 23 is a screen shot from ODK Aggregate and is a typical example of the clutter created when attempting to read the data in the map view.

About half of the participants that had smart phones were utilizing the Android operating system. Those with Android phones preferred using the provided Samsung SIIs versus downloading the Lighthouse application. Participants had concerns with downloading an application that was created by the U.S. government or military, i.e. the Naval Postgraduate School, given the then recent U.S. National Security Agency scandal that had come to light that summer (The Guardian, 2014).

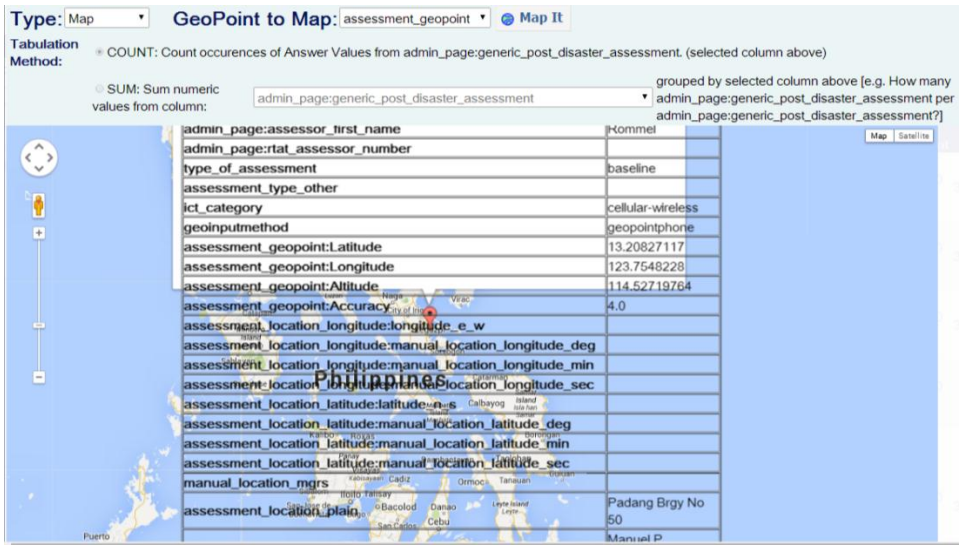

Figure 23. Data clutter in ODK Aggregate Map View

Assessments with videos could not be uploaded to the CORE lab's ODK Aggregate server. The option to take a video was dropped in favor of adding the ability to take multiple pictures.

Due to the modifications to the forms between each day of testing, the collected data could not be integrated together easily and efforts to create a master spreadsheet were abandoned early. This brought to light a shortcoming in the ODK Aggregate server: even a simple typographical correction in a form required a new form to be uploaded to the server. This required a name change to the new form or the deletion of the corrected form and all of its associated data. One can download the data into a spreadsheet or import the data into a database and manually join the data sets.

Users wanted the ability to draw on the photo once taken. ODK supports such a function, but, due to circumstances discussed in the literature review, the CORE Lab had not updated its Lighthouse application to take advantage of the newer capabilities.

Users wanted the ability to "slew" their location on a map, that is, move their position electronically vice accepting the current GPS position. Rationale: What if the assessor cannot be at the actual location to use the device's GPS due to safety or security issues. This cannot be done currently in ODK and may require the use of the Internet for

mapping or third party offline map that can be preloaded on the phone before deployment. There is no budget to fund this requirement and was deemed a "nice to have" by the group.

Some questions were deemed *non-value added* and dropped to shorten and simplify the form. One example of this simplification was in the electrical power assessment. Initial questions taken directly from Appendix G such as 110 volts or 220 volts, Direct versus Alternating current, 2 versus 3 phase and 60Hz versus XX cycle were not understood by many of the first responder volunteers, were unknown by many of the points of contacts we met on location, and were dropped by consensus of the RTAT members. Even staunch supporters of the original questions conceded that what was important was the status of the power (working, not working or intermittent) and do they have a generator with fuel on hand.

The feedback trend was a desire to get at what was really important for each service being assessed. Did it work? If not, what did you need to fix it?

Additionally, users wanted one form to assess multiple services at one location. The tested form required the user to create a separate assessment form for each service at the location. Unfortunately, this form was too complicated and could not be built/tested during the experiment.

2. Savvion Process Model

By standardizing the forms and assessment procedures during the Legazpi City field experiment RTAT demonstrated that it could teach others to conduct RTAT assessments, thus multiplying its reach and speed. Savvion was utilized to quantify how much utility there was in the train-the-trainer/crowdsource concept of operations. Specifically, Savvion was utilized to test a crowdsourcing model that was modestly demonstrated during the Legazpi City field experiment.

This experiment attempts to quantify the value of the change in the operating model proposed in the enterprise architecture assessment (Beeson, 2013), specifically the

need to increase organizational agility as enabled by an increase in process standardization and process integration.

a. The Hypothesis for the Savvion Experiments: Utilizing Crowdsourcing Techniques Will Reduce RTAT Costs While Decreasing the Time to Complete ICT assessments.Experiment Format

Three Naval Postgraduate School students collaborated to create a model of RTAT's business processes; see Figure 24 for a visual representation and Appendix C for complete details. These processes were then modified and tested through Savvion simulations.

The team analyzed the processes from a pre-Legazpi City experiment organizational structure (Excel, email and subject matter expert assessor only) to a post-Legazpi City model that leverages the mobile data collection tool, satellite communication, and automated/integrated backend servers for aggregation and dissemination as well as incorporating a crowdsource train-the-trainer assessor model.

Figure 24 shows the "As Is" model that utilizes a hierarchical process that utilizes three deployed subject matter expert assessors, the MS Excel spreadsheet that relies upon manual inputs, and manual dissemination via email to the UN-ETC for manual review, processing and dissemination. This model only utilizes subject matter expert assessors (pre-Legazpi City experiment model).

The "As Is" model, Figure 24, requires the RTAT assessment (supply) to go through an intermediary (UN-ETC) before dissemination to the end customer (NGO organization). This intermediary must conduct quality assurance and locate the assessment on a map. This assumes higher man hours in assessment form processing, quality assurance, location services and rework than an electronically automated and integrated process.

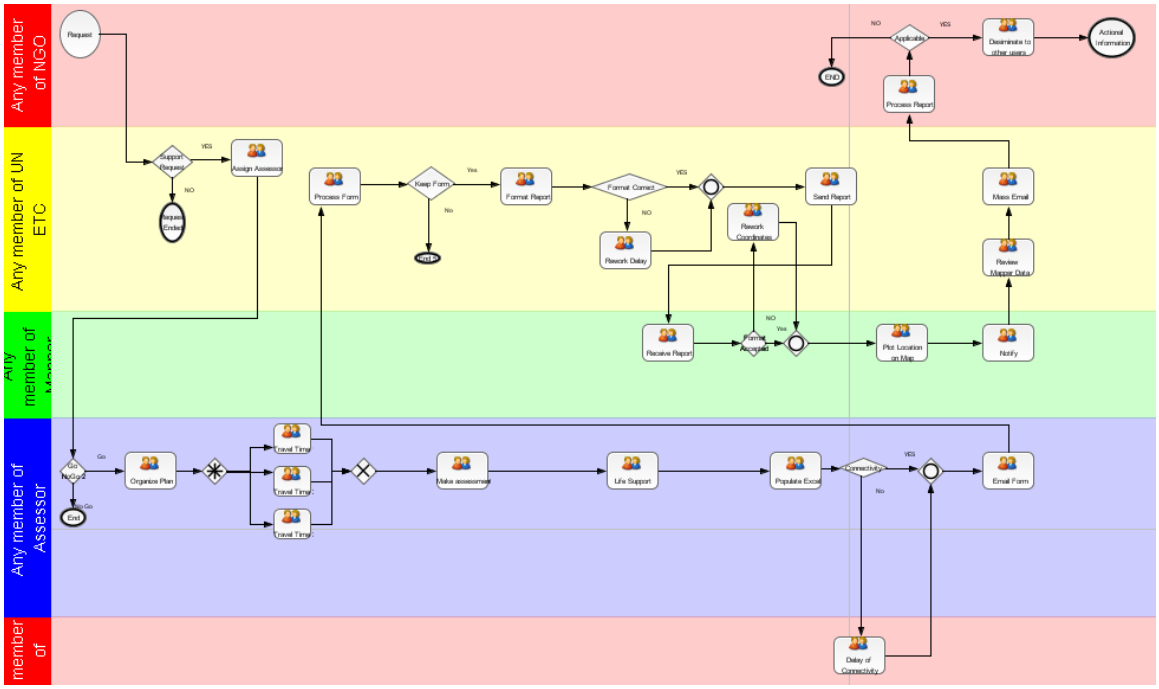

Figure 24. RTAT "As Is" Process Model (from Beeson et al., 2014)

b. Process Changes

Figure 25 shows the highlighted process changes tested with Savvion.

As Is

- NGO request IT assessments from UN
- Personnel dispatched to conduct assessments via UN
  - Responsible for all travel arrangements
- Personnel conduct assessments
  - Forwards assessments to UN
- UN process assessments
  - Forward to Mapper
- Mapper (Confirms & Plots location)
  - Mapper returns to UN
- UN confirms info & forwards to NGO for display

To Be

- NGO request IT assessments
- Personnel dispatched to conduct assessments via UN
  - Responsible for all travel arrangements
- Assessors conducts training for volunteers
  - Conduct assessments digitally (RTAT Tool, GPS).
  - Upload information and forward to NPS Servers
- NPS Servers assemble info and automatically forward to PDC
- PDC automatically publishes assessments for display
- NGO views updates on PDC DisasterAware website

Figure 25. Savvion RTAT Process Changes (after Beeson et al., 2014)

The front end cost of crowdsourcing is shown with the training of volunteers. The RTAT tool's integrated GPS ensures valid location, thus cutting out the UN mapper. The nature of its electronic form interface ensures compliant spatial data values and facilitates the link with Pacific Disaster Center (PDC). Display/link on PDC's DisasterAWARE (Figure 20) closes the data to situation awareness (current operational picture) process and ensures that assessments can be delivered in a timely manner to those who need it.

In the "To Be" model the information management exchange model changes from a push or pull model reliant upon point-to-point social contacts (email) in the "As Is" process to a bulletin board posting or, in this case, current operational picture format model. This is in line with literature review information flow improvement recommendations (Donahue & Tuohy, 2006) (Kennerly & Mason, 2005), and (Office for the Coordination of Humanitarian Affairs, 2014a).

Figure 26 shows the "To Be" model that was tested with Savvion. The reader will note the expansive number of assessment teams that the crowdsourced model enables. The Legazpi City experiment showed that both SME and non-SME volunteers could conduct the assessment if given a proper mobile data collection tool and two hours of training.

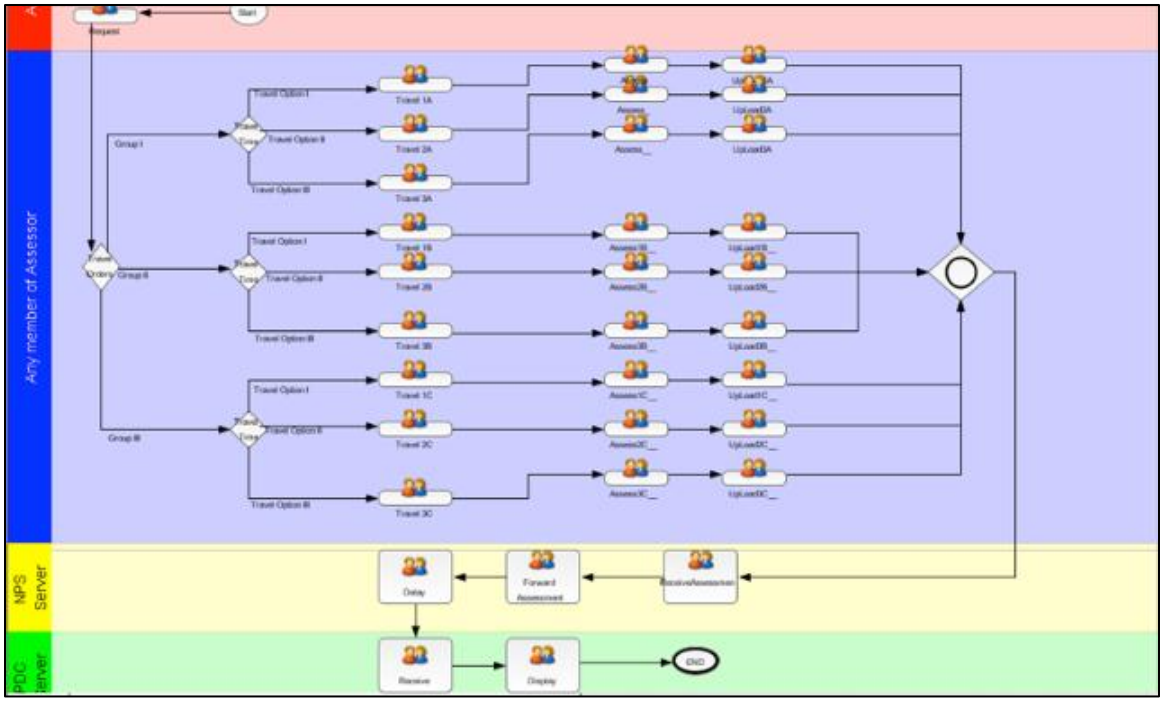

Figure 26. Savvion "To Be" Process Model (from Beeson et al., 2014)

c. Conclusion and Results

Despite doubling the number of assessments from 100 to 200, the "To Be" model expenses dropped 87 percent, wait time decreased by 81 percent, and it took only 20 percent of the time to complete the 200 surveys (Beeson et al., 2014). Unfortunately, Assessor utilization remained high (89 percent) but is unlikely to be significantly reduced due to the nature of the disaster scenario (Beeson et al., 2014).

When stretched further, the "To Be" model shows over 500 assessments are possible in approximately 1/3 the time required in the original "As Is" model, while still reducing costs by nearly 70 percent (Beeson et al., 2014). Figure 27 shows a detailed metric comparison of the "As Is" and "To Be" models.

	As Is	To Be 20 Assessors (includes training)		
#Assessments	100	200	500	
Duration (hrs)	300.7	62.33	108.05	
Assessments completed/Hr	0.33	3.21	4.63	(~3 hrs to ~20 min/ assessment)
Duration (days)	12.5	5.2	9.0	(24 hrs to 12 hr days)
Revenue/hr	$166.30	$1,604.28	$2,313.74	
Total Revenue	$50,000.00	$100,000.00	$250,000.00	($500/ assessment)
UN-ETC	$5,828.56	$2.60	$6.60	PDC
Mapper	$850.43	$4.00	$9.80	NPS
NGO	$404.72	$452.43	$1,137.93	NGO
RTAT	$28,458.74	$4,080.00	$9,894.00	RTAT
Total Process Costs	$35,542.44	$4,539.03	$11,048.33	
change in Costs	-	-$31,003.41	-$24,494.11	
% Change in Costs	-	-87.23%	-68.92%	
Wait Time	15,740	2,907	17,858	(81% reduction)
RTAT Utilization	96.40%	88.82%	98%	(For twice as many Assessments!)
RTAT Change in Costs	-	-$24,378.74	-$18,564.74	(For twice as many Assessments!)
RTAT % Change in Costs	-	-85.66%	-65.23%	(For twice as many Assessments!)

Figure 27. Savvion As Is-To Be Comparison (from Beeson et al., 2014)

Critical changes included nine satellite BGAN terminals and the train-the-trainer/crowdsourcing model, which both greatly improved speed and efficiency. The addition of the user-friendly but highly (data) structured mobile data collection tool application eliminated the redundant internal mapping and quality assurance cycles and enabled the use of crowdsourcing/volunteers; both of which drastically improved the RTAT performance and capability.

Quality of assessments was addressed in this experiment through the reduction of rework of GPS coordinates and incorrect data values. The quality of the qualitative assessment remarks from a crowdsourced novice versus a seasoned information technology (IT) professional, however, could not be gauged. A "good enough" philosophy was incorporated in this model in that even a novice can tell if something is broken, even if all they can say is "a service call" or "new tower is needed" to fix the issue, see Figure 27 for an example.

Figure 28. Broken Broadcast Tower Assessed by RTAT in the Aftermath of Typhoon Haiyan

Savvion team concluded that RTAT should switch to a train-the-trainer model and crowdsource assessments to significantly reduce costs and wait times. The crowdsourcing solution, however, must be simple enough for the layperson to use while providing the fidelity and quality required of stakeholders and end customers.

E. DEMONSTRATION STAGE

RTAT proved that the ODK/Lighthouse mobile data collection tool was a better solution in Legazpi City, and Savvion lab tests validated the crowdsourcing model. RTAT needed to demonstrate the train-the-trainer model and prove that its data could be displayed on PDC's DisasterAWARE current operational web portal in a field exercise or real world humanitarian event.

1. Typhoon Haiyan Deployment

On November 8, 2013 Typhoon Haiyan (known locally as Yolanda) made landfall in the central Philippines (see Figure 29) at nearly 200 miles per hour, making it one of the strongest storms ever recorded (United States Agency for International Development,

2014a). As a result, 6,300 people lost their lives, 1.1 million homes were damaged or destroyed and 4.1 million people were internally displaced (United States Agency for International Development, 2014b).

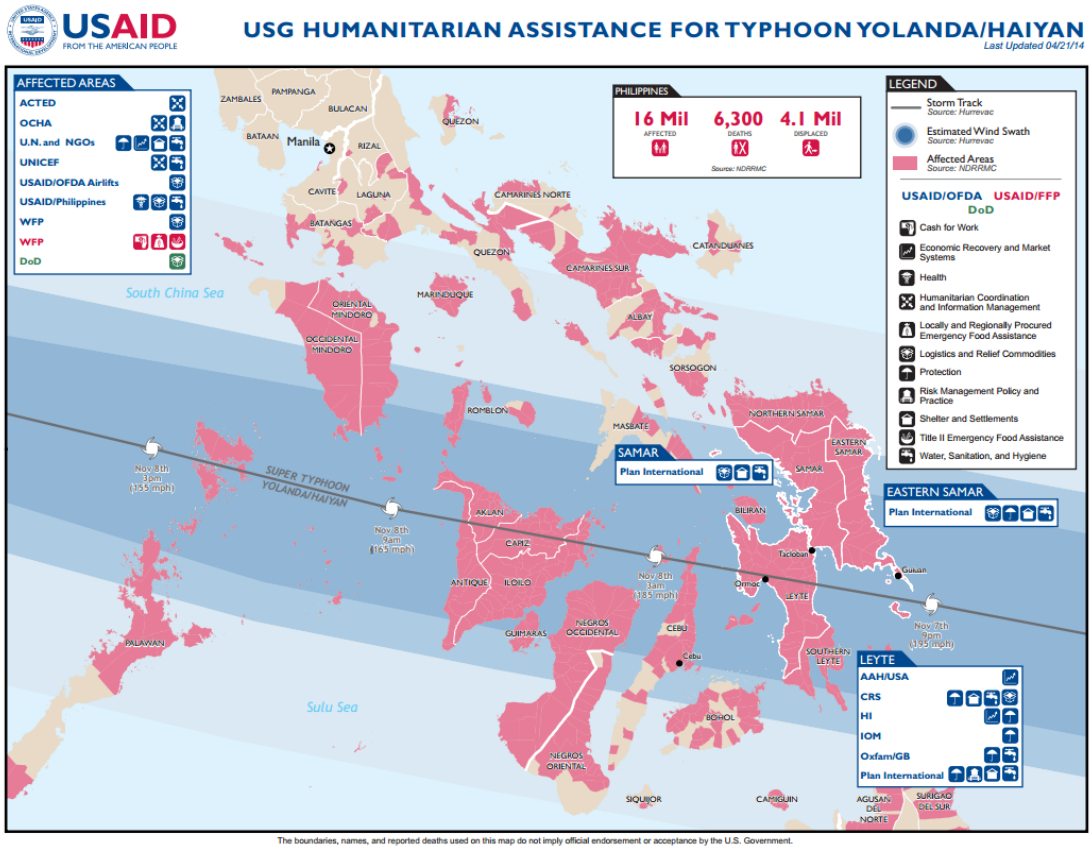

Figure 29. USAID Typhoon Haiyan Effected Area (from USAID 2014b)

In response, RTAT members deployed to the Republic of the Philippines (ROP) to conduct information and communication technology assessments to aid in the relief efforts and validate the RTAT concept (Steckler, 2013).

Specifically, RTAT tested and validated the hypothesis that RTAT assessments could be crowdsourced using locally acquired volunteers in or near a disaster zone and those assessments could be posted to the DisasterAWARE web portal.

a. Concept of Operations

RTAT sent two waves of teams to conduct assessments within the Tacloban/Borongan City areas in the Leyte Province (Steckler, 2013). The first wave was led by the Roddenberry Foundation with the assistance of the author (Steckler, 2013). The second wave was led by this thesis's advisor, and program development leader, Mr. Brian Steckler. Both waves were greatly assisted by Bicol University, Team Patola non-governmental organization (NGO) and various local volunteers as well as the support of both the Armed Forces of the Philippines (AFP) and Philippine National Police (PNP) (Steckler, 2013).

The first wave consisted of three NGOs from the Roddenberry foundation, four faculty members from Bicol University that helped with the Legazpi City experiment, as well as the author. Volunteers were obtained through previously established contacts within the Philippine Armed Forces, Philippine National Police and the Team Patola NGO.

The second wave consisted of the aforementioned Mr. Steckler, one other student from the Naval Postgraduate School, three faculty members from Bicol University as well as several local volunteers (Steckler, 2013).

b. Execution

The author trained the Roddenberry members and volunteers in Cebu City (Figure 30), and the Philippine Armed forces provided logistical support to/from Tacloban City the following day. Team Patola provided a volunteer and logistical support within Tacloban City and the greater Leyte Province.

Figure 30. Author Conducting RTAT Training in Cebu City

In Tacloban, the teams contacted the UN established relief center and provided ICT assessment support as requested, see Figure 31.

Figure 31. First Wave Confers with Local Officials

The first wave then broke up into three teams before heading out to conduct RTAT assessments in the local area, see Figure 32.

Figure 32. RTAT Conducting an Assessment in Tacloban City

c. Results

RTAT successfully conducted 40 assessments using the Lighthouse application and the ODK forms. Assessments were successfully uploaded in the disaster zone to the NPS CORE Lab ODK Aggregate servers located in Monterey, CA. Assessments were then manually transmitted and displayed on the DisasterAWARE web portal.

RTAT was able to obtain over 40 volunteers for the first wave alone and had to turn volunteers away due to logistical constraints. The sheer numbers of volunteers obtained within a 24 hour period validated Savvion process assumptions for the number of RTAT teams that could be created in a disaster zone. Further, the ability of volunteers to conduct and upload assessments validated the hypothesis that RTAT could crowdsource the RTAT assessments with the Lighthouse application and ODK forms.

Results from the two waves were taken from the author's notes during the operation's hot wash and are available upon request.

(1) What Worked

The two waves conducted 40 assessments in the Leyte Province in support of Typhoon Haiyan "real-world" relief operations. Figure 33 shows the results of the effort on the ODK Aggregate mapping view.

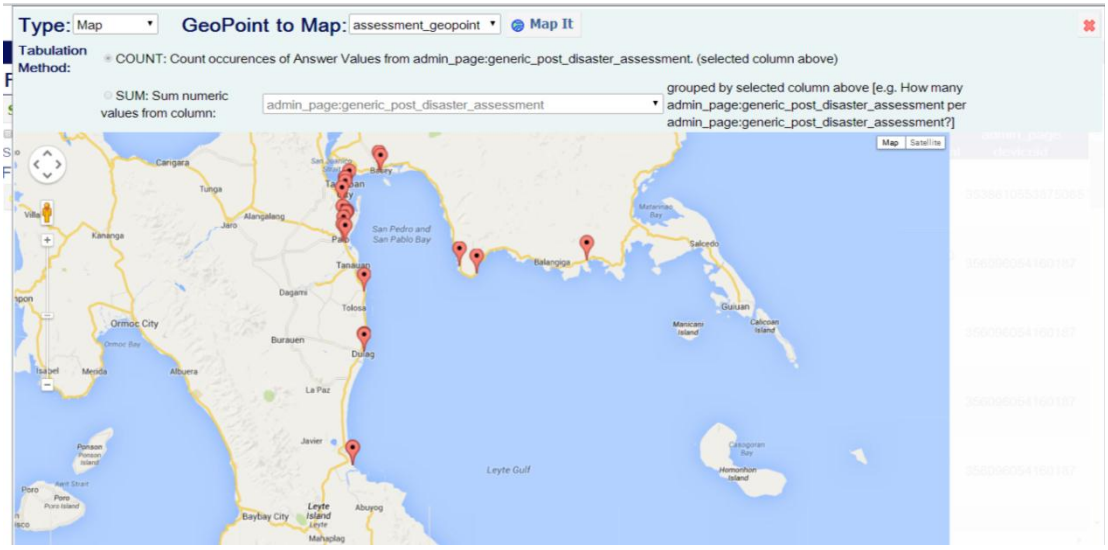

Figure 33. Typhoon Haiyan Mission ODK Aggregate Results

Local knowledge and language skills were a must. The local volunteers were invaluable for both the safety of team members and for communicating with local points of contact while conducting assessments.

Crowdsourcing works. Simplifying the forms enables volunteers with no IT experience to contribute to the RTAT effort; volunteers had to be turned away due to logistical constraints. RTAT was able to field more teams using simple Crowdseeding techniques discussed in the literature review.

The developed operating model from Savvion was validated, albeit at a smaller scale due to logistical constraints. The author obtained and trained 40+ volunteers within 24 hours of arrival in Cebu City. Three RTAT subject matter experts and four Bicol University faculty members, who trained during the Legazpi City experiment, deployed along with seven local volunteers to Tacloban City. RTAT was able to deploy three separate teams on the first wave; only one team would have been supportable without the

volunteers. Additionally the teams could have been made into four teams if more transportation assets within the disaster area could have been obtained.

(2) What Did Not Work

Two conflicting RTAT forms were utilized during the second wave. The form was improved between the first and second RTAT waves; unfortunately, an in person turnover could not be accomplished due to length of flights to/from the United States. As a result, some of the devices had the older version of the form and some were utilizing the new form. This became problematic when it came time to integrate the data with PDC. PDC needed one set of variables, thus the two forms needed to be manually collated into one data set. This process was delayed for days due to the communication issues and competing priorities of RTAT and PDC.

Integration with Pacific Disaster Center had to be accomplished manually. Late form changes precluded the use of any automated import functions developed during earlier PDC/RTAT team interactions. As a result, data was manually exported from ODK Aggregate into an MS Excel spreadsheet and emailed to a point of contact at PDC for import and display on their DisasterAWARE website (see Figure 34). Timeliness of data posting was not an acceptable (near) real time posting for decision making use during the disaster, but it did prove that the hypothesis was correct. Crowdsourced assessments could be displayed on the PDC DisasterAWARE web portal.

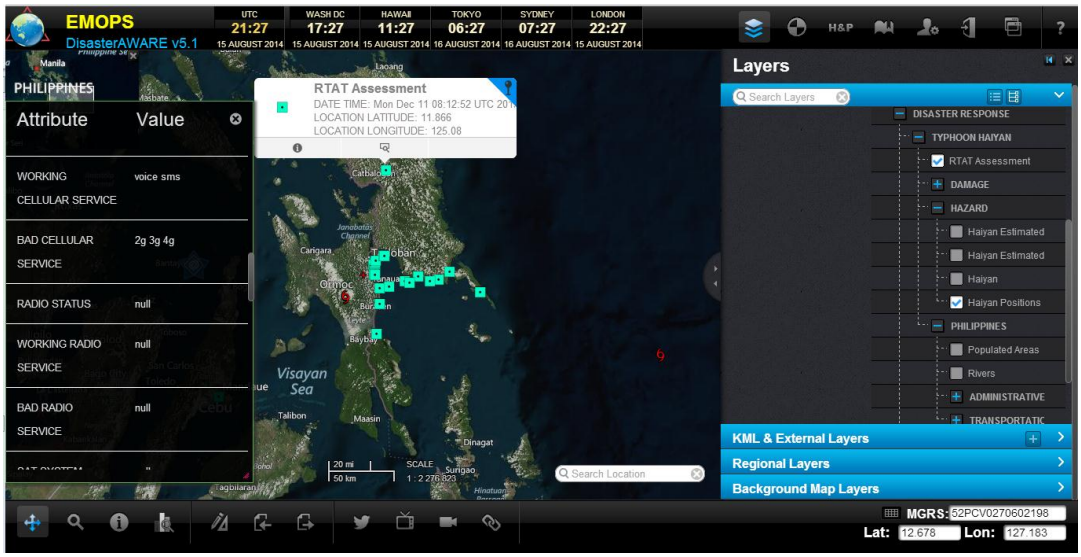

Figure 34. DisasterAWARE Screenshot with RTAT Data

This operation's success (Figure 34 germane) brought to light some shortfalls with the current RTAT assessment display. The icon for an assessment is set to a default value on DisasterAWARE. The aqua blue box on DisasterAWARE that denotes an assessment does not intuitively convey any information to a viewer. According to personal communications with T. Bosse from PDC (December 12, 2013), icons can be established and color coded based on a specific variable within the form. Unfortunately, the change that fixed the Legazpi City requirement and enabled the assessment of several sub-services versus a single assessment for the location did not support the requirements of PDC. For example, under Cellular services, cellular data, text and voice were assessed but there was not a single assessment value for the Cellular service itself nor one for that assessment overall, i.e., something is "not working" at this location. The logic to allow a single overarching assessment for the location while allowing for the independent assessment of all (sub) services without creating a lengthy form was discovered to be a challenge for ODK XLS2Form and required further experimentation to fix. More information on this can be found within the form development section. Further discussion on DisasterAware display improvements can be found in Chapter V.

While outside the scope of the Typhoon Haiyan demonstration experiment, it is worth noting: RTAT did not make any attempt to integrate RTAT assessment data into the larger UN-ETC current operational picture, Figure 35.

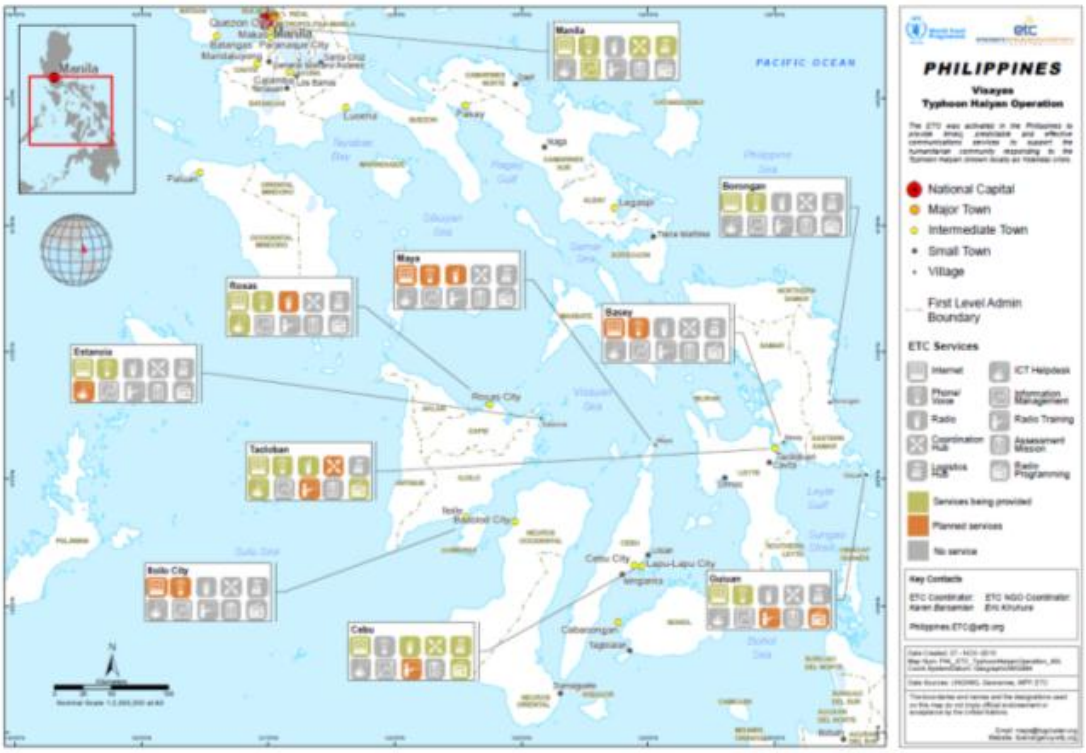

Figure 35. UN-ETC Current Operational Picture (from WFP, 2013c)

One other notable challenge during the experiment was that many of the volunteers had no information technology background and did not know what to look for to start conducting an assessment. An ad hoc class was conducted on various antennas types and how electrical power is distributed. A small, weather resistant, quick reference card should be developed to help volunteers identify ICT related infrastructure.

Many of the participants, as in the Legazpi City experiment, had hesitation downloading an application (Lighthouse) that was created by the U.S. government, albeit the Naval Postgraduate School. Fortunately, the gravity of the situation and volunteer desires to help prevailed.

Team member life support was an issue. Water purification methods were brought, but no fresh water was available within the disaster area. Energy was also an issue; charging stations were available and teams brought alternate power sources, but time spent charging a phone was time spent not assessing. See Figure 36 for an example of a charging station. Teams need a quick small form factor method of recharging RTAT devices

Figure 36. RTAT Member at a Charging Station in Tacloban City (From Appendix K)

2. Joint Interagency Field Exercise 2014–4

The purpose of the Joint Interagency Field Exercise (JIFX) is to,

> [p]rovide a field experimentation resource for the Unified Combatant Commands (COCOMs) and other federal agencies. In addition, State, local and international emergency management, disaster response and humanitarian assistance organizations are most welcome to help create an innovative cooperative learning environment. (Naval Postgraduate School, n.d.)

JIFX events are held quarterly, and elements of RTAT participated with other organizations from 10–14 August 2014 (Goolsby, & Steckler, 2014). The author participated in this event as an RTAT assessment tool subject matter expert.

The RTAT goals for JIFX 2014–4 were: To test and evaluate the RTAT assessment form version 6 (v6) for finalization, and to test the ODKCollect application to ensure that it works as well as the Lighthouse application in a field environment, but with the benefit of the Google Play store for application dissemination (Goolsby, & Steckler, 2014).

RTAT v6 included the logic to independently assess all of the (sub) services, while skipping non-assessed sub-services at the location. RTAT v6 marks the final form expected to be developed on the ODK suite of systems. Future RTAT development efforts will focus on an operating system agnostic solution; see Chapter V for more details.

a. Concept of Operation

Building upon the Typhoon Haiyan success, the author trained two teams in the same manner: classroom instruction using Appendix I, followed by practical application utilizing the required equipment. Teams then deployed in a simulated disaster scenario in the Camp Roberts, CA training areas (Chang, 2013).

The teams consisted of three military officers and five civilians. The mission of the RTAT teams was to conduct RTAT assessments throughout the Camp Roberts training area in support of other collaborative experiments (Goolsby, & Steckler, 2014). None of the team members, save the author, had used the RTAT tool prior to training, and all of them had at least a bachelor's degree. About half had never used an Android based smart device before and one had just received his first smart phone (Android) that week. All were able to grasp the use of the phone and the RTAT mobile data collection tool (Lighthouse and ODKCollect) after just one full assessment use. Participants with Android smart phones downloaded the ODKCollect application from the Google Play application store.

b. Results and Recommendations

Fourteen assessments were conducted during the exercise and no bugs were found within the form. Approximately two thirds (2/3) of the assessments were conducted using

the ODKCollect application with no issues being recorded. As a side note, participants preferred downloading ODKCollect from the Google Play application store versus using an "untrusted" application transferred from the author. RTAT v6 was validated at the conclusion as ready for use in the next disaster (Goolsby, & Steckler, 2014).

The team utilized available cellular data networks (AT&T and Verizon), the Cisco Rapid Response Kit (RRK)'s BGAN satellite modem or cellular connection, along with the Goal Zero Yeti 1250 power system to submit RTAT assessment forms on location.

The RRK is a lightweight low electrical power networking solution in an austere environment (Bharania, 2014). The RRK can connect to the Internet via a satellite broadband global area network (BGAN), or via a cellular data connection (Bharania, 2014). Figure 37 shows the RRK. Note the cases can fit in the overhead compartment of most major airlines (Bharania, 2014).

Figure 37. Two Cisco Rapid Response Kits (from Bharania, 2014)

The Goal Zero Yeti 1250 is a 1,250 watt power system that can be recharged via solar panel or by plugging in some other power source (Goal Zero, n.d.). The system fully deployed includes solar panels and the base shown in Figure 38 (Goal Zero, n.d.). The base system includes a large marine battery, a built-in inverter, a charge controller, alternating and direct current outlets, as well as charging input (Goal Zero, n.d.).

Figure 38. Goal Zero Yeti 1250 (from Goal Zero, n.d.)

(1) What Worked?

RTAT form v6 was validated. A sample of the RTAT Assessments is included in Figures 39 and 40.

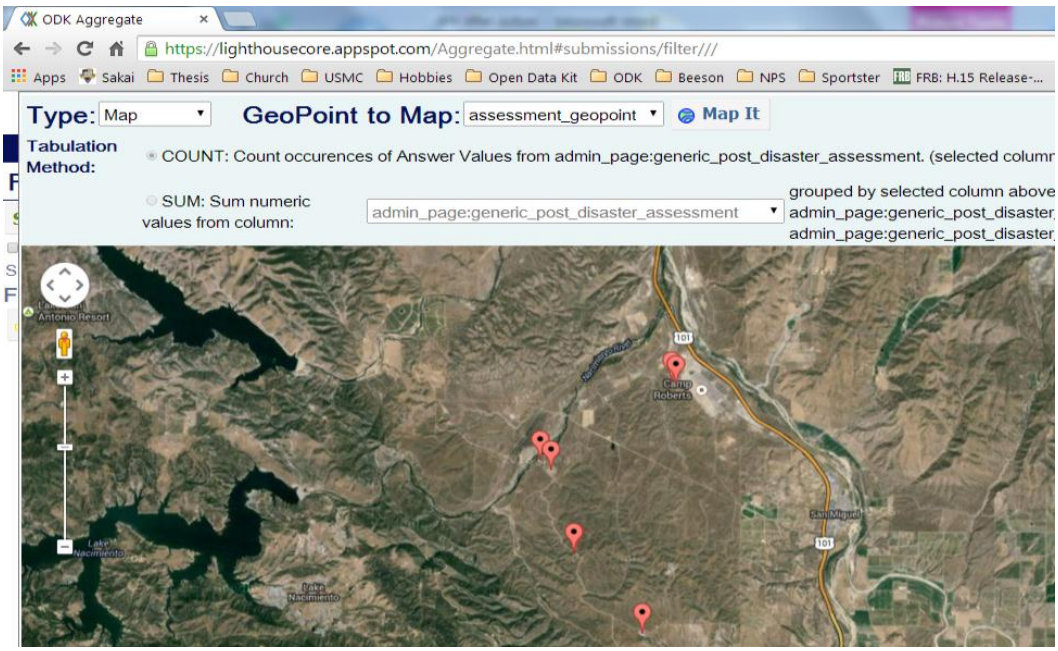

Figure 39. Sample of JIFX 14–4 RTAT Assessments

Figure 40. Antennae Hill Assessment Photos, Author is Shown Testing the Goal Zero and Rapid Response Kit (from Appendix L)

The availability of the ODKCollect application on the Google Play store greatly aided in RTAT mobile data collection tool adoption and use, albeit it on a micro scale, and should be the preferred method of disseminating and promoting RTAT. Lighthouse's ability to be stored on a computer and locally available in an Internet challenged environment should not be discounted and should remain as a back-up to ODKCollect.

The RRK worked as advertised. The Goal Zero easily provided all of the power requirements for the RRK and for charging the utilized phones.

(2) What Didn't Work?

RTAT v6 is awaiting official RTAT organizational blessing before attempts to integrate v6 data into PDC's DisasterAWARE web portal.

The Goal Zero Yeti 1250 system was more than the mission required and was extremely heavy to move. Note the use of two people carrying the base in Figure 38.

(3) Recommendations.

Consideration should be given to utilizing a much smaller Goal Zero or comparable product.

RTAT needs to officially approve the RTAT v6 form and continue integration discussions with Pacific Disaster Center.

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IV. SUMMARY, CONCLUSIONS, AND LIMITATIONS

A. SUMMARY

Coordination within the humanitarian assistance response community to efficiently and effectively respond to international large-scale disasters is hard. Compounding this problem is the widespread destruction of the affected nation's critical information and communication technology (ICT) infrastructure, and the lack of ICT operational status situational awareness. As a result, most responding organizations don't bring the right communication equipment, have difficulty communicating with one another and therefore cannot collaborate to affect a coordinated response. Many organizations have been organized to assess the ICT environment and combat this problem. However, all of these organizations have a narrow focus pertinent to their field and have the added responsibility of providing communication capabilities to their parent organization. The Rapid ICT Assessment Team (RTAT) was created to provide a holistic assessment of the ICT environment, pass on all pertinent ICT assessment findings and provide recommendations for recovery to the humanitarian assistance response community. RTAT is a fledgling, ad hoc, unfunded, volunteer organization looking to improve and integrate their processes into the larger response community. This campaign of experimentation as a first step towards that strategic aim

During the course of this thesis, RTAT discovered that their current means of conducting assessments and disseminating their findings were outdated and inefficient. Due to constraints, restraints, and available support, the open source Open Data Kit (ODK) suite of tools were down selected for further testing and developing to solve this problem.

The ODK developed assessment forms were successfully tested on both the Naval Postgraduate School (NPS) Common Operational Research Environment (CORE) lab's Lighthouse, and on the Google Play available ODKCollect applications. Unfortunately, Lighthouse and ODKCollect are currently limited to Android based smart devices only.

Investigative experiments were conducted in Legazpi City, in the Republic of the Philippines (ROP), where form refinements were made and it was discovered that crowdsourcing the assessments may be possible.

Investigative experiments with the Savvion process modeler compared the "As Is" process to the "To Be" model. The "As Is" process utilized only RTAT subject matter experts, the old Excel spreadsheets assessment forms, and email to communicate data to points of contact within the humanitarian assistance response community. The "To Be" model was comprised of crowdsourced assessments on the developed mobile data collection tool with automated backend server integration with the Pacific Disaster Center's (PDC's) DisasterAWARE web portal. This experiment revealed the "To Be" model to be superior in every regard. Using the "To Be" model, the number of assessments could be doubled from 100 to 200, expenses dropped 87 percent, wait time decreased by 81 percent and it took only one fifth (1/5) of the time to complete the 200 surveys. Further, the number of surveys in the "To Be" model could be increased five-fold from 100 to 500 and expenses and time would still be lower than the "As Is" model.

RTAT's demonstration experiment and deployment in response to Typhoon Haiyan in Tacloban City, ROP tested the findings of the Savvion experiment in a real-world environment and proved that the RTAT assessments could be crowdsourced given the caveats of the "Limitations" section below. Typhoon Haiyan deployment further validated that the crowdsourced assessments could be viewed on, and its data disseminated through, the Pacific Disaster Center's DisasterAWARE web portal given the boundaries outlined in the "Limitations" section below.

Finally, the demonstration experiment during Joint Inter-Agency Field Exercise (JIFX) 2014–4 at Camp Roberts finalized the RTAT v6 assessment with plans to further integrate the forms into and improve their display on DisasterAWARE. See Chapter V for further details.

The campaign of experimentation ended successfully with a usable mobile data collection tool and processes that could integrate the process of data collection to situational awareness dissemination in near real time.

B. CONCLUSIONS

The NPS CORE lab's Lighthouse application, as well as the ODKCollect application, were successfully used in real-world testing conditions as the electronic form interface to download, fill out, and upload completed RTAT assessment forms to the NPS ODKAggregate servers located in Monterey, CA.

Demonstration experiments further validated that ODK data could be exported and assessments displayed on PDC's DisasterAWARE website with conditions outlined below.

RTAT v6 meets current needs to integrate with Pacific Disaster Center. No research was conducted into compliance with the Humanitarian Data Exchange initiative which could influence whether v6 will meet RTAT needs going into the future.

C. LIMITATIONS

There are many caveats and limitations that are discussed in this section that affect the conclusions outlined above.

1. Lack of Budget

Given the lack of budget, available Samsung S2 and S3 phones at no charge, the prevalence of experience and support within the Common Operational Research Environment (CORE) lab at the Naval Postgraduate School, and its ability to meet initial mission requirements, the Open Data Kit (ODK) suite of tools was selected for further RTAT development and testing. According to research, there were no free ODK compatible Apple iOS applications available that met the requirements of RTAT. This is an ongoing limitation within the adoption realm and a solution will be discussed in Chapter V. Many RTAT design and selection decisions were based primarily on cost. Removing this limitation may invalidate the ODK selection.

2. Displaying Typhoon Haiyan Data on DisasterAWARE

The Typhoon Haiyan successful demonstration experiment to display RTAT data on PDC's DisasterAWARE was conducted after returning to the United States. Further,

this display experiment was a non-automated process that included the manual exportation of the data, transmission via email, and then manual importation of the data by PDC. This was due to the lack of formal organizational letters of agreement between the NPS, CORE lab and PDC; as well as form changes that took place after PDC points of contact left the Philippines for other operational commitments. This limitation will be further addressed in Chapter V.

3. Integration with Other Humanitarian Assistance Organizations

Talks have begun, but there have been no serious efforts to link RTAT assessment data into other partner or stakeholder organizations such as USAID, the UN-Emergency Telecommunication Cluster, the All Partners Area Network (APAN) web portal, or the Association of the Southeast Asian Nations (ASEAN). Nor has there been an effort to ensure data collected is compliant or harmonized with recent open source Humanitarian Data Exchange (HDX) developments. Any future database builds and HTML5 developments must be in line with partner initiatives to ensure widespread use and adoption of the RTAT mobile data collection tool.

4. ODK Form Development Limitations

The ODK compliant forms were developed initially on the ODK XLS2XFORM program until logic within the XLS2XFORM could no longer be supported. XLS2XFORM developed Extensible Markup Language (XML) form file lines of code were then edited manually to meet the needs of RTAT. This severely limits the simplicity of, and time to create, form edits and changes.

5. Satellite Communication

Internet connectivity in the form of surviving cellular data service, NGO provided Internet café, or BGAN is required within the disaster zone to meet the needs of RTAT and validate the Savvion findings.

6. Local Language

Ability to speak the local language is a must in interviewing local points of contact in the conduct of RTAT assessments. It should be noted that ODK does support numerous languages. However, Filipino (Tagalog) is not one of them.

7. Crowdsourcing

There were crowdsourcing limitations during Typhoon Haiyan. All but two volunteers had either military, first responder or an ICT background. More research should be conducted into the validity of assessments by volunteers with no military, ICT or first responder experience (or combinations thereof). Further, no comparative analysis was done between those that had prior experience at the Legazpi City demonstration experiment and those that were using the RTAT assessment tool for the first time during Typhoon Haiyan.

Vast improvements in the Savvion process costs hinge upon obtaining 10–20 local volunteers. This is tied to the crowdsourcing limitation above. RTAT members must train those crowdsourced volunteers before they can be utilized. Legazpi City and Typhoon Haiyan demonstrated that large numbers of volunteers could be obtained in a short period of time given the right motivation.

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V. FOR FURTHER RESEARCH

The intent of RTAT is to deploy scores of crowdsourced evaluators that could conduct ICT assessments and for those collected data points to automatically work its way up the information chain shown in Figure 1. The real purpose of this data collection effort is the integration of RTAT data into the situational awareness that can be found directly in or gleaned from and overarching ICT current operational picture (Figure 41). Holistic situational awareness, regardless of cluster, is the means by which better collaborative decisions can be made by humanitarian assistance (HA) responders.

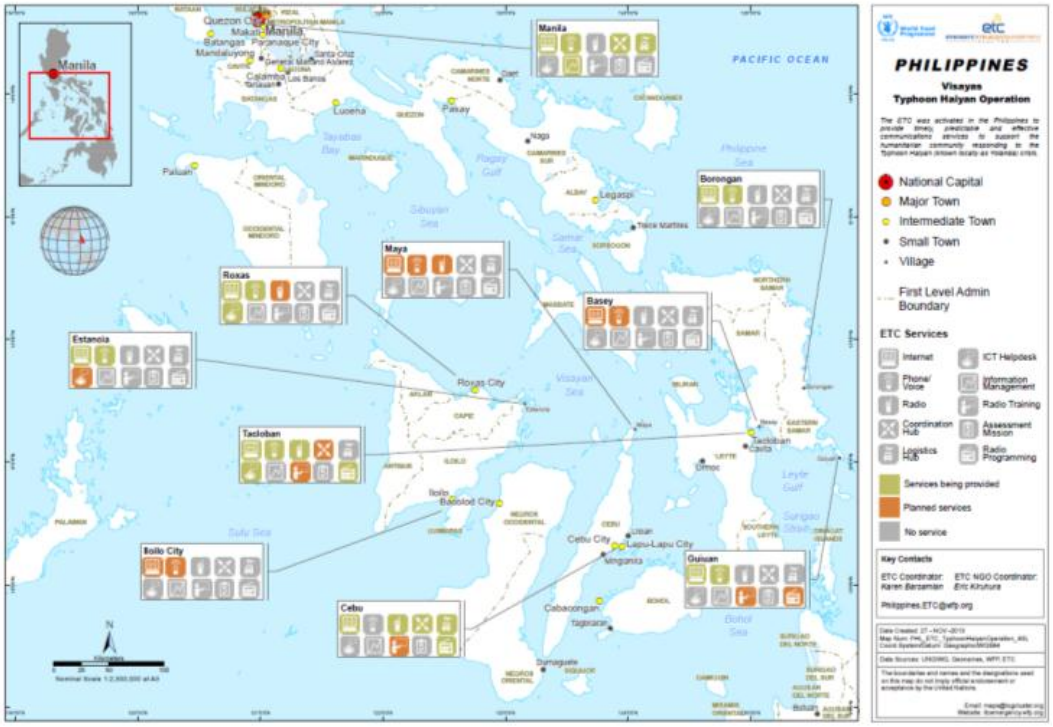

Figure 41. UN-ETC Typhoon Haiyan Current Operational Picture November 27, 2014 (from WFP, 2013c)

This chapter outlines efforts that were ongoing at the conclusion of the thesis, potential future research areas, as well as some solutions to the limitations discussed in Chapter IV.

1. Integration with Humanitarian Assistance Response Community

RTAT should explore collaborating more with the USAID, UNDAC and FITTEST teams to align assessment efforts and future assessment developments (collection data, form, and tool). As discussed in the *Limitations* section of Chapter IV, efforts must be harmonized with partner initiatives to ensure widespread use and adoption of the RTAT mobile data collection tool specific areas for further research and develop are outlined and discussed below.

a. Hyper Text Markup Language 5

As previously discussed, the RTAT mobile data collection tool is not compatible with Apple's iOS operating system. This is a problem because nearly half of all smart phones run on iOS. One potential solution is to create a Hyper Text Mark-up Language 5 (HTML5) program that would be operating system agnostic while meeting the requirements of RTAT. Project requirement discussions are underway to explore this avenue with Humanitarian Tool Box (HTBox), an organization that volunteers computer programming to HA organizations. Discussions are in the requirements development stage and could be accelerated with an upcoming "hack-a-thon." If, however, the Naval Postgraduate School (NPS) Common Operational Research Environment (CORE) Lab's Lighthouse application HTML 5 project is any indication, these efforts will take six months to a year to complete. Therefore the ODK RTAT v6 solution must remain viable until a follow-on operating system agnostic solution is brought on-line and discussions with PDC to integrate v6 forms should continue.

b. Data Base Development

ODKAggregate can export a flat file (spreadsheet) that can be imported into a database such as MySQL or MS Access. ODK does have some rudimentary query capabilities that have thus far met the needs of RTAT. Unfortunately, ODKAggregate's flat file interface will not be able to keep pace as RTAT grows and integration with Pacific Disaster Center and the rest of the HA response community continues. Constant revisions of RTAT assessment forms have thus far hampered this effort and should be addressed as soon as RTAT v6 is officially adopted.

c. Humanitarian Disaster Exchange Compliance

Database efforts should align with current and anticipated Humanitarian Disaster Exchange (HDX) requirements to facilitate sharing of collected data to the rest of the HA response community. This will ensure assessment harmonization with other UN assessment reports.

2. Pacific Disaster Center Integration

The primary development partner, in regards to assessment display, has been the Pacific Disaster Center (PDC) and its DisasterAWARE web portal. Late form finalization has effected both the database development discussed above and with RTAT assessment data integration with PDC and will be discussed in greater detail below.

a. Data Exchange

RTAT Assessment v6's successful demonstration test at the Joint Interagency Field Exercise (JIFX) in August 2014 marks the unofficial finalization of the RTAT assessment form. However, RTAT as a whole still needs to officially bless the form before efforts to fully automate and integrate a data exchange can begin. JIFX assessment data was sent to PDC on September 9, 2014 with an initial conference call to discuss the data and server letters of agreement pending at the time of thesis submission.

b. DisasterAWARE View

The current view of a RTAT assessment on DisasterAWARE yields little intuitive information, Figure 42. Research is needed to develop the best operational view that easily conveys pertinent information to the end user, see Figure 43 for latest proposal.

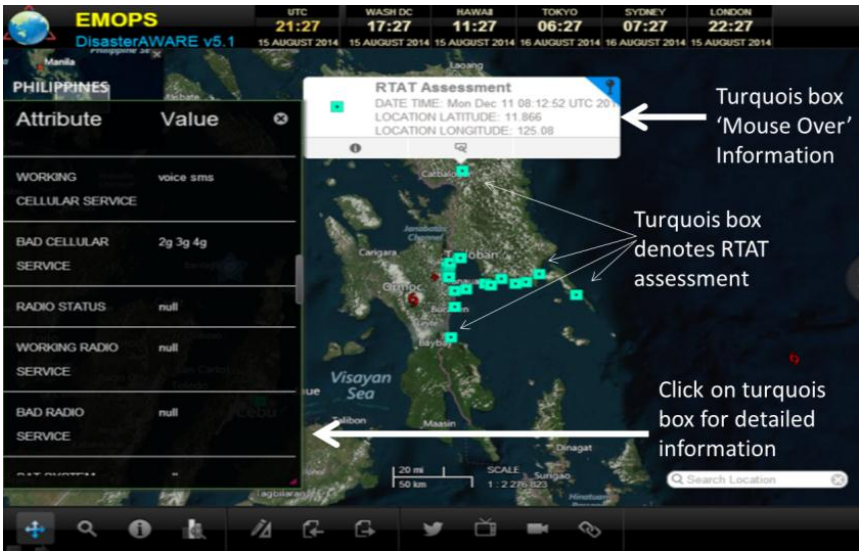

Figure 42. Current DisasterAWARE view

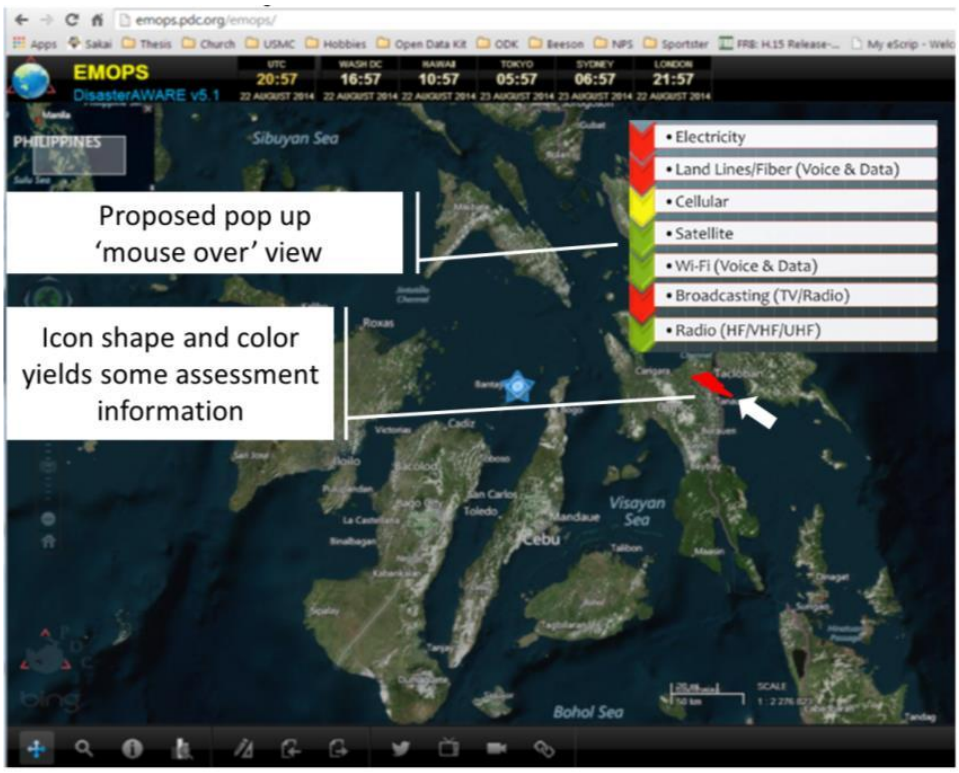

Figure 43. Potential DisasterAWARE view (after B. King, personal communication, April 22, 2014)

In the Figure 43 example, the red lightning bolt indicates that electricity is "Not Working" at that assessment location. A quick "Mouse Over" (Figure 43) of the

assessment location reveals additional issues with Land Lines/Fiber (sub-) services, Cellular (sub-) services, and Broadcasting (sub-) services. Double clicking on the icon would return the RTAT assessment report discussed next.

c. RTAT Assessment Reports

Tied to the database and HA response community integration, RTAT needs to develop a standardized report that can be generated from collected data. Figure 44 is an example of one such proposed report. Research into intuitive report design and harmonization with common HA response community assessment report practices should be conducted before report finalization. Further, integration (coordination or harmonization) into USAID reports and the UN's Situational Analysis and MIRA reports are a must going forward if RTAT's contributions are to remain valid within the larger HA response community.

Rapid Technology Assessment Team - ICT Field Report	
Assessment Date	4/13/14
Assessment Time (Local)	6/17/04
Location (LAT)	11.14.13.11N
Location (Long)	124.59.53.74E
Locaiton Common Name/Description	Devine Word Hospital - Tacloban
Assessors Team Name	PHL RTAT Team One
Assessors Contact Info:	SAT #: 123.456.7891, APAN Team 5, Email, RTATTeam1@TeamRTAT.org

Electricity	Land Lines/Fiber (Voice & Data)	Cellular	Satellite	Wi-Fi (Voice & Data)	Broadcasting (TV/Radio)	Radio (HF/VHF/UHF)	Final Remarks	Photos
Condition RED	Condition RED	Condition YELLOW	Condition YELLOW	Condition RED	Condition YELLOW	Condition YELLOW		Insert URL here.
Intermittent	Voice services not working	Voice service is intermittent	Satellite voice service is intermittent	Wi-Fi Voice and Data not working.	Broadcast TV is working	Replacement HF Antenna's needed (x4)	Locals in desperate need of Water. Expect limited supplies to run out in less than 24 hours. Hosptial low on plasma per Dr. Smith and Dr. Raji.	
Fuel being rationed. Generators are being shut down at night at every 3 hours.	Data service is not working	Cellular text service is intermittent	Satalite data service is intermittent	BGAN systems (x2) but no spare bandwidth.	Broadcast Radio is working			
Max 2 days operation based on current fuel reserves even with rationing.	Heavy damage to all telephone poles in area.	Cellular text is only working off local cell tower. No ability to text or talk outside local area.	Spare SAT phones are not available at this location for use.	VSAT systems needed (x3) and at least 2 more BGAN systems plusSIMS and power systems to support all for 2 weeks.	Local reception by Hoptial staff is not possible due to power problems for TVs and portable Radios. No spare power not otherwise committed to Hopital critical gear.			
Grid power unavailable. Heavy damage to all power transmission lines. No other power alternatives seen.	Phone repair teams need to be dispatched to area. Based on damage expect restoration may take significant amount of time. Alternative means of communications needed at hospital.	Celluair towers heavily damaged. Lack of power will cause problems even if towers can be reapaired. Cellular service for voice or data not a viable option for communications to outside resources at this location.	NGO's have 2 BGANs, but no spare bandwith.	POC: SMART, John Smith 123.456.7891, POC GLOBE, Jane Smith 123.456.7891, POC APAN, Charles Smith 123.456.7891, Hopital POC Dr. S Smith via NGO RTAT POC	See Electricity remarks for summary of power needs. Also need an additional 4 battery operated TV sets and 15 portable battery operated radios. 12 for use on Hopital campus and 3 for use in Camp Charlie located just West of the main Hospital.			
Additonal fuel is urgently requiered. Additonal generators (2kW or highter power) needed. Total = 7	POC: John Smith, Local Telco, 123.456. 789, Secondary POC at Local Telco: Jane Smith 123.456.7891	Alternative means of communications with power need to be provided to the hospital.	Need 4 - 6 SAT phones with SIM cards for use by mayor and Hospital staff.		Channel 2 and 700AM are available with proper gear in this location.			
POC: John Smith (SAT# 123.346.7891)		Celluar providers are SMART and GLOBE	NGO 1 POC: John Smith 123.456.7891, NGO 2 POC: John Smith, 123.456.7891					
		POC: SMART is John Smith 123.456. 7891, POC GLOBE is John Smith 123.456.7891						

Figure 44. Proposed RTAT Assessment Report (after B. King, personal communication, April 22, 2014)

APPENDIX A. COMMAND & CONTROL CASE STUDY OF THE RESPONSE TO HURRICANE KATRINA

Appendix A is an unpublished paper written as a final project by five officers at the Naval Postgraduate School for a command and control class (Canon et al., 2012). Quotes and ideas were taken from this paper. This document could not be found by any other means other than by inclusion with the thesis.

Command & Control Case Study of the Response to Hurricane Katrina

Christopher Cannon

R. Travis Beeson

Keystella Mitchell

Patrick Spencer

Michael Liguori

Naval Postgraduate School

15 November 2012

Command & Control Case Study of the Response to Hurricane Katrina

Introduction

Hurricane Katrina made landfall as a Category 4 storm on August 29, 2005 near New Orleans, Louisiana. Katrina's devastation was exacerbated by the subsequent failure of the levee system that protected New Orleans from Lake Pontchartrain, 24 hours after land-fall. The levee failure resulted in wide spread flooding of New Orleans causing extensive damage to its infrastructure that in turn hampered the command and control of rescue, relief and recovery efforts. The official death toll surpassed 1,200, over 1 million people were displaced and damages exceeded $200 billion. Hurricane Katrina created a

humanitarian crisis on a scale unseen in the history of the U.S. and is to date the most destructive and costliest natural disaster in the history of the United States (Striedl, Crosson, & Farr, 2006).

This paper will explore the Command and Control (C2) inter/intra relationships between the involved local, state, federal government entities, as well as, non-governmental and regional partnership organizations and discuss what worked and what should be improved upon. Additionally, this paper will glean from the Katrina lessons learned a set of C2 principles that are both Katrina specific and generalizable to other complex endeavors.

Background

The U.S. *National Response Plan* (NRP), resulting from Presidential Directive No. 5 in 2004, recognizes that planning, preparing for and responding to natural and other disasters are primarily responsibilities of the individual states. This reflects the U.S. constitutional perspective, and results in a pull response assumption, with local authorities having the lead at the start, escalating to state level and then to federal level, if necessary and if requested (Moffat, 2008).

The Stafford Act also outlines the process by which state governors request this assistance from the federal government when the event becomes one of "National Significance." The U.S. President then has to decide whether this merits designation as an Emergency (releasing limited resources to the states), a Major Disaster (releasing much greater resource to the states) or a Catastrophe. The first two of these result in a pull response: the states requesting and drawing down from these federal resources as they see the event unfolding. The third category of Catastrophe would have resulted in a proactive push of resources to the region, states and local level, irrespective of the states' requests (Moffat, 2008). The Stafford act attempts to organize and capture all Federal costs associated with the significant event. However, its processes can be cumbersome, slow and ill-suited to a dynamic situation where a rapid response, vice monetary accountability, is the gauge of success.

Under the NRP, a comprehensive framework of response to significant event is set up. At the Federal level, the Homeland Security Operations Centre, the Federal Emergency Management Agency (FEMA) National Response Centre and the Interagency Incident Management Group jointly coordinate the response across government departments. The federal coordinating officer (FCO), a representative of the Secretary for Homeland Security, is authorized to lead a Joint Field Office (JFO). This is a temporary federal facility established locally at the time of a disaster to coordinate the local, state, and federal response. It consists of senior representatives from all of the agencies and responders involved, and develop objectives, strategies, plans, and priorities. The membership of this office is envisaged as growing and adapting over time as the incident escalates or diminishes (Moffat, 2008).

In summary at pre-Katrina landfall, the NRP and Stafford Act clearly delineate that states have the lead on handling natural disasters within their states and with the exception of "catastrophic" events are required to request assistance from the federal government if necessary. FEMA is the lead federal C2 agency for handling "nationally significant" events (Meeds, 2006). The entire system is set up in a strict, regimented, hierarchical system, local, state, regional and or federal respectively, that will be shown to be ill-suited and deficient for the dynamic task at hand.

Analysis of Principles with Alternate Decisions

Principle: Fit

A key C2 principle relevant to the Hurricane Katrina response involves the concept of fit. **Fit is the match between the organization structure and contingency factors that has a positive effect on performance** (Nissen & Burton, 2011). Regardless of the mission, successful C2 systems "fit" within the constraints of the environment and successfully match organizational structure and methodology to the mission. Organizations that fail to appropriately design their C2 system to the operational environment and mission achieve a "misfit," which significantly degrades organizational performance.

The organizational structure and methodology employed by local, sand federal agencies during the response to Hurricane Katrina was based off the National Response Plan (NRP). The NRP is the federal government's baseline plan to coordinate disaster response, and is designed to facilitate coordination of federal resources in response to a catastrophic event. The NRP is based off a structured C2 configuration closely resembling a Machine Bureaucracy. Thus, the C2 organization predicated in the NRP is hierarchical and utilizes centralized command structure, high degrees of specialization, highly formalized vertical communications pipelines, high decision thresholds and standardization of work processes for coordination. It is designed around the assumption that the environment is stable and simple (i.e. predictable), and seeks to optimize responses based off repeatable cause-and-effect relationships. The strength of the Machine Bureaucracy resides in its stability; however, this stability also makes it slow and inflexible.

Unfortunately, the bureaucratic machine designed to respond to Katrina was too slow and inflexible to handle the chaotic situation in Louisiana, Mississippi and Alabama—which "misfit" the situation. The high decision thresholds and "red tape," which accompanied each major decision, slowed recovery efforts. Highly formal and vertically oriented communications pipelines slowed information flow that led to poor situational awareness. Highly centralized command functions and the lack of self-contained units exercising initiative in distributed areas resulted in duplicated recovery efforts in some areas and total neglect in other locations. Together, these results indicate that the recovery effort (particularly during the initial stages of the response) was largely conflicted and unsynchronized which caused unnecessary suffering and additional loss of life.

A C2 configuration offering a better "fit" to the highly chaotic and unpredictable post-Katrina environment is the Adhocracy. A C2 system organized along these lines is the polar opposite of a Machine Bureaucracy. The Adhocracy utilizes decentralized and informal command structures, low degrees of specialization, informal communications pipelines (particularly horizontal), low decision thresholds and mutual adjustment for coordination. It performs best in highly dynamic and unstable environments, by stressing

fully distributed patterns of interaction, broad dissemination of information and peer-to-peer allocation of decision rights (low decision thresholds). The Adhocracy assumes that the environment is unpredictable and favors agility to respond to unknown circumstances over optimization of responses to predictable scenarios (Machine Bureaucracy approach).

The strength of the Adhocracy lies in its speed and maneuverability, which comes at the cost of accuracy and stability. In catastrophic response scenarios however, the critical factor is time not accuracy; therefore, speed of response vice accuracy of response should have been the key factor dictating the federal government's response to Katrina. Consequently, the C2 configuration representing the best "**fit**" to these operational requirements should have been identified as an Adhocracy vice a Machine Bureaucracy—the improved performance from employing the better fitting C2 system would likely have eased suffering and saved lives.

Principle: Unity of Command

Another principal that stood out due to not having the right "fit" as stated above was the concept of unity of command. C2 is largely about *organizing* people with aligned goals, who coordinate efforts via procedures and leverage capabilities through technologies (Van Creveld, 1985, 10). Van Creveld's biggest learning point was that command systems cannot be understood in isolation. Movement towards labeling command as a "system" vice a hierarchical chain produces a deeper understanding of relationships in a complex environment. Unity of command is paramount in C2. Command as a process vice an individual, effectively uses information in a more powerful way to coordinate people and equipment. Great leaders understand that the organization does not exist to serve them rather that they exist to serve the organization, to work with others to help create conditions necessary for success (Alberts and Hayes, 2003).

> C2 of all support forces was a serious issue during recent disaster relief operations... the answer to "Who is in charge?" depended on to whom you posed the question. Lack of unity of effort led to overloaded support in some areas and not enough in others (Center for Army Lessons Learned 06–11: Hurricane Katrina, 2006).

The above statement from the Army lessons learned amplifies the point that given a complex disruption (catastrophe), people often look to a stated person in charge. When the "commander" does not appear, chaos and lack of cohesion exponentially rise. Some argue that the focus should be on unity of effort vice unity of command. By focusing on unity of effort, the cure to a symptom is sought rather than the root cause in that command is still a function of the commander vice a process. The principle views command as a process emphasizing unity of command that produces unity of effort as a bi-product.

The lack the unity of command unfortunately points out many of the failures from the Katrina response. Specifically, the lack of coordination to align goals produced duplicate efforts, confusion, frustration and misappropriated assets. By not organizing people to coordinate efforts, the system from the start became conflicted. The Final Report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina (2006) listed an overwhelming lack of unity of command that spawned dismal coordination. Below are a few key identifiers from the report that conveyed a lack of unity and coordination (pp. 3, 4, 299, 315):

- The C2 of the National Guard units and the federal level could not exchange information.
- No unified C2 system was put in place during the search and rescue, evacuation, and supply delivery missions. The effect was that of having multiple rescue teams operating in the same area while other areas were left uncovered.
- DOD, FEMA, and the State of Louisiana had difficulty coordinating with each other, which slowed the response.
- DOD-DHS coordination was not effective during Hurricane Katrina.
- Government did not effectively coordinate private air transport capabilities for the evacuation of medical patients.
- Lack of coordination led to delays in recovering dead bodies.
- State officials feel there has been a lack of coordination within the interagency community causing delay in relocating and housing people.

The large organizations (local, state, DOD, DHS, FEMA, etc.) may have had great intentions to help; however, the leaders decisions broke down in the dynamic, less predictable environment that conflicted the entire system. Commanders and top-level

officials were making decisions with the understanding *they* are the C2 of their organization vice looking at C2 as a process. The sheer overwhelming event of Katrina exposed the vulnerability in the system that gave too much importance to some individuals. Fortunately, due to the tireless work of people at the tactical level, coordination began to produce direction. As the maturity level grew due to unflagging tactical initiatives, the efforts matured and the system evolved to deconflicted with signs of coordination at the very end. Specifically, what evolved were multiple organizations communicating with liaisons. The steep learning curve came at a very high cost.

Unfortunately, many official definitions continue to be focused on the authorities associated with command, not on *the what* and *the how* of what needs to be accomplished (Alberts and Hayes, 1995). To better employ and maximize the stated principle, the process must be the focus. By focusing on the process, coordination will prosper. Specifically, to increase maturity and coordination rapidly (key in a Katrina like event), the frequency of interactions among the entities must be emphasized. These interactions shift the focus from the Information domain (from sparse to rich exchange of information) to the Cognitive domain (from low to high degrees of shared awareness) and to the Social domain (from low to high sharing of resources) (Moffat and Alberts, 2006). Concrete examples to employ are to emphasize liaisons and establish coordination centers for fusion cells to coordinate efforts. Other key aspects to improve C2 came from the White House's Lessons Learned, 2006. These initiatives began to acknowledge coordination and C2 as a process to empower unity of command:

- Ensure that for events preceded by warning, we are prepared to pre-position an interagency federal joint field office (JFO) to coordinate and, if necessary, direct federal support to the disaster.
- Ensure that relevant federal, state, and local decision makers, including leaders of the State National Guard, are working together and in close proximity to one another in the event of another disaster.
- Embed DOD points of contact at the JFO and FEMA regional offices to enhance coordination of military resources supporting the response (liaisons).

Principle: Communications must be adaptive

Poor unity of command exacerbated the third principle concerning communications. Communication is broken into two facets to support C2. **The need to**

maintain an informal, as well as a formal network of communications inside the organization; as well as the need for a regular reporting and information transmission system working both from the top down and from the bottom up (Van Creveld, 1985, 270). Communication is a vital aspect to Command and Control (C2) whether one is looking at it from a much defined warfighting organizational structure or a fairly loose coordinated structure such as a disaster relief effort. Communication must be adaptive to provide needed information to the right place at the right time.

Communication can be viewed as a system with multiple roles to support the C2 process (JP-6, 2006). One role of the system is to ensure connectivity thus to provide the capability to effectively plan, conduct, and sustain operations. Another role is to provide the essential tools necessary to collect, transport, process, protect, and disseminate information. Finally, it serves a role to provide processes and procedures in which to aid in ensuring information availability to facilitate the need for distributed operations in a nonlinear process. A communication system that is effective in each of these roles as well as being agile, interoperable, trusted and shared forms a network that is linked and synchronized in time and purpose to allow a C2 process to successfully implement to achieve the mission.

Now taking a look at the disaster relief efforts of Hurricane Katrina in 2005 from a national, regional and local perspective on how well their communication system support the operational efforts to accomplish the mission. There were inherent failures at all levels of this disaster relief effort from a communication perspective. Starting from the top of the U.S. Emergency Structure that was obviously not in place or operating properly to effectively deal with the devastation that Hurricane Katrina left behind. The lines of communication with respect to the Stafford Act were not at all effective statistically there were 1,833 fatalities, winds gusting at 175mph and an estimated 108 billion dollars in damages however the response from the federal government was to wait to determine if whether the state and local government could handle to destruction that was caused by the hurricane. The timeline of responsive action is the biggest indicator of an ineffective communication system it took what must have seemed like a lifetime to those affected to get the necessary assistance required. As the devastation and destruction played out in the

national media civilian and military decision makers throughout the government estimated that the inflow of National Guard troops was sufficient to handle the situation. On 31 August after being given a "blank cheese" for any DOD resources General Honore still "did not believe that federal ground forces were needed." This proved the breakdown or lack of communication from a national level.

On a regional level the federal government and the governor of Louisiana required 24 hours to agree on a structure of separate active-duty and National Guard task forces. However, the final agreement was not reached until six days after the landfall of Hurricane Katrina. From a local level the coordination of the local law enforcement did not take place until eight days after the landfall of the hurricane. Failure to establish an effective communication system with identified lines of communication resulted in the situation experienced during Hurricane Katrina one of mass chaos and confusion. Specifically, multiple units searched for survivors covering the same ground while other areas go unsearched.

Establishing an effective communication networks which allows the necessary communication between and among national, regional and local agencies that are agile, interoperable, trusted and shared would alleviate issues experienced by Hurricane Katrina. Linking and synchronizing the C2 process through communications would greatly improve the probability of success in a dynamic environment. Formal and informal communications that are interoperable and synced would also increase the unity of command as a process with in a coordinated effort against a complex situation.

Principle: Agility

The concept of C2 agility and maturity surfaced a fourth principle tied to Van Creveld's idea in that an organization that will make such low-decision thresholds possible must provide self-contained units at a fairly low level (Van Creveld, 1985, 270). The more uncertain and dynamic an adversary and or the environment are, the more agile a C2 organization must be or become (Alberts and Hayes, 2003, 124).

Alberts and Hayes (2003, 127-128) went on to define agility by six key dimensions: robustness, resilience, responsiveness, flexibility, innovation and adaptation.

The aforementioned dimensions will be the lens used to analyze the Hurricane Katrina C2 organization with respect to the stated principle.

Robustness is the ability to maintain effectiveness across a range of tasks, situations, and conditions (Alberts and Hayes, 2003, p.128). Mobilized state, National Guard, regional partners, and local assets were not capable of handling the C2 requirements of Hurricane Katrina and the subsequent levee failures that flooded New Orleans (Meeds, 2006). As federal DOD assets became available C2 of the relief efforts became an attainable objective.

Resilience is the ability to recover from or adjust to misfortune, damage, or a destabilizing perturbation in the environment (Alberts and Hayes, 2003, p.128). The C2 system was not resilient to a hurricane, Dourandish, Zumel, and Manno (2007) found that "severe damage to the communications infrastructure created significant difficulties and hampered rescue efforts due to the resultant lack of situational awareness by civilian and military officials."

Responsiveness is the ability to react to a change in the environment in a timely manner (Alberts & Hayes, 2003, p.128). The entire mobilization effort was not responsive, of the 50,000 National Guard and 20,000 federal military personnel eventually deployed to the affected areas, only about 11,000, or about 16 percent were on the ground within the first three days of the event, including approximately 9,000 prestaged National Guard personnel (Dourandish, Zumel, and Manno, 2007).

Flexibility is the ability to employ multiple ways to succeed and the capacity to move seamlessly between them; innovation is the ability to do new things and the ability to do old things in new ways (Alberts & Hayes, 2003, p.128). FEMA provided funding for a Southeast Louisiana Catastrophic Hurricane Planning Project, and two planning conferences were held in the 6-8 weeks leading up to hurricane Katrina for federal, state and local entities. Shortfalls were identified, but not corrected, and more importantly no one exercised the plan drafted. As a result, the entities involved could not exercise the plan created nor adapt as the events did not go as planned (Townsend, 2006). This gives rise two applicable combat principles: ***the plan is nothing, planning is everything***

(conversations with Colonel D. Crall, USMC, 2007), tempered with, ***no plan ever survives first contact*** (derived from quotes from Carl von Clausewitz and Helmoth von Moltke).

The final dimension to agility is Adaptation. Alberts and Hayes (2003, p.128) defined adaptation as the ability to change work processes and the ability to change the organization. The first week post Katrina land fall was chocked full of examples of ad hoc and adaptive processes and changes but their efforts were sporadic and overall inefficient and ineffective. With that said, the Katrina C2 system matured from non-existent or conflicted operations to de-conflicted operations after the first week as more entities and assets arrived in theater and working relationships were developed (Meeds, 2006).

Recommended agility improvements. Scalable, modular capability package organizations should be regionally developed/based that can provide Emergency Support Functions capabilities to the federal coordinating officer. Specific DOD and National Guard units should be tasked with setting up and manning Civil Military Operations Centers and those units should participate in annual FEMA exercises with their state and local counterparts to exercise C2 capabilities. These organizations should be nimble, maneuverable/mobile, self-sufficient and capable of sustained operations for 10 days. These entities will be the forerunner to larger more hierarchical capabilities.

Summary

By using a number of lenses to analyze C2 during Hurricane Katrina, we concluded that the organizational structure and methodology employed by local, state and federal agencies were less than adequate. By understanding the guiding documents used during the response to Hurricane Katrina (National Response Plan, and Stafford Act) we assemble some necessary principles:

1. Unity of command
2. Agility
3. Adaptive communication
4. Organizational fit

The lack of ***unity of command*** unfortunately points out many of the failures from the Katrina response; having individuals, organizations and systems change the way they relate to one another will enhance coordination at all levels. In the complex dynamic environment where no single entity is in charge, the coordination and process of C2 will prevail vice individual commanders. Through this coordination ***agility*** will increase providing clarity in uncertain and dynamic situations; this agility will provide enhanced communication. By establishing an effective formal and informal ***communication*** network that is agile, interoperable, trusted and shared the necessary communication between and among national, regional and local agencies would have decrease issues experienced during Hurricane Katrina.

Subsequently, the C2 configuration representing the best ***"fit"*** to these operational requirements must be identified and executed to improve performance during the employment at the local, state and federal level. Regardless of the mission, successful C2 systems must have agility with clear communication in order exercise unity of command, which ultimately provide the optimal fit. There is no single approach, no best system design or configuration, no best process for all situations and circumstances (NATO NEC C2 Maturity Model, SAS-0651, 14).

References

Striedl, P., Crosson, J., & Farr, L. (2006) Association of Contingency Planners Observations of Hurricane Katrina Lessons Learned. Albany, NY. ACP

Meeds, H. K. (2006). *Communication Challenges During Incidents of National Significance: A Lesson from Hurricane Katrina.* (Dissertation). U.S. Army War College. Carlisle Barracks. PA.

Dourandish, R., Zumel, N., Manno, M. (2007). *Adapting C2 to the 21st Century*: 2007 Command and Control Research & Technology Symposium. Newport, RI.

Nissen M. E., Burton R. M. (2011). Designing Organizations for Dynamic Fit: System

Stability, Maneuverability, and Opportunity Loss, IEEE, VOL. 41, 3.

Alberts, D. S., Hayes, R. E. (2003). *Power to the Edge*, DOD Command and Control

Research Program: CCRP Publication Series.

Creveld, M. V. (1985). *Command in War*. Cambridge, Massachusetts: Harvard University Press.

Teague M. J., Col, U.S. Army. The Domestic Coalition: *The C2 Relationship Between Active Component And National Guard Forces In Defense Support Of Civil Authorities Operations,* http://www.dtic.mil/dtic/tr/fulltext/u2/a476794.pdf

U.S. House of Representatives. (2006). Preparation for and Response to Hurricane Katrina, , http://www.c-span.org/pdf/katrinareport.pdf

Alberts and Hayes (1995), *Command Arrangements for Peace Operations*. Washington DC: CCRP, 1995 pp 5- 6; Alberts and Hayes, *Understanding Command and Control*. Chapter 4; NATO Glossary: http://www.nato.int/docu/glossary/eng/15- main.pdf & http://www.dtic.mil/doctrine/jel/other_pubs/aap_15_04rev1.pdf ; BiSC C2 Plan: Bi Strategic Commands (NATO), the coordinated position of the two Strategic Commands: Allied Command Europe (ACE) and Allied Command Atlantic (ACLANT).

Moffat J. & Alberts D. (2006), Maturity Levels for NATO NEC Command Dstl Unpublished Report

Townsend, F. (2006). *The Federal Response to Hurricane Katrina, Lessons Learned*. Department of Homeland Security, Washington, DC.

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APPENDIX B. RAPID INFORMATION AND COMMUNICATION TECHNOLOGY ENTERPRISE ARCHITECTURE ASSESSMENT

Appendix B is a paper written by the author for an enterprise architecture strategy class at the Naval Postgraduate School (Beeson, 2013). This paper was instrumental in the development of the RTAT "As Is" and "To Be" models tested with Savvion and was instrumental in understanding the RTAT organization. Ideas, figures and quotes were taken from this paper.

Rapid Information and Communication Technology Assessment Team (RTAT) Enterprise Assessment (EA)

By: Major R. Travis Beeson
Instructor: Professor Kishore Sengupta

Naval Postgraduate School
CC 4250—Enterprise Architecture
Summer 2013

Cataclysmic events such as the Indonesian tsunami in 2003 and hurricane Katrina in 2005 leave a wide and devastating wake of destruction. The horrific human suffering in these types of events is exacerbated by the inability of relief organizations to collaborate efforts, that is collectively assess the situation, prioritize efforts and effectively allocate scarce resources. This is due in large part to an ineffective or missing overarching collaboration organization, and further compounded by severely damaged host nation communication infrastructure. Most organizations "don't know what they

don’t know” when they show up and as a result incorrectly equip themselves for the information and communication technology (ICT) environment. Several organizations assess various aspects of the ICT infrastructure, but none collate the information into a complete understanding. To fill the gaps the Rapid ICT Assessment Team (RTAT) was created to conduct a holistic assessment of the ICT environment and share this information with other responding organizations. However, the problem of efficiently and effectively collecting the data, creating a common ICT operational picture and getting this information into the right hands has yet to be solved. This assessment is being conducted to help RTAT solve this problem. RTAT is a startup organization that currently has no documented Enterprise Architecture (EA) strategy. This assessment will be the foundation of that strategy and the building block for its eventual Enterprise Resource Planning solution.

ASSESS THE ENTERPRISE

Sengupta (2013) stated, "The architecture must be congruent with the organization of the enterprise, technology must be aligned with the "business" requirements and "the architecture must be robust and durable." For the purposes of this paper the RTAT "Enterprise" is defined as the people, equipment and processes associated with the collection, storage and promulgation of pre and post disaster ICT data collection.

What does RTAT do?

The mission of RTAT: Conduct and promulgate baseline and post-disaster Information Communication Technology (ICT) infrastructure assessments, to facilitate host nation and international disaster relief efforts (Steckler, 2012). "Facilitate" includes the management and dissemination of a shared common operational picture and ICT recovery prioritization recommendations.

Currently RTAT is conceptually organized into "rapidly deployable small, nimble, multi-organizational, multi-national integrated assessment teams of specialists in key ICT areas such as wireless data communications, voice communications, radio technologies, power, information sharing, social networking, etc." (Steckler, 2012). These teams would be led by team leader and a "national affected state member (such as National Disaster Management Agency, Ministry of Communications or equivalent affiliated organization)" (Steckler, 2012). RTAT is currently made up of international founding member organizations/volunteers, but the aforementioned cadre of standardized prepositioned teams and equipment is the future model.

There are several stakeholder organizations associated with RTAT and include: The UN, Association of Southeast Asian Nations (ASEAN), Pacific Disaster Center (PDC), U.S. Pacific Command, and the Naval Postgraduate School, as well as several other governmental and Non-Governmental Organizations (NGO) (Steckler, 2012).

How is the work done?

Core processes are outlined in the use cases of attachment 1 and include:

1. Conduct of baseline, update and post-disaster ICT and power assessment.
2. Process assessments into a Common Operational Picture (COP) or understanding.
3. Make recovery ICT priority recommendations.
4. Distribute the ICT assessments, COP and priority recommendations to host nation and the international relief community.

Lines of reporting and responsibilities are still being developed and are a source for friction for the organization.

Current proposed RTAT team roles and responsibility model (based on Steckler, RTAT Executive Summary 15 November 2012)

Team Leader:

1. Prioritizes the team's efforts accounting for member strengths and environmental requirements/limitations.
2. Determine the team's make up and skill sets for the mission.
3. Coordinates with host nation and other international relief organizations to prevent duplication of efforts and add value to the relief efforts.
4. Receives input from host nation ICT counterpart and team members, to make a prioritized ICT repair recommendation list.
5. Disseminate assessments and recommendations to host nation and participating international relief organizations.
6. Make recommendations/decisions regarding follow on RTAT efforts. I.e. Extend the stay for current RTAT, turnover to a relief RTAT, or conclude RTAT efforts.
7. Be prepared to fulfill tasks as a Team Member.

Team Member:

1. Maintain the requisite skills in the area of expertise.
2. Be prepared to deploy within 12–24 hours to the disaster area.
3. Maintain self-sufficiency within the disaster area for up to 2 weeks.
4. Conduct assessments and "push" assessments to the server when and where an Internet connection is available.

ASSESS THE OPERATING MODEL

Assess the Operating Environment

As repeatedly demonstrated, large scale disasters like hurricane Katrina and the Indonesian Tsunami create highly chaotic and turbulent operating environments. Getting into and out of the affected country is difficult, physically moving about within the disaster zone can be nearly impossible. Many disaster prone countries lack adequate logistical and ICT infrastructure, this is further exacerbated by the by the wake of destruction these disasters leave. This is a highly uncertain environment with high levels of equivocality. While no one knows when and where the next disaster will strike, there is certainty that there will be a disaster in certain regions of the earth on an annual basis. To increase response agility, "RTAT teams would be stationed at key locations around the world, perhaps modeled after the UN Disaster Assessment and Coordination Teams program, or possibly as associate members of NetHope, the UN Emergency Telecommunications Cluster (ETC Cluster) or other similar teams. These teams could be called on by the host nation, UN agencies such as OCHA, WPF, or a regional entity such as ASEAN" (Steckler 2012). While no one knows for certain what specific ICT capabilities will be effected or what the operating environment will be like, there are many trends and lessons that can be gleaned from previous disasters. This historical perspective equates to high levels of uncertainty but low levels of turbulence for the operating environment.

Organizational Agility Response

Decision to respond: RTAT is designed to be a niche organization whose services will not be needed for every disaster. RTAT services can be requested by the host nation, regional authorities (ASEAN), global organizations (UN, NetHope, Red Cross), but RTATs can self-deploy based on the team leaders decision.

Range of RTAT responses: RTAT may deploy an assessment team, share baseline assessment information, act as liaison to host nation, or once Lighthouse is on online host/facilitate assessments conducted by locally trained responders. This niche ICT assessment range does include power, wireless (TV, radio, Wi-Fi/WIMAX, cellular), terrestrial (copper, cable, T-1, fiber optic), and satellite communications (Steckler, 2012).

Team deployment response: RTAT members/teams will be highly trained on both ICT assessment and personal sustainment skills (food, water, shelter, hygiene and personal security/safety) to use within the environment (Steckler, 2012). Additionally, teams will carry satellite communication and alternative power assets to facilitate mission accomplishment within the disaster zone. Finally, baseline ICT assessments need to be conducted for disaster prone areas to facilitate faster post disaster assessments (Steckler, 2012).

Correct uncertainty organizational response: Forward located, ready to deploy teams (within 12–24 hours), capable of self-sustainment (personal survival, satellite communication and sustainable electrical power) and armed with baseline ICT assessments are a must level of agility to successfully operate in the post-disaster environment. Figure 1 shows the improvement in Agility Response with the "to-be" IT changes made.

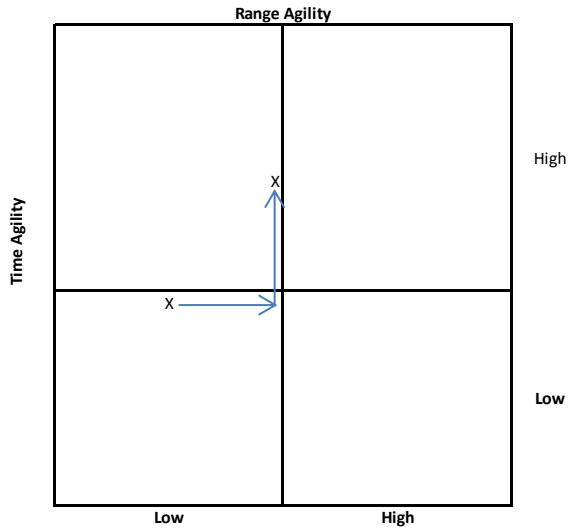


Figure 1 Agility Improvement

Assess the Current State of IT in the Enterprise

Specify "As-Is" models of operation

Currently RTAT uses a Microsoft Office host of programs, Skype as well as various other communication programs to accomplish its mission. A Microsoft excel spreadsheet is used to conduct the assessments and it relies upon assessors professional judgment to gauge non-standardized markings within the spreadsheet. These spreadsheets are then emailed, via various webmail services, to various points of contacts in the disaster recovery effort to disseminate their findings. The current excel assessment spreadsheet does not support export into a query-able database that can then be rapidly promulgated. There is no centralized COP. No standardized RTAT training, team makeup, or "go kit" equipment list. Current capabilities are very ad hoc and vary based on responder's personal assets, skills, and experience. Further compounding these issues is the lack of baseline assessments conducted within disaster prone countries (Steckler, 2012). The current IT model does not meet RTAT mission requirements.

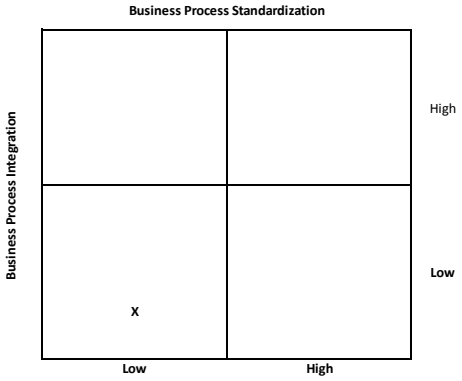


Figure 2

Current RTAT Operating Model

Chart from Ross, Weill, and Robertson (2006)

Currently, RTAT is operating as a start-up/fledgling "Diversification" operating model, with few standardized or integrated processes (Ross et al., 2006). This is an incorrect logic. While one could argue that the plethora of NGO's and countries dictate a

lack of "shared customers" with "independent transactions" and further argue that the disjointedness is par for the industry and or a byproduct of the very chaotic post disaster working environment. However, standards within the organization are a must for consistency in the assessments, COP, and IT Solution. Minimally, there must standards set regionally with a select few nations and NGOs as stakeholder customers. See Enclosure 1 for As-Is IT use cases.

Specify "To-Be" Models of Operation

RTAT is experimenting with a Lighthouse enabled Open Data Kit based mobile data collection tool that will help facilitate core process requirements. This Lighthouse program is the future core method for data collection and dissemination. Lighthouse has some COP features but they currently do not meet all of the expected needs of the international relief community. Lighthouse does have an exportable XML file feature that can be imported by other relief organization. As part of the IT strategy, RTAT is collaborating with the Pacific Disaster Center (PDC) to add ICT related information to their disaster COP (see Figure 3 for screen shot). ICT Assessments would be linked under the "more information" link. This will meet the intent for a common operational picture, but the technical issues, permissions, and letters of agreements must be solved and finalized.

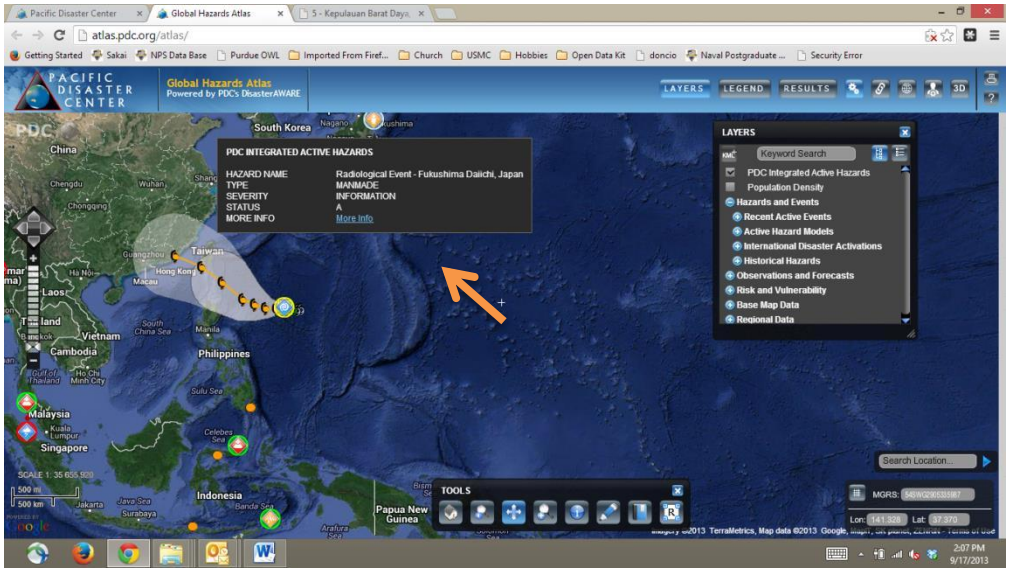


Figure 3, Pacific Disaster Screen Shot (atlas.pdc.org/atlas, retrieved 9/17/13)

Finalizing the RTAT mobile data collection tool would greatly standardize their core process of ICT assessment and dissemination integrating and linking RTAT information to the end user customer. Importing the findings into the PDC Atlas would standardize the COP and better integrate RTAT to the affected nation and responding NGOs. Overall RTAT would shift from their current "Diversification" operating model to a more process standardized and integrated "Replication" operating model with teams/services being interchangeable but with some specialization, see Figure 4 from Ross et al. (2006).

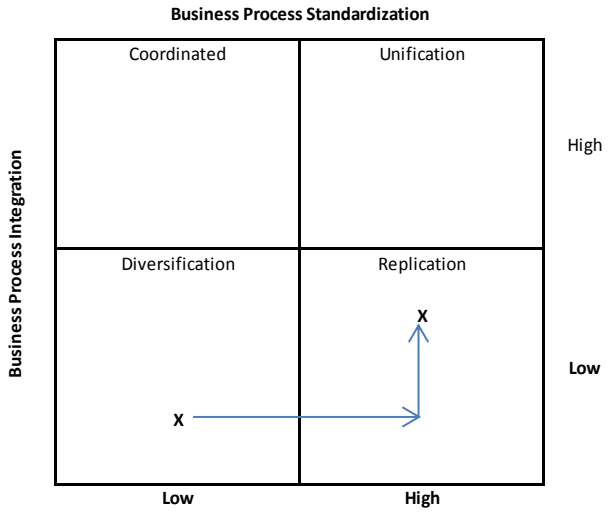


Figure 4 Shift from Diversification to Replication Operating Model Chart (After Ross et al. 2006, p.39)

BUSINESS ARCHITECTURE

RTAT is currently using an iterative/spiral software development plan. Versions of the RTAT assessment tool were tested in Thailand in July 2013. The tool underwent refinement with follow on tests, including "beta" baseline assessments, scheduled in the Republic of the Philippines 23–27 September 2013. Stakeholders at Naval Postgraduate School, PDC, ASEAN and local/regional governments in the Republic of the Philippines are very interested in and supportive of the endeavor to the point of hosting/funding the initial baseline site surveys 23–27 September. Figure 5 shows the Actor Role Matrix "to-be" with RTAT assessment tool and PDC COP operational.

Actor Role Matrix

R: Responsible A: Accountable C: Consulted I: Informed	RTAT Actors		3rd Party Actors		
Activity	RTAT Team	RTAT Leader	PDC	Host Nation	NGOs
Baseline Assessments	C	A, R		C, I	I
Assess ICT	A	R		I	I
Assess Power	A	R		I	I
Make Priority Recommendations	C	A, R		C, I	C
COP		C	A, C	I	I

Figure 5

FORMULATE PRIORITIES, PLANS

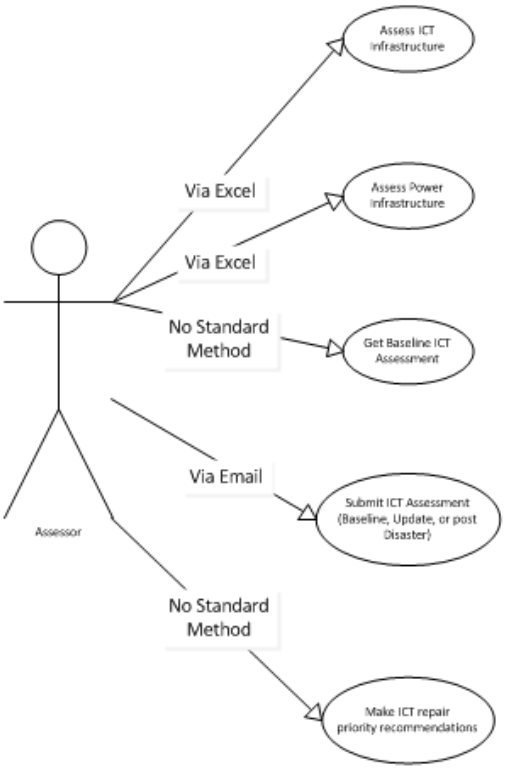
Currently there is no standard way of conducting post disaster ICT assessments, therefore standardizing/ refining the assessment forms in a query-able format has been the priority (Steckler, 2012). Running in parallel is the project with PDC to push the information to their disaster Atlas. Team training, and standardization of "go-kits" is the lowest priority, but some training has been conducted to test the various versions of the RTAT assessment tool.

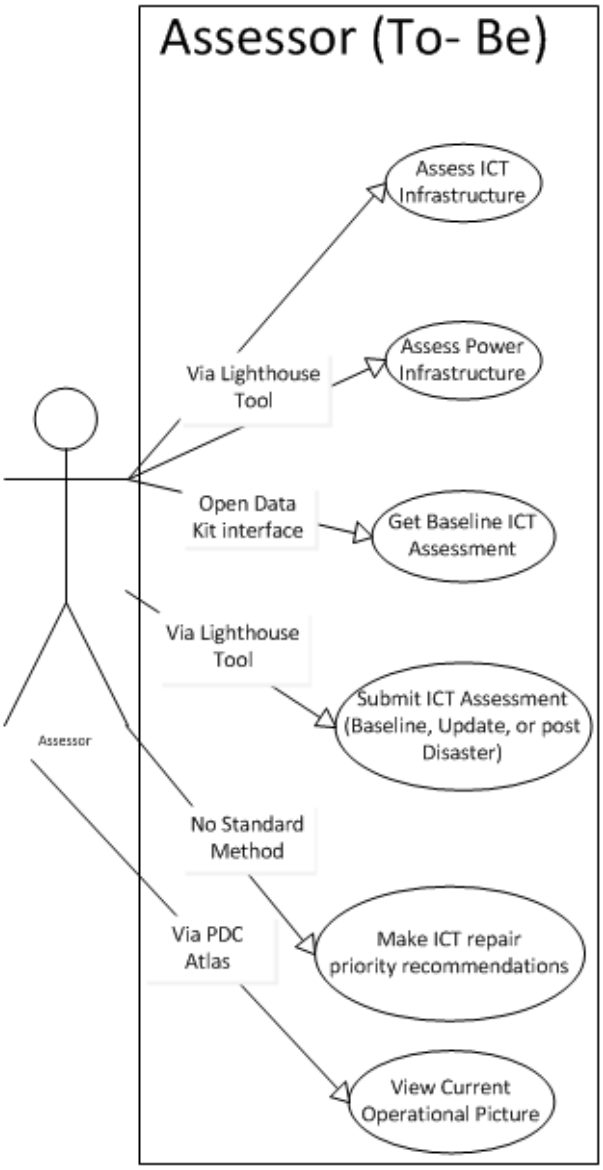
CONCLUSION

Responding efficiently and effectively to large-scale disasters is difficult in the U.S. and near impossible in third world countries. Compounding relief efforts is an inability to effectively collaborate due to the nonexistence of or damage to host nation ICT infrastructure. International relief organization respondents don't know the status of the ICT infrastructure nor what would normally be available. RTAT may not be able to answer the entire uncertainty question of post disaster recovery operation, but it was created to answer the simple questions, "What kind of comms can I expect upon arrival" and what should the respondents repair first to get the most communication "bang for the buck"?

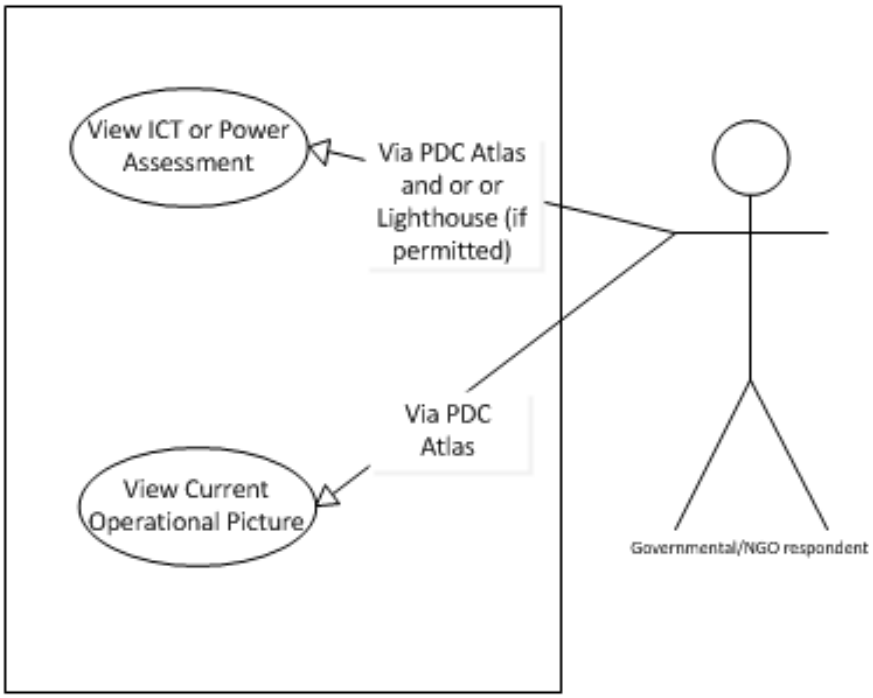
RTAT is a fledgling organization still developing its IT plan. RTAT recognizes that for it to be a viable/ useful part of the international help community it must be able to effectively and efficiently communicate their ICT assessments. The RTAT/ Lighthouse assessment tool combined with the Pacific Disaster Center Atlas integration is not the "silver bullet" Enterprise Resource Planning system, but it is a step in the right direction. The proposed "to-be" IT solution gives RTAT and its end customer an intuitive standardized data collection tool that is useable on intermittent/ low bandwidth/ ad hoc networks. The problem of relief effort collaboration in a post-disaster chaotic environment is a complex problem that requires multiple solutions. RTAT and its new assessment tool and PDC linkage is one such solution.

Assessor (As-Is)




Assessor (To- Be)
Assess ICT Infrastructure
Assess Power Infrastructure
Via Lighthouse Tool
Open Data Kit interface
Get Baseline ICT Assessment
Via Lighthouse Tool
Submit ICT Assessment (Baseline, Update, or post Disaster)
Assessor
No Standard Method
Make ICT repair priority recommendations
Via PDC Atlas
View Current Operational Picture

Respondent To-Be



Bibliography

Ross, J., Weill, P., Robertson, D. (2006) *Enterprise Architecture as Strategy*. Harvard Business School Press. Boston, Massachusetts.

Sengupta, K. (2013) *Enterprise Architecture—A Perspective*. Brief given 8/1/2013.

Steckler, B. (2012) *Rapid Technology Assessment Team (RTAT) Executive Summary 15 November 2012*. Naval Postgraduate School: Monterey, CA.

Galbraithe, J. (2014). *The Star Model*. Retrieved from http://www.jaygalbraith.com/images/pdfs/StarModel.pdf. Accessed 6/10/14.

APPENDIX C. RTAT SAVVION BUSINESS PROCESS MODELING

Appendix C is an unpublished paper written by three students at the Naval Postgraduate School to meet the final project requirements of a business process improvement class (Beeson et al., 2014). RTAT was chosen as the organization of interest for this project. This appendix contains all of the supporting work mentioned in the Savvion model experiments. Tables, figures, quotes and ideas were taken directly from this source. This document could not be found by any other means other than by inclusion with the thesis.

Rapid Information Communication Technology Assessment Team

Savvion Business Process Modeling

Travis Beeson

Jennifer Gladdem

Jose Gonzalez

Naval Postgraduate School

Professor Glenn Cook

Introduction

Cataclysmic events such as hurricane Katrina in 2005, and Typhoon Yolanda in 2013, leave a wide and devastating wake of destruction. The horrific suffering caused by these types of events is exacerbated by the inability of relief organizations to collaborate their efforts and collectively assess the situation, prioritize efforts and effectively allocate

scarce resources. This is due in large part to an ineffective or missing overarching collaboration organization, and further compounded by severely damaged host nation communication infrastructure. Though several organizations assess various aspects of ICT infrastructure, none collate or distribute the information.

To fill the gaps the Rapid ICT Assessment Team (RTAT) was created to conduct a holistic assessment of the ICT environment and share this information with other responding organizations. However, the problem of efficiently and effectively collecting the data, creating a common ICT operational picture and getting this information into the right hands can still be challenging.

We analyzed the current "As Is" RTAT method using Savvion to determine weak points within the process. This analysis led to multiple recommendations for improvement, which were then added to a second "To Be" model of the process. By modeling, analyzing, and re-designing the RTAT process we hope to significantly reduce ICT recovery time and enable HADR in the future.

"As-Is" Model of Operation

Currently RTAT is conceptually organized into "rapidly deployable, small, nimble, multi-organizational, multi-national integrated assessment teams of specialists in key ICT areas such as wireless data communications, voice communications, radio technologies, power, information sharing, social networking, etc." (Steckler, 2012).

"As Is" Scheme of Maneuver (further details are in the "As Is" assumptions section)

Disaster Strikes

- NGO request IT assessments from UN
- RTAT assessors dispatched to conduct assessments via UN
    - RTAT Responsible for all travel arrangements
- Assessors conduct assessments
    - Forward assessments to UN
- UN employees process assessments
    - Forward to Mapper (Confirms & Plots location)
- Mapper forwards back to UN

- UN confirms info & forwards to NGO
- NGO reviews the info for relevance and forwards applicable info to end users

"As-Is" Assumptions

Key assumptions were made based on the cumulative Fighting Hellfish experience with RTAT deployment, these assumptions include:

- Salary is based on the 2013 GS Salary table.
    - (13) UN Employees all GS 9 Step 6 ($23.23)
    - (3003) NGO Employees all GS 4 Step 6 ($13.71)
    - (3) Mapper Employees all GS 5 Step 1 ($13.14)
    - (3) Assessor Employees all GS 12 Step 5 ($32.73)
- All assessors are paid hourly with assessors' pay status beginning when they accept the assessment mission and terminating at the end of the assessment mission.
- All requests originate from the NGO group and are forwarded to the UN who then decided whether to accept the request or deny the request. There is a 50/50 chance that the UN will accept a given request for assessment. All UN accepted requests are forwarded to an Assessor.
- The Assessor evaluates the request and either accepts or denies the request. Once the Assessor accepts the request they begin to establish a plan for the assessment, which will entail travel time. Travel time is broken down into three possible time frames (3, 12 and 24 hours). This is contingent on the Assessors current location and the location of the assessment as well as the mode of travel (Commercial Air, Military Air, Vehicle etc.).
- The Assessor is allocated "life support" time which would include hygiene, food and rest. Combined in the "life support" time is the task of populating an excel document with the completed assessments for the day. Depending on the Assessors connectivity they will forward this information to the UN department. If connectivity cannot be established the document is delayed and an attempt will be tried at a later time. Once connectivity is established the document is forwarded to the UN.
- The limitations of Savvion (or our ability to use it) makes it impossible to easily replicate the disaster model which assumes the assessor will complete as many assessments as possible (*unlimited assessments) during limited time*, instead of completing a set number of assessments (*limited assessments) with unlimited time* like a typical workload model. IE RTAT

will assess as much as possible during the limited timeline of disaster recovery instead of assuming a national disaster will create an exact amount of damage. As such a 100 percent utilization of the assessor is not infeasible since in our model this utilization indicates assessor workload over assessor workload vice the typical utilization of workload over time.

- The UN receives the report and begins processing the form and decides if the information is beneficial. Depending on the information gathered by the assessor and the requirements of the UN the report may be discarded. All forms that are deemed beneficial will be formatted and forwarded on through the UN chain. Any form not correctly formatted will be reworked within the UN personnel. Once the form meets the specification of the UN it will be forwarded to the Mapper.
- The Mapper will receive the report and confirm the format. If there is a discrepancy with the format it will be returned to the UN for clarification. Once the form is deemed format compliant it will be plotted on the map. The Mapper will then notify the UN via the net. The UN will validate the plotted location on the map. If the location plotted is accurate the UN will send a mass communication to all NGOs for action.
- NGOs will review the report and begin their process of the report. NGOs finding the report applicable to them will disseminate the report to other users within their organization for action. For the NGOs that do not find it applicable they will discard the information and await further report.

RTAT "As-Is" Process via Savvion

The assumed "As Is" RTAT process was modeled and analyzed using Savvion in an effort to identify bottleneck areas and determine possible improvements to the RTAT process for future HADR operations. This process, shown in Figure 1, utilizes four key performing groups: NGO (Customer), United Nations (UN) (Facilitator), Mapper (Facilitator) and Assessor (Provider).

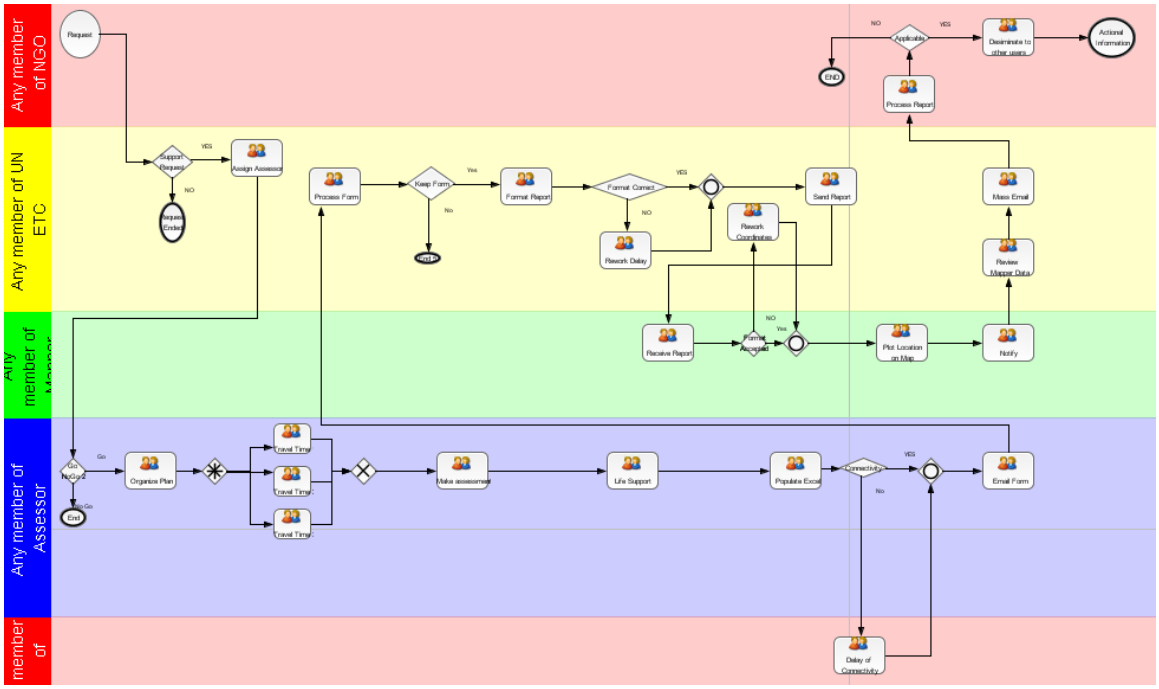


Figure 1 Savvion Process Model

Based on the above assessment and process model, a Savvion simulation of 100 assessments was conducted. The results are depicted in Figures 2 and 3.

Simulation Results

Duration	300:40:00	Time	

Process Time And Cost

Process	Scenario	Instances	Total Cost	Waiting Time (Time)	Total Time (Time)	
RTAT_AsIs	(default)	100	34838.99	15740:43:00	10337:00:00	17072:16:00

RTAT_AsIs

Scenario	(default)
Instances	100

Activity	Performer	Occurs	Waiting Time (Time)	Time To Complete (Time)	Total Time (Time)	
Assign Assessor	Any member of UN ETC	50	0:00:00	50:00:00	50:00:00	50:00:00
Delay of Connectivity	Any member of Delay	19	0:00:00	152:00:00	152:00:00	152:00:00
Desiminate to other users	Any member of NGO	25	0:00:00	0:50:00	0:50:00	0:50:00
Email Form	Any member of Assessor	37	345:07:00	74:00:00	419:07:00	419:07:00
Format Report	Any member of UN ETC	28	0:00:00	13:45:00	13:45:00	13:45:00
Life Support	Any member of Assessor	37	1179:53:00	131:21:00	1311:14:00	1311:14:00
Make assessment	Any member of Assessor	37	2174:04:00	72:25:00	2246:29:00	2246:29:00
Mass Email	Any member of UN ETC	28	0:00:00	2:48:00	2:48:00	2:48:00
Notify	Any member of Mapper	28	4:20:00	3:44:00	8:04:00	8:04:00
Organize Plan	Any member of Assessor	37	1460:54:00	296:00:00	1756:54:00	1756:54:00
Plot Location on Map	Any member of Mapper	28	1:22:00	2:17:00	3:39:00	3:39:00
Populate Excel	Any member of Assessor	37	764:57:00	6:10:00	771:07:00	771:07:00
Process Form	Any member of UN ETC	37	0:00:00	74:00:00	74:00:00	74:00:00
Process Report	Any member of NGO	28	0:00:00	13:56:00	13:56:00	13:56:00
Receive Report	Any member of Mapper	28	1:16:00	56:00:00	57:16:00	57:16:00
Review Mapper Data	Any member of UN ETC	28	0:00:00	28:00:00	28:00:00	28:00:00
Rework Coordinates	Any member of UN ETC	14	0:00:00	3:23:00	3:23:00	3:23:00
Rework Delay	Any member of UN ETC	14	0:00:00	2:20:00	2:20:00	2:20:00
Send Report	Any member of UN ETC	28	0:00:00	56:00:00	56:00:00	56:00:00
Travel Time 1	Any member of Assessor	37	3257:30:00	108:38:00	3366:08:00	3366:08:00
Travel Time 2	Any member of Assessor	37	3270:23:00	95:45:00	3366:08:00	3367:08:00
Travel Time 3	Any member of Assessor	37	3280:57:00	85:11:00	3366:08:00	3368:08:00

Figure 2 Savvion Process Simulation Results

Resource	Unit	Cost/Unit	Threshold	Usage	Cost
Any member of Assessor	Hour	32.73	0	869	$28,442.37
Any member of UN ETC	Hour	23.29	0	230	$5,356.70
Any member of Mapper	Hour	13.14	0	62	$814.68
Any member of NGO	Hour	13.71	0	14	$191.94
Any member of Delay	Hour	0	0	152	$0.00

Performers Queue Length and Utilization

Name	Average	Min	Max	Utilized(%)	Idle(%)
Any member of Assessor	52.33	0	98	96.4	3.6
Any member of UN ETC	0	0	0	5.89	94.11
Value of 'Creator'	0	0	0	0	100
Any member of Mapper	0.02	0	2	6.88	93.12
Generic	0	0	0	0	100
Any member of NGO	0	0	0	0	100
Any member of Delay	0	0	0	0.05	99.95

Bottlenecks

Process	Activity	Performer	Avg Queue Length	Min Queue Length	Max Queue Length
RTAT_AsIs	Email Form	Any member of Assessor	1.15	0	20
RTAT_AsIs	Life Support	Any member of Assessor	3.92	0	30
RTAT_AsIs	Make assessment	Any member of Assessor	7.23	0	31
RTAT_AsIs	Notify	Any member of Mapper	0.01	0	1
RTAT_AsIs	Organize Plan	Any member of Assessor	4.86	0	30
RTAT_AsIs	Plot Location on Map	Any member of Mapper	0	0	2
RTAT_AsIs	Populate Excel	Any member of Assessor	2.54	0	29
RTAT_AsIs	Receive Report	Any member of Mapper	0	0	1
RTAT_AsIs	Travel Time 1	Any member of Assessor	10.83	0	31
RTAT_AsIs	Travel Time 2	Any member of Assessor	10.88	0	31
RTAT_AsIs	Travel Time 3	Any member of Assessor	10.91	0	32

Note:	Red-marked Waiting Time values indicates "Activity has waiting time"
	Red-marked Usage values indicates "Usage crossed threshold"

Figure 3 Costs and Bottlenecks

"As Is" Savvion Results

The overall path of a single assessment is completed using multiple sub-processes within the UN. The assessment is also (potentially) re-worked and re-checked twice, which significantly slows down work flow and adds to labor costs. Very little automation is used and significant delays appear due to connectivity issues (delaying the uploading of data) and travel time to damaged areas. Bottlenecks were also created in the process under the Assessors' travel time section. With the current process bottlenecks are unavoidable within the Assessor's realm. Traveling is a time consuming task, especially within a disaster area. The Assessor is the linchpin of RTAT and is responsible for a very high workload as multiple runs incurred assessor utilizations of over 90 percent. In some instances this may raise concerns; however, as noted previously in the RTAT scenario of a large scale disaster the Assessor is exclusively focused on the RTAT process and will complete as many assessments as possible during a limited time, therefore whether an assessment team completes 1 assessment per day or 20, Assessors' is still completely

occupied by the assessment process. Since making assessments is their primary function their utilization in this process is expectedly high. Due to this high tempo (100 assessments) and short duration (approximately 13 days) workload the assessor is well compensated, earning $28,442.37 for their participation in this assessment mission. Of note this compensation includes pay for a 24-hour workday that incorporates reserved time for food, lodging and transportation while in the disaster area.

"As Is" Recommendations

Some delaying factors such as travel time, breadth and scope of the disaster that affect assessment time, are environmental and not subject to RTAT control. Other factors such as connectivity are caused by the environment but can be mitigated with additional gear or resources (in this case the addition of portable Broadband Global Area Network (BGAN) terminals). However, many factors, such as staffing, process management, automation, and tool functionality are controllable inputs to success.

Within the controllable factors multiple areas can be significantly improved. The largest of which are manpower and automation. As noted in the results section, the "As Is" RTAT process includes a sub-process detour within the UN to process and check assessment data before posting followed by a second review. By eliminating this step, through the replacement of the excel document with a more user friendly Android based, scalable mobile device application, the overall RTAT process was significantly improved.

This app which effectively walks novice assessors through a multi-step process that identifies key infrastructure, potential damages, and utilizes available GPS to auto update positions beneficially affects RTAT two fold. In addition to eliminating the excess sub-process at the UN, the app opens the assessor category to a potential influx of volunteers. By using a train the trainer model, skilled RTAT assessors can conduct an inventory RTAT class to novice volunteers who will then be able to conduct independent assessments, which greatly increases the assessor's overall output without increasing cost.

"As Is" to "To Be"

Based on the recommendations made from the "As-Is" process analysis, the RTAT process was re-designed into a "To Be" model. Goals for the "To Be" model included: increasing the assessment capacity to 200 and reducing costs by 25 percent, wait time by 75 percent, and assessor utilization rate to <= 70 percent.

RTAT "To Be" Model of Operation

The RTAT "To Be" model follows the "As Is" model of "rapidly deployable, small, nimble, multi-organizational, multi-national integrated assessment teams of specialists in key ICT" (Steckler, 2012), but it also incorporates training capability and utilizes host nation volunteers to [potentially] increase manpower available for assessments. Key to the success of this duplicative manpower model is the function of RTAT as an assessment team concept, capable of gathering and relaying information, to entities capable of repairing said infrastructure. RTAT does not seek to fix the situation but rather to provide an accurate picture of the current situation. As such, detailed knowledge of the ICT infrastructure is beneficial but unnecessary for the RTAT assessor. An assessor in the "To Be" model merely relays the status of an ICT node to those capable of taking further action. This makes it possible for a lay volunteer to follow the simple Android application instructions and still provide valuable data that is the basis and beginning of the newly automated "To Be" process.

RTAT "To Be" Scheme of Maneuver

(BOOM!!!!!) Disaster Strikes

- NGO request IT assessments from UN
- RTAT assessors dispatched to conduct assessments via UN
    - RTAT Responsible for coordinating all travel arrangements
- Assessors conduct training of volunteers qualifying them as assessors
- Assessors conduct assessments utilizing Android application
- Upload assessments to Naval Postgraduate School (NPS) servers remotely
- Assessment data is shared with the Pacific Disaster Center (PDC) servers
- Assessments are posted to an interactive PDC website that NGO's and Governments can visit to obtain the latest disaster information

Assumptions

The following are some assumptions, derived from the Fighting Hellfish' experience and resident knowledge of the RTAT process for this new model.

- Salary is based on the 2013 GS Salary Table.
- (10) UN Employees all at a GS 9 Step 6 level ($23.23)
- (3000) NGO volunteers who receive no pay.
- (3) Assessor/Trainer RTAT members all at a $40/hour (roughly GS 12 Step 5 level)
- (17) Volunteer assessors who do not receive monetary compensation.
- All volunteer assessors will be met at the area of operation and will receive an initial 12-hours of training by the Assessor/Trainer team prior to any assessment mission.
- Travel to assessment area will be simultaneously coordinated during the training time.
- 200 assessments will be conducted, with assessment requests arriving in 10-minute intervals.
- All Assessors (non-volunteers) are paid exclusively for time spent making, processing, traveling or training volunteers from RTAT mission acceptance until mission completion.
- Assessors do not receive pay for hours of non-assessment activities (i.e. rest and refit).
- For the safety of Assessors, they are authorized to work only 12 hours in one 24-hour period.

RTAT "To Be" Process via Savvion

The RTAT "To Be" process incorporates 4 key performer groups including: NGO/ UN (Customer), Assessor and Volunteers (Facilitator), NPS Server (Facilitator) and PDC Server (Provider). Assessors and Volunteers are broken up into 9 teams identified by 9 parallel process routes (outlined in Figure 4). Each team will have a BGAN assigned for data transmittal.

All requests originate from the UN/NGO group and are forwarded to the Assessor electronically. These requests are broken equally into three parallel tracks and further broken down into three travel times, netting a total of 9 parallel processes that represent the aforementioned 9 teams. Travel time is broken down into three possible time frames (1, 3 and 9 hours with standard deviations of 15, 30 & 60 min respectively). This is

contingent on the Assessors' current location and the location of the assessment as well as the mode of travel (Commercial Air, Military Air, Vehicle etc.). Upon completion of the assessment, BGANS are utilized to ensure the forms (.XML format) with GPS data are transmitted back to the NPS servers.

The NPS servers receive, aggregate, store, and forward the forms to the PDC servers. The PDC servers utilizes the information and GPS enabled fields in the form to display the information to the correct region thereby disseminate the information via their website to interested NGOs, UN personnel, and host nation officials.

In order to compensate for the addition of (unpaid) volunteers the number of assessors was increased to 20 while the pay per hour in Savvion was simultaneously decreased (3 @$40/hour =$120/hour = 20 @6/hour). The assessors remain compensated for a high workload short duration process and are expected to have significant off time between disasters.

"To Be" Savvion Results

The Savvion analysis (Figures 4 and 5) below was run with the 200 and 500 assessment goal.

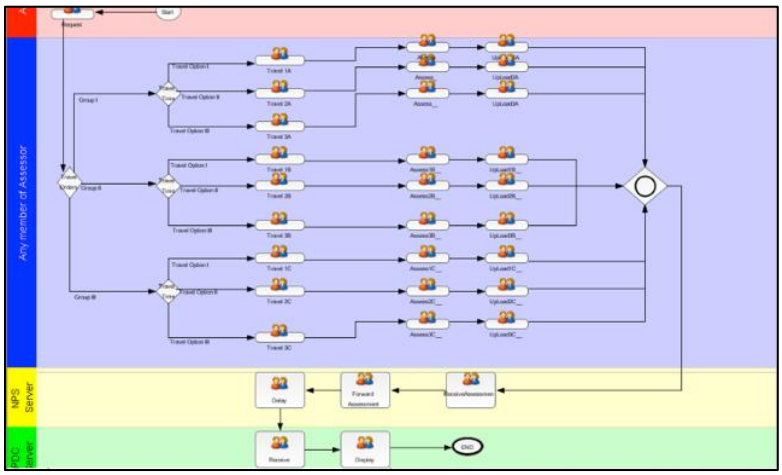


Figure 4 Savvion Process Simulation Results

FinalSavvionRTAT								
Scenario	(default)							
Instances	200							
		Time	38.333 hrs					
Activity	**Performer**	**Occur**	**Waiting Time Time**	**Time To Complete Time**	**Total Time (Time)**	**Work Time**	**Fired (occurs) /Hr**	**AWT**
Assess 1	Any member of Assessor	51	**289:13:00**	12:45:00	301:58:00	12.75	1.33	0.25
Assess 2	Any member of Assessor	13	**75:14:00**	3:15:00	78:29:00	3.25	0.34	0.25
Assess 3	Any member of Assessor	4	**23:12:00**	1:00:00	24:12:00	1	0.10	0.25
Assess 4	Any member of Assessor	44	**239:53:00**	88:00:00	327:53:00	88	1.15	2.00
Assess 5	Any member of Assessor	12	**68:28:00**	24:00:00	92:28:00	24	0.31	2.00
Assess 6	Any member of Assessor	10	**57:47:00**	20:00:00	77:47:00	20	0.26	2.00
Assess 7	Any member of Assessor	49	**269:37:00**	98:00:00	367:37:00	98	1.28	2.00
Assess 8	Any member of Assessor	13	**74:45:00**	26:00:00	100:45:00	26	0.34	2.00
Assess 9	Any member of Assessor	4	**22:13:00**	8:00:00	30:13:00	8	0.10	2.00
						281	5.22	12.75
Travel 1	Any member of Assessor	51	**214:35:00**	52:37:00	267:12:00	52.62	1.33	1.03
Travel 2	Any member of Assessor	13	**50:22:00**	26:01:00	76:23:00	26.02	0.34	2.00
Travel 3	Any member of Assessor	4	**15:14:00**	37:59:00	53:13:00	37.98	0.10	9.50
Travel 4	Any member of Assessor	44	**180:34:00**	22:44:00	203:18:00	22.73	1.15	0.52
Travel 5	Any member of Assessor	12	**49:43:00**	24:18:00	74:01:00	24.3	0.31	2.03
Travel 6	Any member of Assessor	10	**43:23:00**	92:29:00	135:52:00	92.48	0.26	9.25
Travel 7	Any member of Assessor	49	**205:15:00**	25:37:00	230:52:00	25.62	1.28	0.52
Travel 8	Any member of Assessor	13	**52:01:00**	26:01:00	78:02:00	26.02	0.34	2.00
Travel 9	Any member of Assessor	4	**16:06:00**	37:59:00	54:05:00	37.98	0.10	9.50
						345.75	5.22	36.34
UpLoad 2	Any member of Assessor	13	**67:52:00**	3:16:00	71:08:00	3.27	0.34	0.25
UpLoad 3	Any member of Assessor	4	**17:04:00**	1:21:00	18:25:00	1.35	0.10	0.34
UpLoad 4	Any member of Assessor	44	**214:16:00**	11:45:00	226:01:00	11.75	1.15	0.27
UpLoad 5	Any member of Assessor	12	**57:19:00**	3:14:00	60:33:00	3.23	0.31	0.27
UpLoad 6	Any member of Assessor	10	**35:06:00**	2:56:00	38:02:00	2.93	0.26	0.29
UpLoad 7	Any member of Assessor	49	**235:16:00**	13:13:00	248:29:00	13.22	1.28	0.27
UpLoad 8	Any member of Assessor	13	**63:58:00**	3:16:00	67:14:00	3.27	0.34	0.25
UpLoad 9	Any member of Assessor	4	**13:23:00**	1:21:00	14:44:00	1.35	0.10	0.34
UplLoad 1	Any member of Assessor	51	**256:08:00**	13:55:00	270:03:00	13.92	1.33	0.27
						54.29	5.22	2.55
						681.04	15.65	51.64
Delay	Any member of NPS Server	200	0:00:00	6:46:00	6:46:00	6.77	5.22	0.03
Forward Assessment	Any member of NPS Server	200	0:00:00	6:40:00	6:40:00	6.67	5.22	0.03
ReceiveAssessment	Any member of NPS Server	200	0:00:00	6:40:00	6:40:00	6.67	5.22	0.03
						20.11	15.65	0.10
Display	Any member of PDC Server	200	0:00:00	6:40:00	6:40:00	6.67	5.22	0.03
Receive	Any member of PDC Server	200	0:00:00	6:40:00	6:40:00	6.67	5.22	0.03
						13.34	10.43	0.07
Request	Any member of UN/NGO	200	0:00:00	33:20:00	33:20:00	33.33	5.22	0.17
						33.33	5.22	0.17

Resource	Unit	Cost/Unit	Threshold	Usage	Cost	Total Converted Work time (hr)	# People	Utilization
Any member of NPS Server	Hour	0.2	0	20	$4.00	20.11	50	1.05%

Any member of PDC Server	Hour	0.2	0	13	$2.60	13.34	50	0.70%
Any member of Assessor	Hour	6	0	680	$4,080.00	681.04	20	88.83%
Any member of UN/NGO	Hour	13.71	0	33	$452.43	33.33	1	86.95%

H/(K*D3)
worktime/(people*duration)

Performers Queue Length and Utilization

Name	Average	Min	Max	Utilized(%)	Idle(%)
Any member of NPS Server	0	0	0	1.05	98.95
Any member of PDC Server	0	0	0	0.7	99.3
Value of 'Creator'	0	0	0	0	100
Any member of Assessor	75.85	0	137	88.82	11.18
Generic	0	0	0	0	100
Any member of UN/NGO	0	0	0	8.7	91.3

Figure 5 Costs and Bottlenecks

The completion time required for the 200 assessments by 20 assessors/volunteers was 38.33 hours. With irreparable bottlenecks due to the Assessors' travel time. Despite the refinement of the assessment definition (exclude food/ refit/ rest etc.) the assessor remained heavily utilized at 89%; however of note the assessor's utilization was reduced by 7.4%. The unlimited assessments needed with limited time available model remains in effect and the assessor remains solely focused on assessments which accounts for the high utilization, however, the slowed assessment input value (10 min vice 2 min) may account for the reduction of 7.4%. Assessors are still compensated for their high workload but pay is now restricted to a 12-hour workday which includes transportation but excludes life support while in the disaster area.

"As Is" "To Be" Comparison

Despite doubling the number of assessments to 200, the "To Be" model expenses dropped 87%, wait time decreased by 81% and it took only 1/5 the time to complete. Unfortunately, Assessor utilization remains high (89%), but is unlikely to be significantly reduced due to the nature of the disaster scenario. Assessors can rest during the allotted travel times between assessments. When stretched further, the "To Be" model shows over 500 assessments are possible in approximately 1/3 the time required in the original "As Is" model, while still reducing costs by nearly 70%. Critical changes made proved to be the addition of portable SATCOMs via 9 BGAN terminals, and the train the trainer model, which both greatly improved speed and efficiency. The addition of the user-friendly app also eliminated a redundant internal cycle and enabled additional manpower all of which drastically improved the RTAT capability that will hopefully significantly improve HADR in the future.

CONCLUSION

Responding efficiently and effectively to large-scale disasters is difficult in the U.S. and near impossible in third world countries. Compounding the difficulty to relief efforts is an inability to effectively collaborate due to the nonexistence of or damage to host nation ICT infrastructure. International relief organization respondents often don't know the status of the ICT infrastructure nor what would normally be available. RTAT

may not be able to completely eliminate the uncertainty of post disaster recovery operation, but it can possibly provide answers to some questions such as, “What kind of communication infrastructure can I expect upon arrival” and what should the respondents repair first to get the most communication “bang for the buck”?

For RTAT to effectively benefit the international relief community it must effectively and efficiently communicate accurate ICT assessments. The problem of relief effort collaboration in a chaotic post-disaster environment is complex and requires an intricate solution. A requirement to have boots on the ground is essential at this point to gather information on an areas infrastructure; however, by automating as much of the RTAT process as possible costs are dramatically reduced and the process is significantly sped up providing an effective and efficient way to provide vital IT infrastructure status to the proper officials. Additional improvements such as the inclusion of remotely piloted or autonomous vehicles could benefit RTAT in the future, however, in the near term the improved “To Be” RTAT process has proven to be of valuable benefit in both cost and time savings in HADR.

APPENDIX D. TERRESTRIAL SYSTEMS FORM

Appendices E–H represent the starting point for the data collection form efforts. Questions programed into the mobile data collection tool were based on these appendices.

Rapid Technology Assessments
Terrestrial Communications
Copper Ground Based Communications System

Current Status:

Assessment Date:
Operational Status:
Copper Ground Based System Number:
RTAT Assessment Team Number:
Max Duration of Autonomous Operations (Without Resupply):
Resilience to Follow On Incidents:
Comments:

Distribution Site(s):

Number of Distribution Sites:
Distribution Site Number:
Approximate Number of Subscribers:
Bandwidth Available:
Backhaul:
Latitude (degrees and decimal degrees):
Longitude (degrees and decimal degrees):
Any Specific Access Issues (Keys, etc.)?
Any Location Specific Safety Issues?

Ownership:

Individual:
Industry/Private Sector:
Government System:
Military:
NGO or Relief Agency:
Other (please specify):

Owner Contact Information:

Parent Organization:
Primary Contact Name:
Office Telephone:
Cell Phone:
SAT Phone:
Radio Call Sign:
Email Address:
Alternative Contact Methods:

POC Information:

Parent Organization:
Primary Contact Name
Office Telephone:
Cell Phone:
SAT Phone:
Radio Call Sign:
Email Address:
Alternative Contact Methods:
Alt Emergency Contacts or Operators:

Equipment Used:

System Hardware Used:

Power Requirements:

Add. Equipment Available:

Functional Dependencies:

Grid Power:
Fuel/Genset:

Notes:

APPENDIX E. CELLULAR WIRELESS FORM

Assessment Location:

Assessment Team Leader:

Assessment Team Leader contact information:

Assessment Team Member:

Assessment Team Member:

Assessment Date:

Geographical Information

Province:
District:
Sub-district:
Village:
Latitude:
Longitude:

Field no	Field	Prio	Notes	Comments
	Baseline Assessment - Mobile & Communications Operator			
	General Info - For Baseline Assessmen			
1	Name:			
2	Notes:			
3	Network/Holding/Parent Group:			
4	Government legislative body			
	Market Informatio			
5	% of Mobile Phones in country:			
6	Approximate number of towers:			
	Services Y/N			
7	SMS			
8	Cell Broadcast			
9	EDGE			
10	3G			
11	4G			
12	VoIP			
13	Reverse Billing			
14	USSD			
15	Mobile Banking		If Y What Partner	
16	Mobile fundraising Experience		if Y which campaigns/ with whom	
	Contacts & Location			
17	Executive/Administrative/CSR Contact			
18	Technical Contact			
19	NOC Location & Notes			
20	Note structural/building characteristics that may be relevant, power, redundant comms			
21	HQ Location & Notes			
	Emergency Procedure			
22	Additional Contacts (include one off-country if possible)			
23	Emergency Partners			
24	Emergency TOR or LOI established with other parties?			
25	SMS Gateways			
26	SMPP, HTTP, Other (describe)			
27	Voice			
28	VoIP, Other			
29	USSD			
30	Would be willing to collaborate on deploying emergency-related VASs?			
31	Possibility to obtain real time coverage maps during Disasters			
32	Would be willing to share Geo-referencing information about subscribers in limited cases?			

Field no	Field									Prio	Notes	Comments
	Post Disaster Assessment - Mobile & Communications Operator											
			Operator 1		Operator 2				Operator 2			Operator 4
1	Time of assessment post disaster											
2	Region											
3	Regional Contact											
4	Regional up to date coverage maps available											
	Network Status											
5	%age Sites out of action											
6	%age coverage in Region pre disaster											
7	%age coverage in Region post disaster - Minimum	2G										
8	%age coverage in Region post disaster - Current											
9	%age coverage in Region pre disaster											
10	%age coverage in Region post disaster - Minimum	3G										
11	%age coverage in Region post disaster - Current											
12	%age coverage in Region pre disaster											
13	%age coverage in Region post disaster - Minimum	4G										
14	%age coverage in Region post disaster - Current											
	Network Restrictions/Congestion											
15	Voice											
16	SMS											
17	Data											
	Power											
18	%age sites still under mains power											
19	% defecit of emergency power (sites without emergency power - Gap)											
20	Fuel Supply - OK											
21	Fuel Logistics issues											
22	Power - Notes											
	Public Services - offerred											
23	Emergency Charging Points											
24	Credit Recharge Services											
25	Additional RQD -Emergency Charging Points											
26	Additional RQD Credit Recharge Services											
27	**Known Gaps in service**											
	Geographical areas without comms		Area 1	Gap	Area 1	Gap		Area 1	Gap		Area 1	Gap
			Area 2	Gap	Area 2	Gap		Area 2	Gap		Area 2	Gap
			Area 3	Gap	Area 3	Gap		Area 3	Gap		Area 3	Gap
			Area 4	Gap	Area 4	Gap		Area 4	Gap		Area 4	Gap
28	**Urgent Points of Interest - without Comms**											
	Hospitals	Name	Location	Requirement	Name	Location		Requirement	Name		Location	Requirement
	Schools	Name	Location	Requirement	Name	Location		Requirement	Name		Location	Requirement
	Evacuation centres	Name	Location	Requirement	Name	Location		Requirement	Name		Location	Requirement
	Government distribution Point	Name	Location	Requirement	Name	Location		Requirement	Name		Location	Requirement
	NGO/ 1st Responder locations	Name	Location	Requirement	Name	Location		Requirement	Name		Location	Requirement

Field	Prio	Notes	Comments
Ministry of "Communications" or equivalent			
General Info			
Name of ministry			
Areas of responsibilities			expected: licensing governance over airwaves (GSM, HAM, Sat)
Emergency contact:			

Ministry of "Interior"/"Planning" or equivalent			
General Info			
Name of ministry			
Areas of responsibilities			expected: updated geographic, demographic information
Emergency contact:			
			taxation/ customs procedures for equipment?

Field	Prio	Notes	Comments
Local Organizations			
General Info			
Organization Name			
Emergency Contacts (mobile phone, email, Skype			
Capabilities		Localization / Translation / Local tech support / Loca tech development / Mobile data collection / GIS expertise	
Existing international customer:			
Tech Community			
Have there been local bar camps, criss hackathons, o similar informal events?			
Is there a GIS community, OSM group, or other local mapping-related organizations?			
Are there prominent bloggers/social media participants that may becomes a good voice to collect tech-savvy volunteers, in-country or abroad?			
Crisis Mappers?			
Walking Papers?			

APPENDIX F. SATELLITE SYSTEMS FORM

Rapid Technology Assessments
Satellite Communications
Satellite - National & Regulatory

Note: Datum in use is WGS 84

Current Status:

Assessment Date:
Operational Status:
Satellite System Number:
RTAT Assessment Team Number:
Max Duration of Autonomous Operations (Without Resupply):

Regulator:

National Satellite Regulatory Agency Name:
Regulatory Agency POC:
Types of satellite service licensees:
Satellite terminal operation regulations:
Satellite equipment import regulations:
Local purchase requirements:
Regulations on foreign service providers without local presence:

Frequencies:

C-band frequencies licensed for FSS:
Ku-band frequencies licensed for FSS:
Ka-band frequencies licensed for FSS:
Primary/Co-Primary/Secondary overlaps with other users:
Terrestrial wireless licensed in C-band:

Satellites:

Satellites known to have landing rights in country:
Satellites known to be denied landing rights in country:

Domestic Satellite Companies:

Domestic satellite spacecraft operators:
Domestic satellite service providers:
Foreign satellite service providers with local presense & inventory:
Satellite equipment manufacturers/dealers with local offices:

Rapid Technology Assessments
Satellite Communications
Satellite - Mobile Satellite (ie: sat phone & BGAN) Note: Datum in use is WGS 84

Current Status:

Assessment Date:
Operational Status:
Satellite System Number:
RTAT Assessment Team Number:
Max Duration of Autonomous Operations (Without Resupply):

System Availability:

MSS networks with coverage of location:
- Globalstar:
- Iridium:
- Inmarsat:
- Thuraya:
- Other:

MSS networks licensed to provide service:
- Globalstar:
- Iridium:
- Inmarsat:
- Thuraya:
- Other:

Terminal Equipment Availability:

Ability to import & operatate foreign-acquired MSS equipment:
Restrictions on use of foreign SIM cards / service providers:

Local Dealers / Resellers:

Dealer #1:
Dealer Name:
Dealer POC:
Networks dealer is licensed to re-sell:
MSS voice and/or data equipment available:
Dealer #2:
Dealer Name:
Dealer POC:
Networks dealer is licensed to re-sell:
MSS voice and/or data equipment available:

Rapid Technology Assessments
Satellite Communications
Satellite - Fixed Satellite Service (ie: VSAT) Note: Datum in use is WGS 84

Current Status:

Assessment Date:
Operational Status:
Satellite System Number:
RTAT Assessment Team Number:
Max Duration of Autonomous Operations (Without Resupply):

Domestic Satellite Service Provider #1

Company Name:
Company POC:
Alternative Contact Methods:
Services Available:
Hub technology (if relevant):
Ability to facilitate import of similar equipment:
Equipment in warehouse:
Data rates available:

Domestic Satellite Service Provider #2

Company Name:
Company POC:
Alternative Contact Methods:
Services Available:
Hub technology (if relevant):
Ability to facilitate import of similar equipment:
Equipment in warehouse:
Data rates available:

Rapid Technology Assessments
Satellite Communications
Satellite Earth Station Note: Datum in use is WGS 84

Current Status:

Assessment Date:
Operational Status:
Satellite System Number:
RTAT Assessment Team Number:
Max Duration of Autonomous Operations (Without Resupply):

Comments:

Location:

Latitude (degrees and decimal degrees):
Longitude (degrees and decimal degrees):
Magnetic Variation At Site:
Any Specific Access Issues (Keys, etc.)?
Any Location Specific Safety Issues?

Ownership:

Individual:
Industry/Private Sector:
Government System:
Military:
NGO or Relief Agency:
Other (please specify):
Nature of business of earth station facility:

Earth Station Owner Contact Information:

Primary Contact Name:
Office Telephone:
Cell Phone:
SAT Phone:
Email Address:
Alternative Contact Methods:

Earth Station Information

Number of antennas at location:
Number of operating antennas:
Number of inoperable/non-functioning antennas:
Number of idle but functional antennas:
Site primary power source(s):
Site backup power source(s):
Current status of primary power source(s):
Current status of backup power source(s):
Generator fuel capacity & status:
On-Site Structures (buildings, equipment sheds, data centers, offices):
Availability of on-site satellite installers/engineers:

Operational Antenna Information - Antenna #1:

Hardware:
Primary use (eg: data, broadcast):
Antenna size (m):
Antenna frequency band (configured):
Antenna frequency band options (if multi-band):
Mobile system (COTM, COTP, fly-away):

RX-only / RX-TX:
Power amplifier type & power:
Automatic uplink power control:
Modem/encoder/decoder make & model:
Other RF & IP equipment:
IF Frequencies:
Equipment redundency:
Uplink type (eg: TDMA, FDMA, SCPC, DVB):
Downlink type (eg: TDMA, FDMA, SCPC, DVB):
Ability to switch to IP / data service if used for broadcast:
Known Restrictions:

Satellite:
Satellite Operator:
Satellite Name:
Satellite Location:
Antenna Az to satellite:
Antenna El to satellite:
EIRP & G/T at location:
Maximum uplink data rate in link budget with current equipment:
Maximum downlink data rate in link budget with current equipment:
Contract directly with satellite operator? (yes/no):

Provider(s):
Satellite Operator POC (if direct contract exists):
Satellite Service Provider:
Satellite Service Provider POC:
Remote site/hub Operator:
Remote site/hub Location:
Remote site/hub Internet connectivity:
Antenna Installer (identify if third party or self):
Antenna Installer POC (if not self):
Satellite Equipment Maintenance POC (if not self):
Alternative Contact Methods:
Alternative Emergency Contacts or Operators:

Service:
Bandwidth Contracted (specify if contract in MHz or Mbps):
For IP service - Contracted CIR, MIR:
Maximum additional theoretical throughput available beyond service contract without equipment changes:
Maximum additional theoretical throughput available beyond service contract with equipment changes using on-site available equipment:

Operational Antenna Information - Antenna #2:

Hardware:
Primary use (eg: data, broadcast):
Antenna size (m):
Antenna frequency band (configured):
Antenna frequency band options (if multi-band):
Mobile system (COTM, COTP, fly-away):
RX-only / RX-TX:
Power amplifier type & power:
Automatic uplink power control:
Modem/encoder/decoder make & model:
Other RF & IP equipment:
IF Frequencies:
Equipment redundency:
Uplink type (eg: TDMA, FDMA, SCPC, DVB):
Downlink type (eg: TDMA, FDMA, SCPC, DVB):
Ability to switch to IP / data service if used for broadcast:
Known Restrictions:

Satellite:
Satellite Operator:
Satellite Name:
Satellite Location:

Antenna Az to satellite:
Antenna El to satellite:
EIRP & G/T at location:
Maximum uplink data rate in link budget with current equipment:
Maximum downlink data rate in link budget with current equipment:
Contract directly with satellite operator? (yes/no):

Provider(s):
Satellite Operator POC (if direct contract exists):
Satellite Service Provider:
Satellite Service Provider POC:
Remote site/hub Operator:
Remote site/hub Location:
Remote site/hub Internet connectivity:
Antenna Installer (identify if third party or self):
Antenna Installer POC (if not self):
Satellite Equipment Maintenance POC (if not self):
Alternative Contact Methods:
Alternative Emergency Contacts or Operators:

Service:
Bandwidth Contracted (specify if contract in MHz or Mbps):
For IP service - Contracted CIR, MIR:
Maximum additional theoretical throughput available beyond service contract without equipment changes:
Maximum additional theoretical throughput available beyond service contract with equipment changes using on-site available equipment:

Additional Equipment Available for Use:

Notes:

APPENDIX G. RADIO WITH POWER FORM

Rapid Technology Assessments
Conventional Radio

HF Communications System Note: Datum in use is WGS 84

System Priority

Current Status:

Assessment Date:
Operational Status:
HF System Number:
RTAT Assessment Team Number:
Max Duration of Autonomous Operations (Without Resupply):

Comments:

Location:

Latitude (degrees and decimal degrees):
Longitude (degrees and decimal degrees):
Any Specific Access Issues (Keys, etc.)?
Any Location Specific Safety Issues?

Ownership:

Individual:
Industry/Private Sector:
Government System:
Military:
NGO or Relief Agency:
Other (please specify):

Owner Contact Information:

Parent Organization:

Primary Contact Name:
Office Telephone:
Cell Phone:
SAT Phone:
Email Address:
Alternative Contact Methods:

System Operator Contact Information:

Parent Organization:
Primary Contact Name
Office Telephone:
Cell Phone:
SAT Phone:
Call Sign:
Email Address:
Alternative Contact Methods:
Alternative Emergency Contacts or Operators:

Frequencies & Equipment:

Frequencies Used:
Channel Spacing:
Known Restrictions:
Radio System In Use:
Type of System (Analog/Trunked/Digital):
Transmitter Identity Tones or Keys:
Access Limitation Tones or Keys:
Cross Band Capability (If Yes, Details):
Can Additional Frequencies Be Added (If Yes, Details):
Telephone Interconnect Capabilities?
Designated Liaison Frequencies - Executive Level:
Designated Liaison Frequencies - Field Personnel:
Mobile System?

Radio Coverage Information:

Transmitted Power:
Antenna Type:

Mast Height:
Radio Coverage Map:

Additional Equipment Available for Use:

Functional Dependencies:

Grid Power:
Fuel/Genset:

Power - General Setup:

Grid powered or grid isolated site?
Grid power status at the site (ON or OFF):
Power grid damage condition in the immediate surroundings (None, Minor, Moderate, Significant)?
Name of the Electric Power Utility in the area?

External Power Infrastructure:

Condition of site's grid access panel and meter (damaged or not):
Is there a disconnect switch for sites grid tie? Can it be accessed?
Is there information about voltage and rating for the grid tie? Single or 3-phase?
Is there an accessible connection plug for a portable generator?
Is there a permanent diesel generator at the site? What is it's condition? What is the rated power? What is the tank capacity?
Is there a portable diesel generator at the site? What is it's condition? What is the rated power? What is the tank capacity?
Is there a fuel cell at the site? What is it's condition? What is the rated power? What is the tank capacity?
Is there a permanent propane-fueled generator at the site? What is it's condition and it's tank condition? What is the rated power? What is the tank capacity?
Is there a permanent natural gas generator at the site? What is it's condition? What is the rated power? What is the status of the natural gas feed? Is natural gas on or off?

Are there solar panels at the site? What is their condition? What is their rated power?

Are their wind generators at the site? What is their condition? What is their rated power?

Is there some other type of generator at the site? If so, describe and note it's condition and rated power:
Does this site have air conditioning units? If so, how many? What is their capacity? What is their condition? Are they operating?

Internal Power Infrastructure (if the site can be accessed):

What is the condition of the circuit breaker panel? Are there available (empty) positions?
What is the total battery capacity and their condition?
How many rectifiers are at the site? What is their capacity and output voltage? What is their condition?
Are their DC-DC converters (e.g. 24 to 48V)? What is their capacity, input and output voltage? What it their condition?
Are there inverters or UPS's at this site? If so, how many? What is their capacity and output voltage? What is their condition?
Is the controller indicating power consumption? If yes, how much?
Is the controller presenting any alarms? Which ones?

Notes:

Rapid Technology Assessments
Conventional Radio

VHF Communications System

Note: Datum in use is WGS 84

System Priority

Current Status:

Assessment Date:
Operational Status:
VHF System Number:
RTAT Assessment Team Number:
Max Duration of Autonomous Operations (Without Resupply):

Comments:

Location:

Latitude (degrees and decimal degrees):
Longitude (degrees and decimal degrees):
Any Location Specific Safety Issues:
Any Specific Access Issues (Keys, etc.)?

Ownership:

Individual:
Industry/Private Sector:
Government System:
Military:
NGO or Relief Agency:
Other (Please Specify):

Owner Contact Information:

Parent Organization:
Primary Contact Name:

Office Telephone:
Cell Phone:
SAT Phone:
Email Address:
Alternative Contact Methods:

System Operator Contact Information:

Parent Organization:
Primary Contact Name
Office Telephone:
Cell Phone:
SAT Phone:
Call Sign:
Email Address:
Alternative Contact Methods:
Alternative Emergency Contacts/Operators:

Frequencies & Equipment:

Frequencies Used:
Channel Spacing:
Known Restrictions:
Radio System In Use (Hardware):
Type of System (Analog/Trunked/Digital):
Transmitter Identity Tones or Keys:
Access Limitation Tones or Keys:
Cross Band Capability (If Yes, Details):
Can Additional Frequencies Be Added (If Yes, Details):
Telephone Interconnect Capabilities?
Designated Liaison Frequencies - Executive Level:
Designated Liaison Frequencies - Field Personnel:
Mobile System?

Repeaters:

Repeater Number:
Fixed Repeater (Yes/No):
Total Number of Fixed Repeaters:

Location Of This Repeater (Lat/Long):
Access Method (Road/Helicopter, etc.)
Uplink Frequency
Downlink Frequency
Repeater Restrictions (If Any?)
Total Number of Portable Repeaters:
Portable Receiver Receive/Transmit Frequencies:

Comments: Due to nomenclature variances between countries be sure to record the Repeater transmit and receive frequencies and identify each as such.

Radio Coverage Information:

Transmitted Power:
Antenna Type:
Mast Height:
Radio Coverage Map:

Additional Equipment Available for Use:

Functional Dependencies:

Grid Power:
Fuel/Genset:

Power - General Setup:

Grid powered or grid isolated site?
Grid power status at the site (ON or OFF):
Power grid damage condition in the immediate surroundings (None, Minor, Moderate, Significant)?
Name of the Electric Power Utility in the area?

External Power Infrastructure:

Condition of site's grid access panel and meter (damaged or not):
Is there a disconnect switch for sites grid tie? Can it be accessed?
Is there information about voltage and rating for the grid tie? Single or 3-phase?

Is there an accessible connection plug for a portable generator?
Is there a permanent diesel generator at the site? What is it's condition? What is the rated power? What is the tank capacity?
Is there a portable diesel generator at the site? What is it's condition? What is the rated power? What is the tank capacity?
Is there a fuel cell at the site? What is it's condition? What is the rated power? What is the tank capacity?
Is there a permanent propane-fueled generator at the site? What is it's condition and it's tank condition? What is the rated power? What is the tank capacity?
Is there a permanent natural gas generator at the site? What is it's condition? What is the rated power? What is the status of the natural gas feed? Is natural gas on or off?
Are there solar panels at the site? What is their condition? What is their rated power?
Are their wind generators at the site? What is their condition? What is their rated power?
Is there some other type of generator at the site? If so, describe and note it's condition and rated power:
Does this site have air conditioning units? If so, how many? What is their capacity? What is their condition? Are they operating?

Internal Power Infrastructure (if the site can be accessed):

What is the condition of the circuit breaker panel? Are there available (empty) positions?
What is the total battery capacity and their condition?

How many rectifiers are at the site? What is their capacity and output voltage? What is their condition?
Are their DC-DC converters (e.g. 24 to 48V)? What is their capacity, input and output voltage? What it their condition?
Are there inverters or UPS's at this site? If so, how many? What is their capacity and output voltage? What is their condition?
Is the controller indicating power consumption? If yes, how much?
Is the controller presenting any alarms? Which ones?

Notes:

Rapid Technology Assessments
Conventional Radio

UHF Communications System

Note: Datum in use is WGS 84

System Priority

Current Status:

Assessment Date:
Operational Status:
UHF System Number:
RTAT Assessment Team Number:
Max Duration of Autonomous Operatiions (Without Resupply):

Comments:

Location:

Latitude (degrees and decimal degrees):
Longitude (degrees and decimal degrees):
Any Location Specific Safety Issues:
Any Specific Access Issues (Keys, etc.)?

Ownership:

Individual:
Industry/Private Sector:
Government System:
Military:
NGO or Relief Agency:
Other (Please Specify):

Owner Contact Information:

Parent Organization:
Primary Contact Name:

Office Telephone:
Cell Phone:
SAT Phone:
Email Address:
Alternative Contact Methods:

System Operator Contact Information:

Parent Organization:
Primary Contact Name
Office Telephone:
Cell Phone:
SAT Phone:
Call Sign:
Email Address:
Alternative Contact Methods:
Alternative Emergency Contacts/Operators:

Frequencies & Equipment:

Frequencies Used:
Channel Spacing:
Known Restrictions:
Radio System In Use (Hardware):
Type of System (Analog/Trunked/Digital):
Transmitter Identity Tones or Keys:
Access Limitation Tones or Keys:
Cross Band Capability (If Yes, Details):
Can Additional Frequencies Be Added (If Yes, Details):
Telephone Interconnect Capabilities?
Designated Liaison Frequencies - Executive Level:
Designated Liaison Frequencies - Field Personnel:
Moble System?

Repeaters:

Repeater Number:
Fixed Repeater (Yes/No):
Total Number of Fixed Repeaters:

Location Of This Repeater (Lat/Long):
Access Method (Road/Helicopter, etc.)
Uplink Frequency
Downlink Frequency
Repeater Restrictions (If Any?)
Total Number of Portable Repeaters:
Portable Reciever Receive/Transmit Frequencies:

Comments: Due to nomenclature variances between contries be sure to record the Repeater transmit and receive frequencies and identify each as such.

Radio Coverage Information:

Transmitted Power:
Antenna Type:
Mast Height:
Radio Coverage Map:

Additional Equipment Available for Use:

Functional Dependencies:

Grid Power:
Fuel/Genset:

Power - General Setup:

Grid powered or grid isolated site?
Grid power status at the site (ON or OFF):
Power grid damage condition in the immediate surroundings (None, Minor, Moderate, Significant)?
Name of the Electric Power Utility in the area?

External Power Infrastructure:

Condition of site's grid access panel and meter (damaged or not):
Is there a disconnect switch for sites grid tie? Can it be accessed?
Is there information about voltage and rating for the grid tie? Single or 3-phase?

Is there an accessible connection plug for a portable generator?
Is there a permanent diesel generator at the site? What is it's condition? What is the rated power? What is the tank capacity?
Is there a portable diesel generator at the site? What is it's condition? What is the rated power? What is the tank capacity?
Is there a fuel cell at the site? What is it's condition? What is the rated power? What is the tank capacity?
Is there a permanent propane-fueled generator at the site? What is it's condition and it's tank condition? What is the rated power? What is the tank capacity?
Is there a permanent natural gas generator at the site? What is it's condition? What is the rated power? What is the status of the natural gas feed? Is natural gas on or off?
Are there solar panels at the site? What is their condition? What is their rated power?
Are their wind generators at the site? What is their condition? What is their rated power?
Is there some other type of generator at the site? If so, describe and note it's condition and rated power:
Does this site have air conditioning units? If so, how many? What is their capacity? What is their condition? Are they operating?

Internal Power Infrastructure (if the site can be accessed):

What is the condition of the circuit breaker panel? Are there available (empty) positions?
What is the total battery capacity and their condition?
How many rectifiers are at the site? What is their capacity and output voltage? What is their condition?
Are their DC-DC converters (e.g. 24 to 48V)? What is their capacity, input and output voltage? What it their condition?
Are there inverters or UPS's at this site? If so, how many? What is their capacity and output voltage? What is their condition?

Is the controller indicating power consumption? If yes, how much?
Is the controller presenting any alarms? Which ones?

Notes:

Rapid Technology Assessments
Conventional Radio
Broadcast (AM/FM) Communications System

System Priority

Current Status:

Assessment Date:
Operational Status:
Broadcast System Number:
RTAT Assessment Team Number:
Max Duration of Autonomous Operations (Without Resupply):

Comments:

Location:

Latitude (degrees and decimal degrees):
Longitude (degrees and decimal degrees):
Any Location Specific Safety Issues:
Any Specific Access Issues (Keys, etc.)?

Ownership:

Individual:
Industry/Private Sector:
Government System:
Military:
NGO or Relief Agency:
Other (Please Specify):

Owner Contact Information:

Parent Organization:
Primary Contact Name:

Office Telephone:
Cell Phone:
SAT Phone:
Email Address:
Alternative Contact Methods:

System Operator Contact Information:

Parent Organization:
Primary Contact Name
Office Telephone:
Cell Phone:
SAT Phone:
Call Sign:
Email Address:
Alternative Contact Methods:
Alternative Emergency Contacts/Operators:

Frequencies & Equipment:

Frequencies Used:
Channel Spacing:
Known Restrictions:

Radio Coverage Information:

Transmitted Power:
Antenna Type:
Mast Height:
Radio Coverage Map:

Additional Equipment Available for Use:

Functional Dependencies:

Grid Power:
Fuel/Genset:

Power - General Setup:

Grid powered or grid isolated site?
Grid power status at the site (ON or OFF):
Power grid damage condition in the immediate surroundings (None, Minor, Moderate, Significant)?
Name of the Electric Power Utility in the area?

External Power Infrastructure:

Condition of site's grid access panel and meter (damaged or not):
Is there a disconnect switch for sites grid tie? Can it be accessed?
Is there information about voltage and rating for the grid tie? Single or 3-phase?
Is there an accessible connection plug for a portable generator?
Is there a permanent diesel generator at the site? What is it's condition? What is the rated power? What is the tank capacity?
Is there a portable diesel generator at the site? What is it's condition? What is the rated power? What is the tank capacity?
Is there a fuel cell at the site? What is it's condition? What is the rated power? What is the tank capacity?
Is there a permanent propane-fueled generator at the site? What is it's condition and it's tank condition? What is the rated power? What is the tank capacity?
Is there a permanent natural gas generator at the site? What is it's condition? What is the rated power? What is the status of the natural gas feed? Is natural gas on or off?
Are there solar panels at the site? What is their condition? What is their rated power?
Are their wind generators at the site? What is their condition? What is their rated power?
Is there some other type of generator at the site? If so, describe and note it's condition and rated power:
Does this site have air conditioning units? If so, how many? What is their capacity? What is their condition? Are they operating?

Internal Power Infrastructure (if the site can be accessed):

What is the condition of the circuit breaker panel? Are there available (empty) positions?
What is the total battery capacity and their condition?
How many rectifiers are at the site? What is their capacity and output voltage? What is their condition?
Are their DC-DC converters (e.g. 24 to 48V)? What is their capacity, input and output voltage? What it their condition?
Are there inverters or UPS's at this site? If so, how many? What is their capacity and output voltage? What is their condition?
Is the controller indicating power consumption? If yes, how much?
Is the controller presenting any alarms? Which ones?

Notes:

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APPENDIX H. RTAT V6 TRAINING POWERPOINT

Appendix H was created by the author to help explain and teach how to use the RTAT mobile data collection tool. A similar document was used to train volunteers in the Philippines and for JIFX 2014–04.

This appendix is included to give the reader a better understanding of how the RTAT mobile data collection tool works and to give a better understanding of how training was conducted for crowdsourced volunteers.

Desired Form Build Capability

- Ability to modify or create new forms

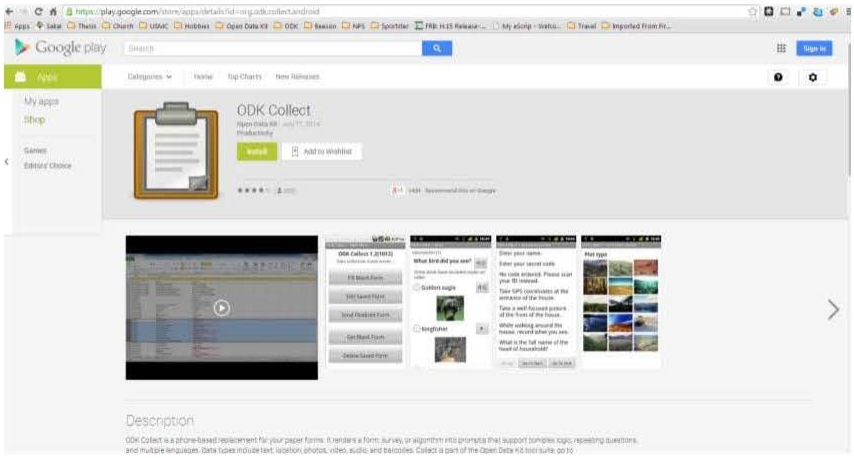
Questions???

- Point of Contact
  - R. Travis Beeson
    - rtbeeson@nps.edu
    - Skype rtravisbeeson (monterey, ca)
    - rtravisbeeson@gmail.com

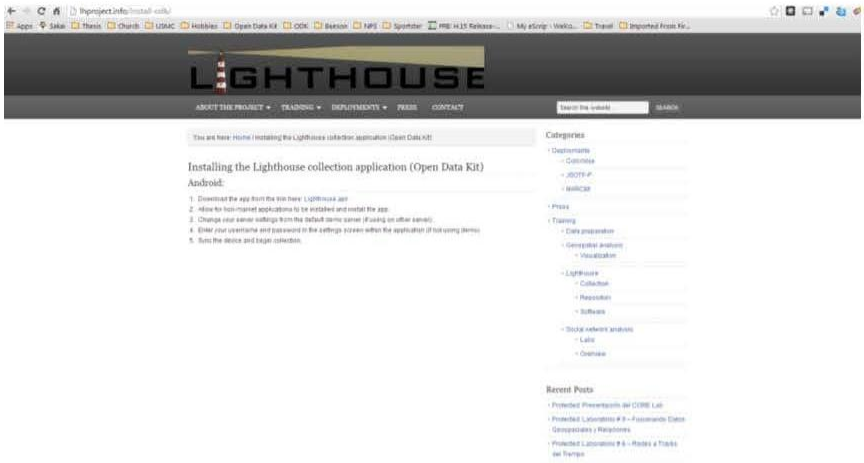
RTAT Survey v6

R. Travis Beeson
rtbeeson@nps.edu

Where to get ODK Collect



Where to get Lighthouse

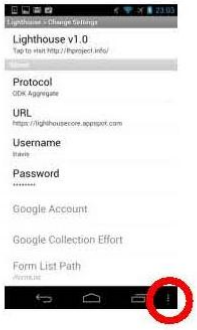


http://lhproject.info/install-odk/

Understanding the PowerPoint

- Select
- Swipe to the next page
- Scroll down on same page

- Click Open Lighthouse or ODK Collect
- Tools



URL: https://lighthousecore.appspot.com

Username: travis

Password: lighthouse

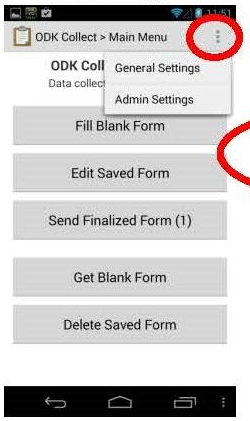
Open the Application

Google Play: "ODKCollect"

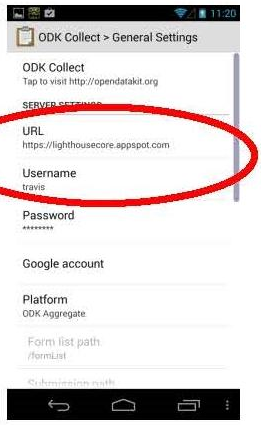
Lighthouse application

ODK Collect Settings

Open General Settings

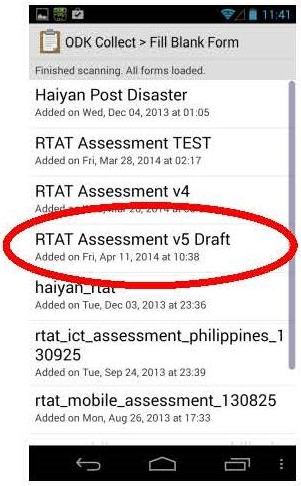


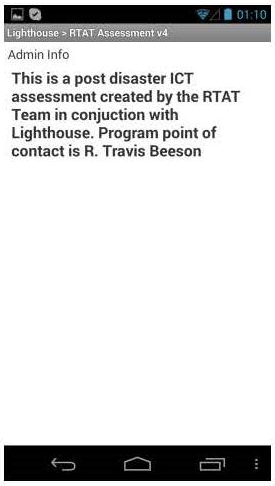
Settings



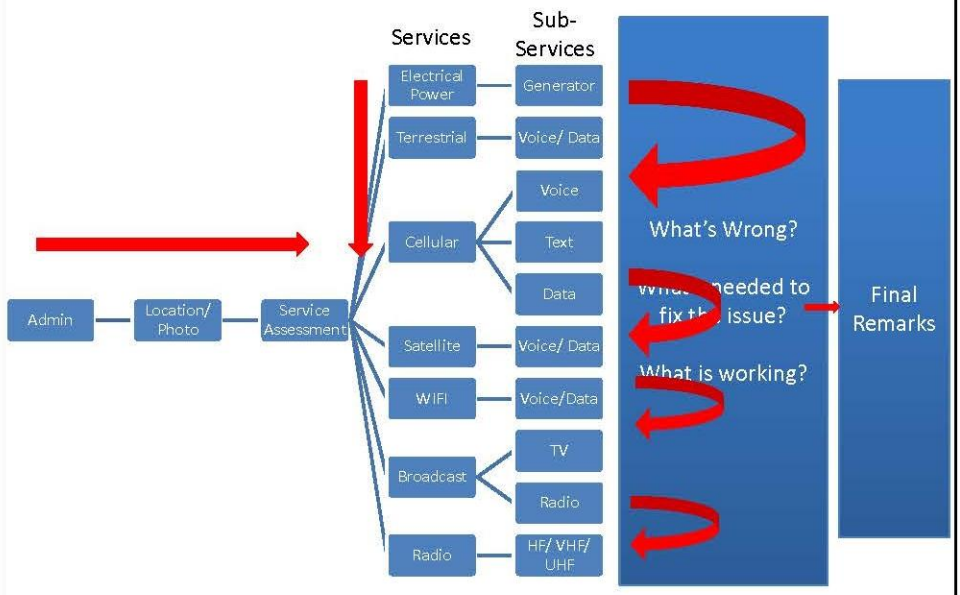
Password

Getting Started





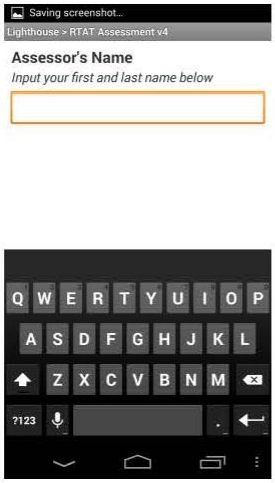
Form Flow



Logic Flow

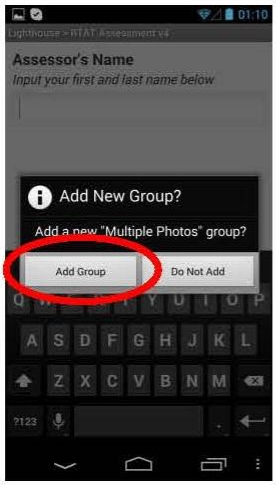
- Asked on every survey
  - Admin Q's
  - Location input
  - Photo input
  - Service operational status
    - "Working"
    - "Not Working",
    - "Intermittent"
    - Or "Not Assessed at this location"
  - Final Remarks
- If service "Not assessed at this location"
  - Sub-service statuses are skipped
- If service "Working"
  - "What's Wrong?" and "What's needed to Fix the Issue?" Questions are skipped
- If NOT "Not Assessed at this location"
  - "What's Working?" is asked
  - i.e. asked for all systems that were assessed

Assessor Name



- Text Box
- *v6 Assessor Contact info

Add Photo



- Click 'Add group' to add a photo

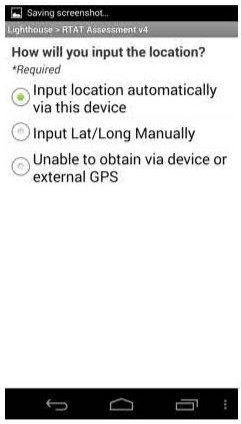
Take Photo

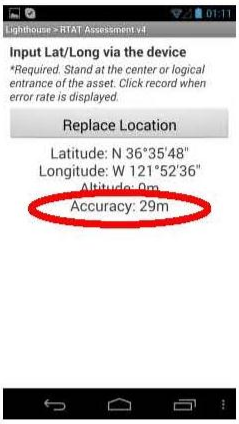
Add Multiple Photos

- Click 'Add Group' to add another photo
- Click 'Do Not Add' to move to the next section

Input Location-GPS

Swipe next when accuracy is displayed





Input Location Manually

Common Name for Location

- Address, or common location.
- Drop down, select 'best' fit for type of location (ties to PDC area brief)
  - ❑ Comm Tower/Antenna
  - ❑ Comm Junction/Node
  - ❑ Satellite Link
  - ❑ Local Government Hall
  - ❑ Hospital
  - ❑ School
  - ❑ Evacuation Center
  - ❑ Gov Distribution Point
  - ❑ NGO/1st Responder location
  - ❑ Public internet hotspot
  - ❑ Other

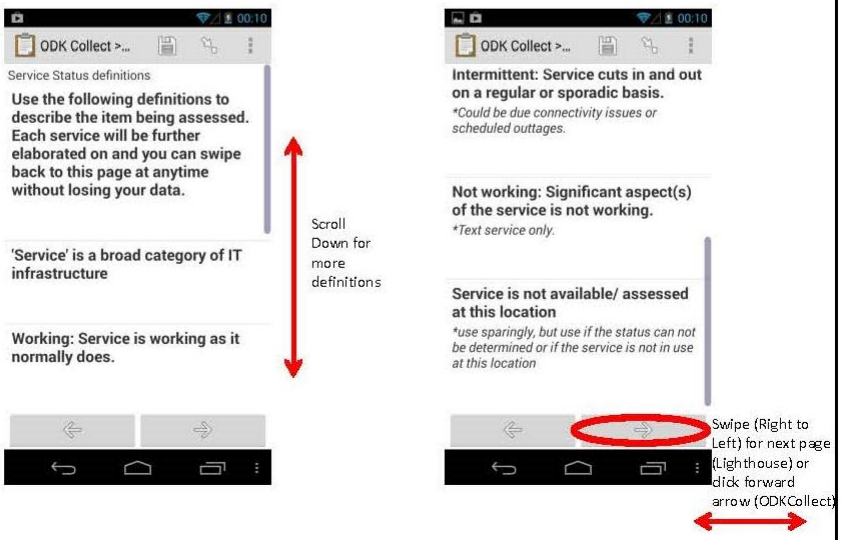
Assessment Definitions

- **Working**
  - Works normally
- **Intermittent**
  - Degraded service or local service only
  - Scheduled Outage
  - Sporadic Outage
- **Not Working**
- **Service is not available at this location**
  - Assess service if at the location, check this box if the service is not at the location
  - Do not check if service is 'not working' (check above)

Service Status

- Working
  - Working as it normally works.
- Intermittent
  - Local connectivity only .
  - or the system is working/ not working on a consistent basis.
- Not Working
- Service is not available at this location
  - Service is not being assessed on this assessment.

Definitions on the Form



Services Being Assessed

- Electrical Power
- Terrestrial (Land Line/Fiber Voice/Data)
- Cellular (Voice/Text/Data)
- Satellite (Voice/Data)
- Wi-Fi (Voice/Data)
- Broadcast (TV/Radio)
- Radio (HF/VHF/UHF)

Service Status

Services answers minimized

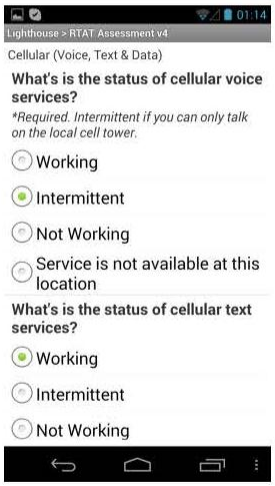
Click on question to open selections

Sub-Service Status

- Sub-Services will be skipped if the service is marked, 'Service not Available/Assessed.
- I.e. Service is marked, 'Working', 'Intermittent', or 'Not Working'

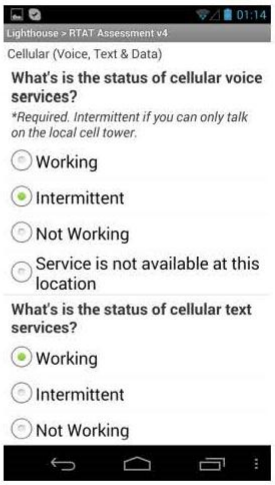
Example 1 Cellular 'Working'

- If Service (Cellular) is marked 'Working' Sub services (Voice, Data, and Text) will be assessed and follow on question will ask 'What's working'-skipping the 'What's Broken' and 'What's Needed to Fix the Issue'



Example 2 Terrestrial 'Intermittent'

- If Service (Cellular) is marked 'Working' Sub services (Voice, Data, and Text) will be assessed and follow on question will ask 'What's working'-skipping the 'What's Broken' and 'What's Needed to Fix the Issue'



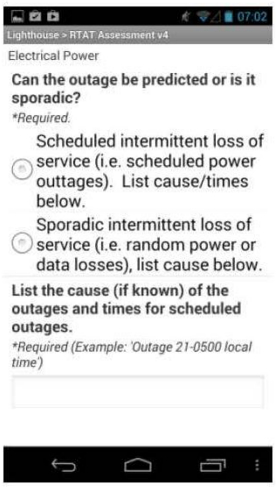
Qualitative Remarks (at the end of each assessed service)

- What's Broken?
- What's needed to fix the problem?
- What's working?
  - Open qualitative text remarks to amplify the assessment quantitative assessment marks.
  - List Point of Contact for the service if known/available.
- There is a 'Final Comments' section at the very end of the survey

Electrical Power Service Assessment

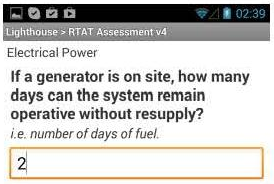
- If the Electrical Power service is assessed it will skip directly to the Generator question (Electrical Power 'sub-service') unless marked intermittent

Power Assessment Intermittent



- Appears only if 'Intermittent' was selected for status
- List the scheduled outage if known.
- Swipe to next page

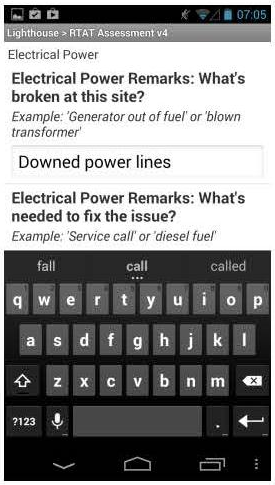
Power Generator Supply



- Based on the amount of fuel on location.
- Leave blank if there is no generator on site.

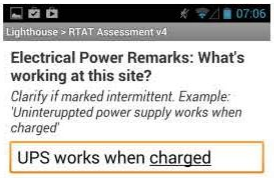
- Swipe to next page.

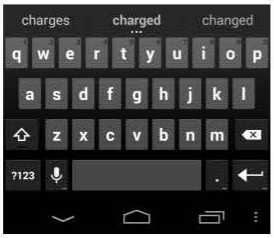
Electrical Power Remarks



- What's Broken?
- What's needed to fix the issue
- Swipe to next page

Electrical Power Remarks

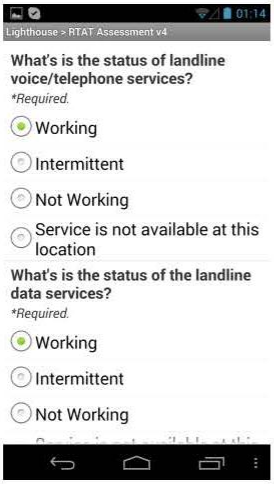




- What's Working at the site

- Swipe to next page

Terrestrial Sub-Service Assessment



- If Terrestrial Service is assessed and marked 'working', 'Intermittent', 'Not Working'

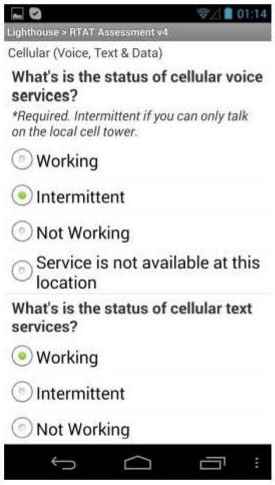
Terrestrial Service Remarks

- Terrestrial includes
  - Telephone Wire
  - Fiber Optic Cable
  - Coaxial Cable
  - Etc.
- What's Broken?
- What's Needed to Fix the Issue?

Terrestrial Service Remarks

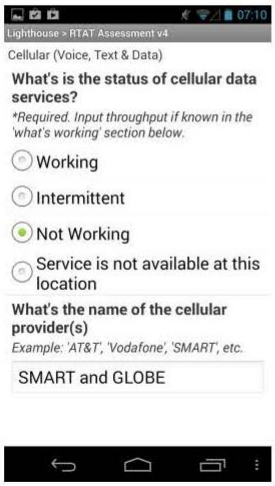
- What's Working?

Cellular Sub-Service Assessment (Voice, Text & Data)



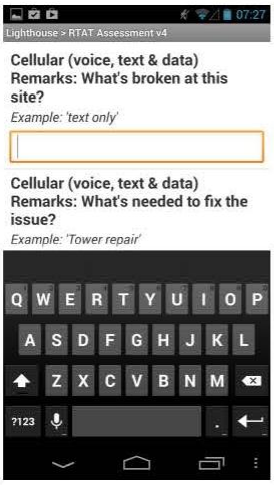
- Status of cellular voice services?
  - Select Intermittent'
    - If calls can only be completed to other subscribers on the same local tower.
    - Or if services have scheduled outages
    - Or are unpredictable
- Status of cellular text services
  - See above for 'Intermittent' guidance

Cellular Sub-Service Assessment (Voice, Text & Data)



- Status of cellular data?
  - Overall assessment for
    - 2g
    - 3g
    - 4g LTE data
- Name of the cellular provider

Cellular Service Remarks

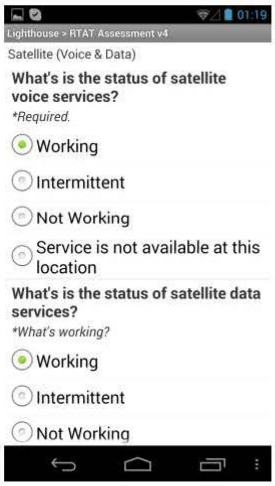


- Combined remarks for all cellular services
  - Voice
  - Text
  - Data
- What's Broken at the site?
- What's needed to fix the issue?

Cellular Service Remarks

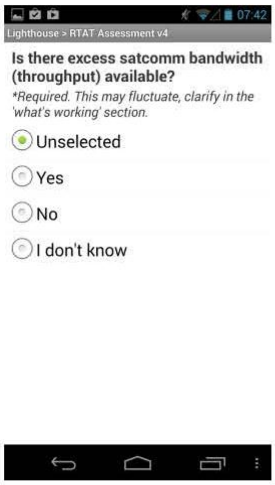
- What's cellular services are working?
  - Examples
    - '2G data only'
    - 'Voice local only'
    - 'Text nationally'

Satellite Sub-Service Assessment



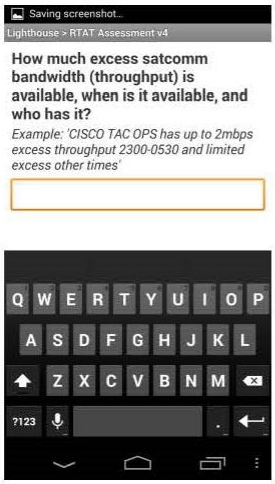
- Satellite Voice Services include any available sat phones at the site.
- Satellite Data Service include satellite terminal such as
  - GATR
  - BGAN

Excess Satellite Throughput



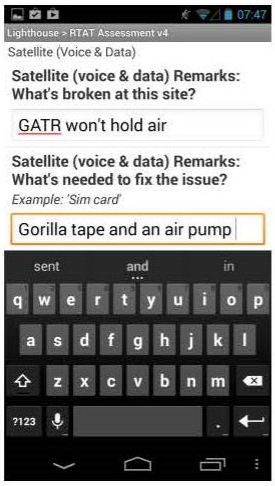
- Just because the service is available that doesn't translate into service being available to new entrants.

Excess Satellite Throughput



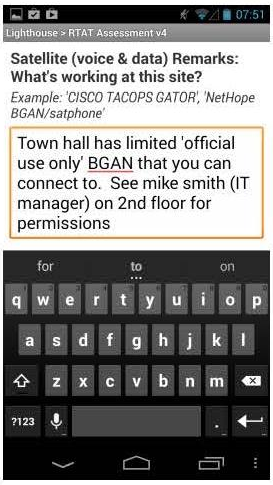
- Question is only available if 'yes', there is excess throughput.
- Include point of contact if that would be helpful.

Satellite Service Remarks



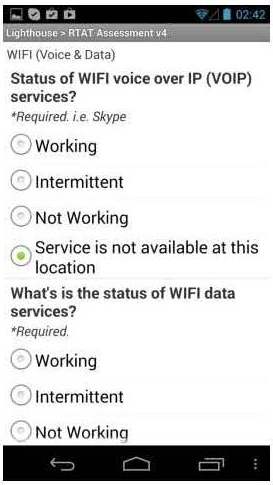
- Combined remarks for all satellite services:
  - Voice
  - Data
- What's broken at the site?
- What's needed to fix the issue?

Satellite Service Remarks



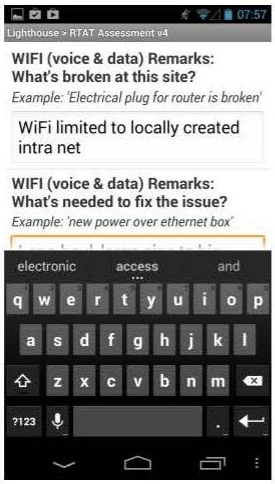
- What's working at the site.
- Examples:
  - 'Multiple sat phones available in the area for SMS or short calls'.

Wi-Fi Sub-Service Assessment



- Voice
  - Skype
  - VOIP
- Data
  - Internet Access

Wi-Fi Service Remarks

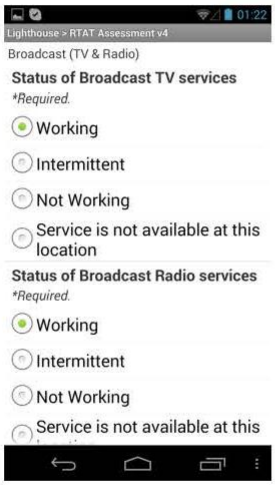


- Combined remarks for all Wi-Fi services:
  - VOIP
  - Data
- What's broken at the site?
  - 802.11g channel congestion limits number of routers/users
- What's needed to fix the issue?
  - More wireless 802.11n routers

Wi-Fi Service Remarks

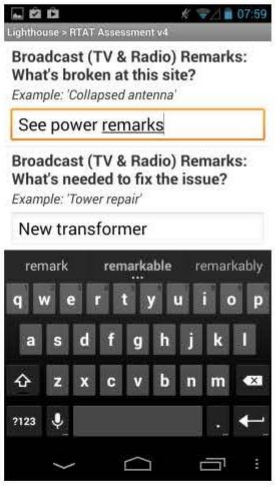
- What's working at the site?
  - 'Camp has created an internal network that displays current relief effort information that is periodically updated.'

Broadcast Sub-Service Assessment (TV/Radio)



- What you can get on a TV or on your normal car radio

Broadcast Service (TV/Radio) Remarks

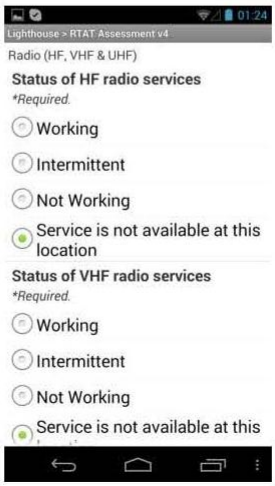


- Combined remarks for all radio services:
  - TV
  - Radio
- What's broken at the site?
- What's needed to fix the issue?

Broadcast Services (TV/Radio) Remarks

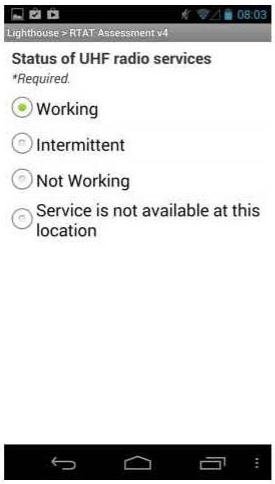
- What's working at the site?

Radio Assessment



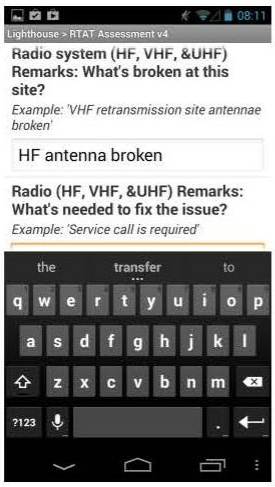
- HF (non-AM radio)
- VHF (non-FM radio)

Radio Assessment



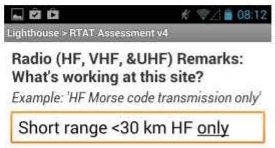
- UHF (non-UHF broadcast)

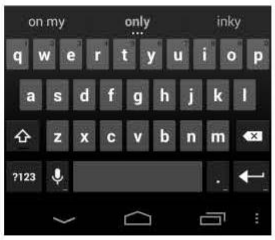
Radio Remarks



- Combined remarks for all radio services
  - HF
  - VHF
  - UHF
- What's broken at the site?
- What's needed to fix the issue?

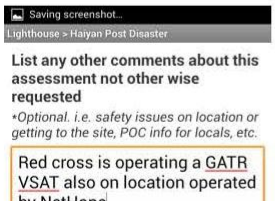
Radio Remarks

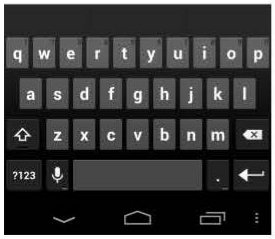




- Combined remarks for all radio services:
  - HF
  - VHF
  - UHF
- What's working at the site?

Final Comments





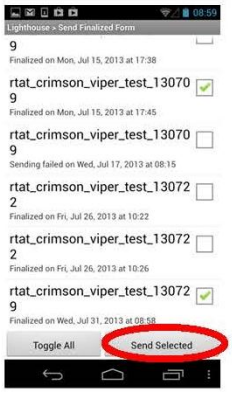
- Final Qualitative comments.
- Clarify or add anything that you couldn't list elsewhere.
- List any security concerns
- Point of contact information.
- **Reliability of the Point of Contact interviewed for the information.**

Complete and send the form

Save and Exit

Send Finalized Form

Select the saved form



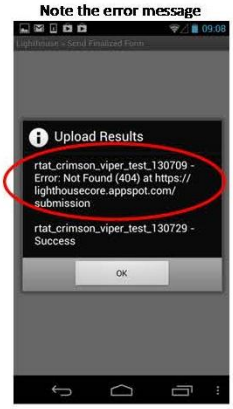
Click Send Selected

Sending the form

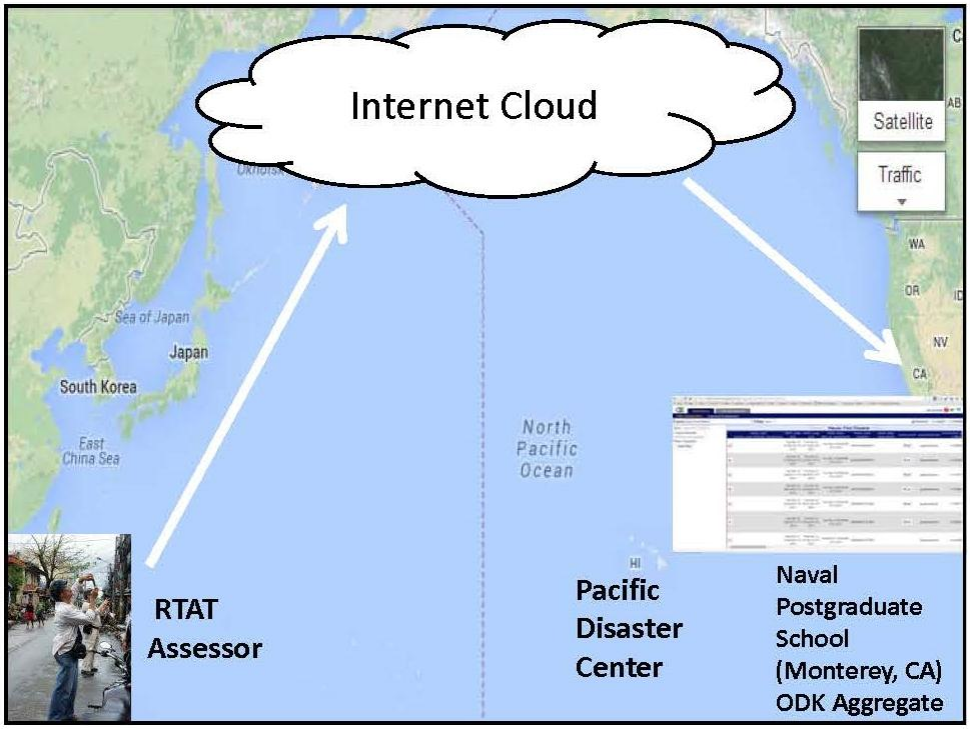
Verify Username/password

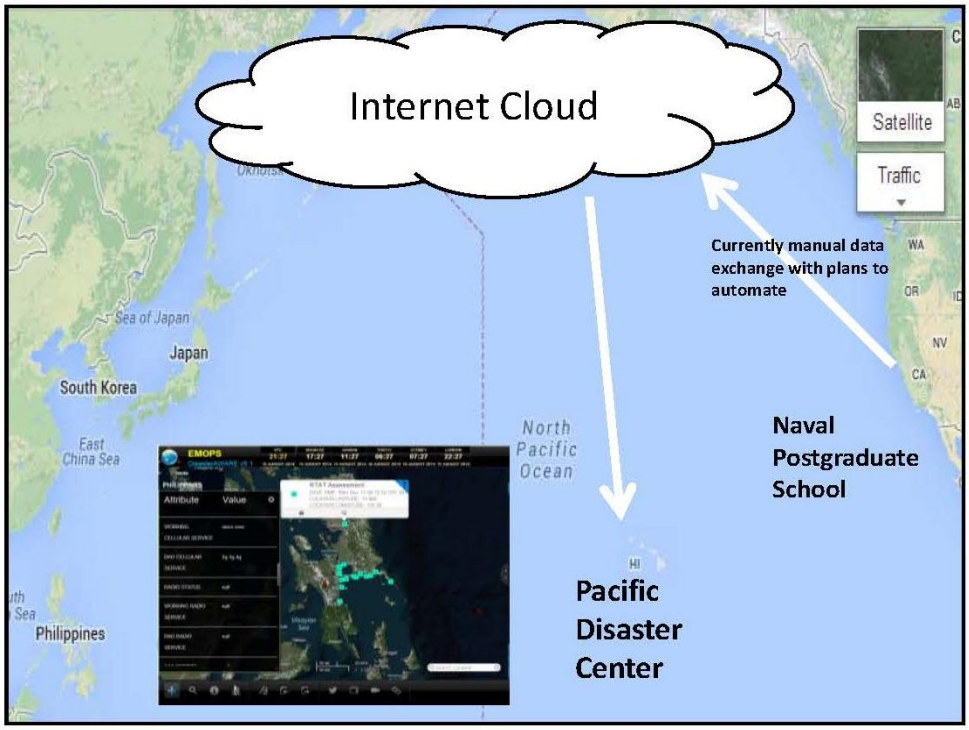
Select 'OK' Send

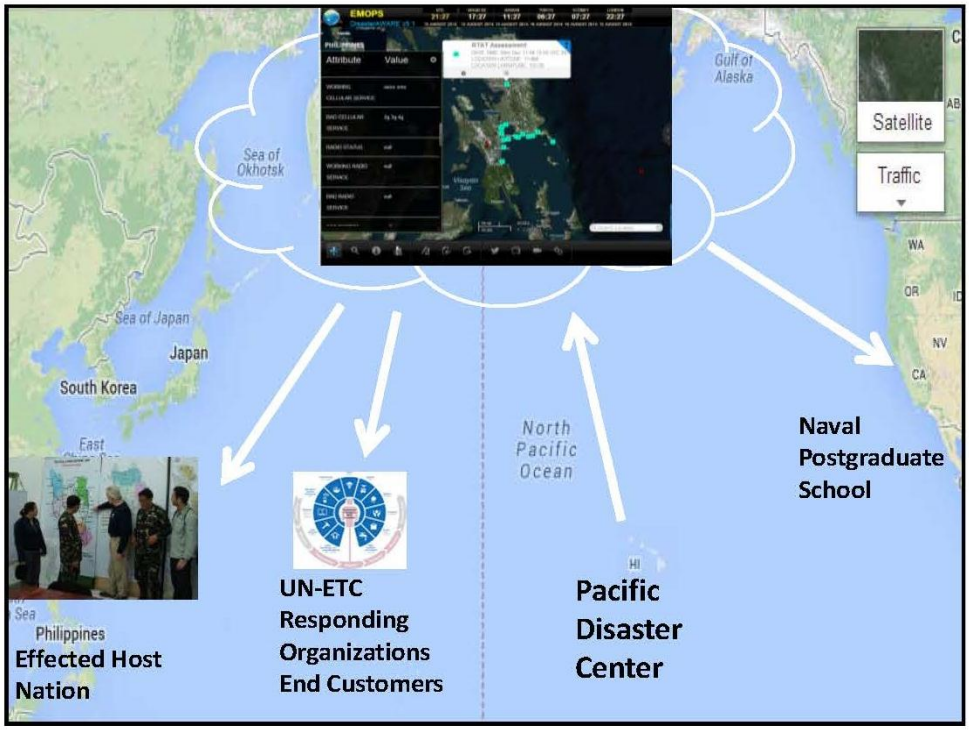
Results
Note the error message



Where does the data go?




Internet Cloud
Satellite
Traffic
Currently manual data exchange with plans to automate
Sea of Japan
Japan
South Korea
East China Sea
Philippines
North Pacific Ocean
Naval Postgraduate School
Pacific Disaster Center

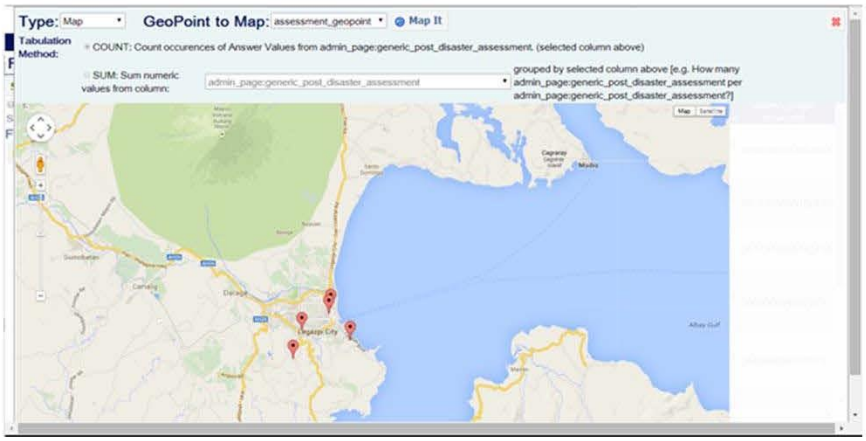

Sea of Okhotsk
Gulf of Alaska
Satellite
Traffic
Sea of Japan
Japan
South Korea
East
Philippines
Effected Host Nation
UN-ETC Responding Organizations End Customers
North Pacific Ocean
Pacific Disaster Center
Naval Postgraduate School

FUTURE BUILDS: V7 AND BEYOND

Still a work in progress

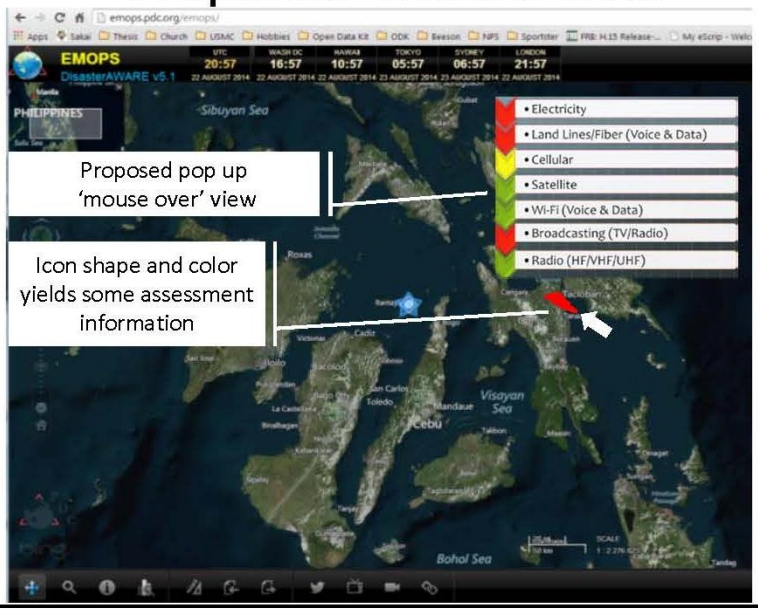
- ODK Collect/Lighthouse Android only
- Link between NPS (ODK Aggregate) and PDC DisasterAware is NOT automated
- Display on DisasterAWARE needs a more intuitive look
- Form just finalized within RTAT
- UN Humanitarian Disaster Exchange (HDX) compliance?

Current ODK Aggregate Map Display



Current DisasterAWARE Display

Proposed 'Mouse Over'



Proposed 'Click' Report

Rapid Technology Assessment Team - ICT Field Report

Assessment Date	4/13/14
Assessment Time (Local)	6/17/04
Location (LAT)	11.14.13.11N
Location (Long)	124.59.55.74E
Location Common Name/Description	Devine Word Hospital - Tacloban
Assessors Team Name	PHL RTAT Team One
Assessors Contact info	SAT #: 123.456.7891, APAN Team 5, Email, RTATTeam1@TeamRTAT.org

Electricity	Land Lines/Fiber (Voice & Data)	Cellular	Satellite	Wi-Fi (Voice & Data)	Broadcasting (TV/Radio)	Radio (HF/VHF/UHF)	Final Remarks	Photos
Condition RED	Condition RED	Condition YELLOW	Condition YELLOW	Condition RED	Condition YELLOW	Condition YELLOW		Insert URL here
Intermittent	Voice services not working	Voice service is intermittent	Satellite voice service is intermittent	Wi-Fi Voice and Data not working.	Broadcast TV is working	Replacement HF Antenna's needed (x4)	Locals in desperate need of Water. Expect limited supplies to run out in less than 24 hours. Hospital low on plasma per Dr. Smith and Dr. Raji	
Fuel being rationed. Generators are being shut down at night at every 3 hours.	Data service is not working	Cellular text service is intermittent	Satalite data service is intermittent	BGAN systems (x2) but no spare bandwidth.	Broadcast Radio is working			
Max 2 days operation based on current fuel reserves even with rationing.	Heavy damage to all telephone poles in area.	Cellular text is only working off local cell tower. No ability to text or talk outside local area.	Spare SAT phones are not available at this location for use.	VSAT systems needed (x3) and at least 2 more BGAN systems plusSIMS and power systems to support all for 2 weeks.	Local reception by Hoptial staff is not possible due to power problems for TVs and portable Radios. No spare power not otherwise committed to Hopital critical gear.			
Grid power unavailable. Heavy damage to all power transmission lines. No other power alternatives seen.	Phone repair teams need to be dispatched to area. Based on damage expect restoration may take significant amount of time. Alternative means of communications needed at hospital	Celluair towers heavily damaged. Lack of power will cause problems even if towers can be reapaired. Cellular service for voice or data not a viable option for communications to outside resources at this location.	NGO's have 2 BGANs, but no spare bandwith.	POC: SMART, John Smith 123.456.7891, POC GLOBE, Jane Smith 123.456.7891, POC APAN, Charles Smith 123.456.7891, Hopital POC Dr. S Smith via NGO RTAT POC	See Electricity remarks for summary of power needs. Also need an additional 4 battery operated TV sets and 15 portable battery operated radios. 12 for use on Hopital campus and 3 for use in Camp Charlie located just West of the main Hospital.			
Additonal fuel is urgently requiered. Additonal generators (2kW or highter power) needed. Total = 7	POC: John Smith, Local Telco, 123.456. 789, Secondary POC at Local Telco: Jane Smith 123.456.7891	Alternative means of communications with power need to be provided to the hospital.	Need 4 - 6 SAT phones with SIM cards for use by mayor and Hopital staff.		Channel 2 and 700AM are available with proper gear in this location.			
POC: John Smith (SAT# 123.348.7891)		Celluar providers are SMART and GLOBE	NGO 1 POC: John Smith 123.456.7891, NGO 2 POC: John Smith, 123.456.7891					
		POC: SMART is John Smith 123.456. 7891, POC GLOBE is John Smith 123.456.7891						

How Does the RTAT Tool Currently Work

- Form resides on the phone (i.e. don't need internet once downloaded)
- Filled assessment remains on phone until it can be opportunistically uploaded

Desired Capabilities

- Device agnostic (iPhone, Android, Symbian, Microsoft Windows, etc)
- Must work independent of an internet connection once deployed (accept to send filled form)
- GPS
  - Slew location on a map
  - Map must reside on the phone
- Photo
  - Write notes (circle important item) on taken photo

Desired Capabilities

- Video
  - If detailed enough to be of use, but not too big to clog connection
- Ability to stop and save or resume an assessment mid-form

Desired Capabilities: Logic

- Skip Logic built in to skip 'not assessed' services
  - 'Check all' menu of assessed Services
- Single overarching location assessment attribute based on inputs of the various services/sub-service operational status(es)
  - Ability to give PDC a single variable value to display a set icon for the location

Desired Capabilities: Logic

- 'Flow up' Service operational status logic
  - If any Sub-Service (s) = 'not-working' then Service = 'not working'
  - If all Sub-Service(s) = 'Working' then Service = 'Working'
  - If any Sub-Service(s) = 'Intermittent' and no Sub-Service = 'Not Working' then Service = 'Intermittent'

Desired Backend Capabilities

- Data base
  - Reports similar to the proposed mouse click report above
  - Ability to view assessments on a map
  - Ability to export data
  - Ability to add a web link to photos in the exported data so that others can click to see the picture
  - Data compatible with UN Humanitarian Data Exchange (HDX)

APPENDIX I. RTAT QUICK LOOK REPUBLIC OF THE PHILIPPINES SEPTEMBER 2013 V2

Appendix I is a report done by Marine Forces Pacific and is not readily available (Chang, 2013). Figures, photos, supporting after action/experimental results are contained within this document.

RAPID INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) ASSESSMENT TEAMS (RTAT) V2

QUICK LOOK REPORT

REPUBLIC OF THE PHILIPPINES

SEPTEMBER 2013

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
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13. SUPPLEMENTARY NOTES		

14. ABSTRACT

This Quicklook Report provides results of the RTAT baseline site surveys/assessments, RTAT mobile data collection tool refinement and validation, as well as briefs conducted various entities and government officials from 21—27 September at various locations in and around the city of Legazpi in the Republic of the Philippines. The RTAT team included participation by the MEC, Naval Postgraduate School, Bicol University, University of the Philippines, USAID, World Food Programme, NetHope, the Armed Forces of the Philippines and the Philippine National Police. Site surveys included providing hands

This Quicklook Report describes the Rapid Information and Communication (ICT) Assessment Teams (RTAT) project's activities in Legazpi city Philippines from 21–27

SEP 2013. The RTAT project is a partnership between United States Pacific Command (U.S. PACOM), United States Marine Corps Forces, Pacific (MARFORPAC) Experimentation Center (MEC), the Naval Postgraduate School, the national and regional government early responder community of the Philippines, and the Armed Forces of the Philippines (AFP). This document provides feedback and observations gathered by the MEC and Naval Postgraduate School and does not necessarily represent the official position of the Marine Corps or the Department of the Navy.

This report is approved for public release, distribution unlimited. The use of trade names in this document does not constitute an official endorsement, approval, or the use of such commercial hardware or software. This document may not be cited for purposes of advertisement.

The MEC especially wishes to recognize the collaboration, support, guidance and force protection provided by the AFP, in particular, AFP Navy Intelligence and Navy Intelligence Security Forces.

Shujie Chang, P.E.
Director, MEC
October 2013

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EXECUTIVE SUMMARY

The U.S. Marine Corps Forces, Pacific Experimentation Center (MEC) conducted the Rapid ICT Assessment Teams (RTAT) activities with support from the Naval Postgraduate School (NPS) to engage the Armed Forces of the Philippines (AFP) and selected members of the Philippines government disaster early responder community. The focus of this RTAT event was to test and demonstrate the use and effectiveness of the RTAT hardware, software and web based tools, techniques, and practices (TTPs) in a real-world environment partnering with real-world disaster early responders.

Climate Change in recent years has been a significant contributor to a huge increase in the number and severity of natural disasters around the world. Stronger and more frequent major weather related events (Typhoons, hurricanes, tropical storms, rain-caused flooding and landslides, tornados, etc.) have challenged the global early responder community as well as the donor base for Non-Government Organizations (NGOs), United Nations, and other non-profit international organizations that focus on humanitarian assistance/disaster relief (HA/DR). One key aspect of providing adequate response to these disasters is the status of the Information and Communication Technology (ICT) infrastructure in the affected communities. One glaring gap in the tool sets of the global early responder community is that they do not know what the status of the ICT infrastructure is immediately after a disaster. They do not know if or how they will be able to communication internally or externally once they arrive in a disaster zone. The purpose of RTAT is to conduct fast, thorough assessments of the ICT infrastructure immediately after the disaster and on an ongoing basis in the first weeks or months post-disaster. These RTAT ICT assessments are made available to the global early responder community as soon as they are conducted. RTAT assessment teams are made up of ICT subject matter experts who come from academia, industry, UN, NGO, foreign government/military, and affected nation government/military. RTAT assessments include reporting status of the disaster zone's copper/fiber landline systems, cellular networks, Internet Service Providers (ISPs), UHF/VHF radio infrastructure, RF broadcast networks (AM and FM for example), and the power grid.

The U.S. RTAT facilitation team's advance party (four people from the Naval Postgraduate School (NPS)) spent 21–22 Sept 2013 in Legazpi City, Philippines conducting RTAT target site surveys and briefing various regional/local Philippines government and military personnel. 23 Sept was spent with personnel from various sectors transiting to Legazpi City Philippines - the most disaster-prone city in the entire country - and obtaining RTAT tools familiarization and training by the NPS team. The complete RTAT team included: NPS, MEC, AFP, national, regional and local government personnel, local academia and the RTAT event host Bicol University. After training, the entire RTAT team conducted actual RTAT assessments from 24–26 Sept in Legazpi City Philippines. These RTAT personnel divided into 6 teams of 7–8 personnel each and drove vans to the various pre-designated RTAT locations and conducted the RTAT surveys for those three days. During these RTAT tests and training sessions, the team also interacted with numerous local government leaders including the Albay Province Governor's office and the Legazpi City Mayoral office.

INTRODUCTION

RTAT Purpose

The first hours and days after the onset of major global disasters are typically fraught with chaos and lack of situational awareness. While there are existing disaster assessment teams from major organizations that deploy to such events, these teams primarily focus on sector specialty areas other than Information and Communications Technology (ICT) and Information Sharing. The ICT sector is critically important as it enables and supports all others.

The arrival of the global response community usually brings a welcome and powerful ICT capacity resource, but sometimes their arrival and the accompanying ICT equipment and capabilities do not link effectively with the host nation ICT and power suppliers. This can mean that the effectiveness of the combined available resources are not maximized, leading to gaps and duplication when there may be enough technical solutions present to accommodate all requirements.

Recent disasters have shown the reluctance of the affected host country to request international assistance, this trend is expected to continue. These disasters were managed internally with only very specific host nation assistance requests being made. Unfortunately these disasters revealed that the needs outpaced the host nation's resources and the affected nation was unable to provide an accurate assessment of ICT and power needs to responding international efforts. As stated, this information is critical to enable collaborative relief efforts that lead to focused and timely support to the affected population. This vital information will directly reduce suffering and the overall recovery time for the affected nation.

Specific problems include:

- In the immediate aftermath of a major disaster there is often a gap in the knowledge of ICT infrastructure status and a lack of communication between the International Humanitarian Community (IHC) arriving on scene and the affected state's national infrastructure stakeholders.
- We do not know how to get the overall ICT infrastructure Common Operating Picture in the hands of the effected state and the IHC as well as to the ISP/GSM/Telecom Ministers, etc.
- We do not know how to discover the methods and resources being used in a disaster for sharing information up and down the chain between the national, government, and infrastructure providers.
- There is no coordinated approach today of establishing a common situational overview of this ICT infrastructure
- Current assessment methods are limited as no single agency has the resources to perform a comprehensive assessment of the ICT situation

What Exists Now:

There are teams that currently perform some very basic ICT assessment functions including (i) the United Nations Disaster Assessment and Coordination (UNDAC) international emergency response system whose core mandates are assessment, coordination and information management to assist the UN and governments in an

emergency; (ii) the Emergency Telecommunications Cluster (ETC); (ii) the International Federation of Red Cross/Red Crescent (IFRC) First Assessment and Coordination Teams (FACT); and iv) ICT based NGO's such as NetHope and TSF have some assessment responsibilities. Some of these teams are on standby to deploy rapidly (in 12–24 hours) as required.

The Requirement:

A proposed solution is to create/ fund RTAT teams - creating the ability to rapidly deploy ICT Assessment Teams—small, nimble, multi-organizational, multi-national integrated teams of specialists in key ICT areas (wireless data communications, voice communications, radio technologies, power, information sharing, social networking, etc.). The real niche this program represents is that the teams can be made up of experts from a variety of different organizations –industry, UN, NGO, academia, IO, affected nation government and military, and international governments/militaries.

Once a comprehensive overview of the ICT situation has been established, a priority list of ICT needs can then be drawn up in coordination with the host nation.

The RTAT team will also be requested to provide specific ICT disaster assessments in the event that full International assistance has not been requested by the host Nation.

RTAT Teams Provide:

Field data containing both Host nation and IHC information and communications technology and power needs and capabilities.

Quality assessment of this information by experts and the distribution of *reliable, trusted* information.

This Initiative does not seek to duplicate any existing process but to reinforce and ena*ble the existing i*nternationa*ll*y accepted processes by meeting a need that is recognized but that is not currently effectively being met. Concentrating on human interfaces and not technology, the team of highly trained inter-organizational personnel will identify and find answers to specific questions, compile a common operations plot and link with the host nation and the IHC enabling fast early recovery.

Specific requirements or capabilities include:

- Having the ability to quickly deploy (within 24 hours)
- Having direct links to local industry and government
- The ability to stay in the disaster zone 1–2 weeks, then reassess need to remain longer or to rotate in new teams
- The team having access to ICT expertise across the functional spectrum (ISP, cellular, data networks, power, etc.) with both the international technical community as well as local/national citizen experts
- To have a keen understanding of the need to work in close collaboration with existing teams on the ground

Who the RTAT teams are made up of:

Ideally these small teams of experts are composed of 1–2 representatives from each of the following organization types: UN, NGOs, IGOs, academia, industry, military and government agencies from around the world. The formal/legal/business organizational makeup of the overall program and teams themselves would be determined by the founding member organizations.

The leadership of the teams should be:

- Team Leader (from either the global or regional technical community)
- National (affected state) Member (National Disaster Management Agency or Ministry of Communications or equivalent organizations affiliated for example)

What the RTAT teams readiness status should be:
Small teams of qualified/trained experts from across the ICT spectrum on 24x7 stand-by to deploy as soon as possible but likely for 1–2 weeks in shifts.
We believe that before being ready and able to deploy to a specific disaster zone there should be a BASELINE ICT/Info Sharing assessment capability in place. These assessments should be accomplished well ahead of time in each country prone to regular disasters at a minimum. Such assessments could be done by RTAT supporting entities such as industry and academia. The benefits for such assessments, which would be provided to the host nation government, would go well beyond the RTAT concept and be able to point out potential general ICT vulnerabilities and resilience gaps to all concerned parties.
Where the RTAT team members should be located:
RTAT teams should be stationed at key locations around the world, perhaps modeled after the UN Disaster Assessment and Coordination Teams program, or possibly as associate members of NetHope, the UN UNDAC, ETC or other similar teams. These teams should be called on by the host nation, UN/OCHA, or a regional entity such as ASEAN.

Legazpi City 24–26 September RTAT Assessment Concept of Operations (CONOP):

WHO: Led by the Naval Postgraduate School's Hastily Formed Networks (HFN) Center, this initiative to conduct a baseline Information and Communication Technology (ICT) assessment in Legazpi City, Albay Province, Philippines between 24 and 26 SEP 2013, included a number of people from the Philippine government and military communities. The invited participants included people from Manila and locally in the Albay Province / Legazpi City area from NDRRMC, DOST, OCD, Manila Observatory, Philippines National Police, University of the Philippines, Bicol University (project hosts), the NGO consortium NetHope, the Japanese Civil Response community, U.S. military and academia, and others.
WHAT: The group divided into up to 6 teams of approximately 8 members each. Each team was equipped with vans, drivers, security and the teams featured mixed subject matter expertise to conduct these ICT baseline assessments in the most disaster prone region of the Philippines (Legazpi City and Albay Province region). The SME's conducted baseline assessments of cellular, UHF/ VHF, land lines such as copper and fiber, Internet service provider provided access, satellite communications, meshed Wi-Fi, wireless bridges with WiMAX or LTE, and alternate power systems to better prepare the

community for the next catastrophic event. Having a completed baseline ICT assessment will smooth host nation and international responses during the next real world disaster. The local/regional early responder community will already have critical information on the communications infrastructure and will not have to try to dig this information up while in the chaos of a real-time disaster.

WHEN: The baseline ICT assessment was conducted in Legazpi City between 24 and 26 September 2013.

WHERE: In the vicinity of Legazpi City, Albay Province, Philippines with Bicol University as the base of operations. Bicol University has also volunteered to be our host and to provide classrooms for training sessions and meetings as well as their contact network to help determine exactly where in the area we will be conducting the baseline ICT assessments.

WHY: Since RTAT has never before been used to conduct actual pre- or post-disaster ICT assessments, this opportunity to do a real-world, real country assessment is very important to the overall RTAT development process. The RTAT ICT assessments conducted this week also coincides with one of the agreed upon projects of the year-old Kabalikat Science and Technology Innovation Initiative (STI2) that involves the same organizations listed above (NDRRMC, DOST, OCD, Manila Observatory, AFP, PNP, UP, Bicol University, etc.).

HOW: The RTAT effort will utilize a U.S. Naval Postgraduate School (NPS) created hardware/software application system called Lighthouse to do the data collection and dissemination. This Lighthouse application is Android based, and heavily leverages standard Android smart phones and tablet computing devices during the week to document the ICT status and information collected. The data was sent in real time (via Wi-Fi or cellular connections) up to a data server housed at the Naval Postgraduate School in Monterey, California, U.S.A.

Timeline of RTAT activities in the Philippines in September 2013:

21 September, Legazpi City, Bicol Province, Philippines

The U.S. RTAT Advance Team (Naval Postgraduate School personnel including faculty member Brian Steckler and students, Major Travis Beeson, Capt Jennifer Gladem and LT Jason Chamberlain) transited from Metro Manila to Legazpi City, Albay Province, Philippines to conduct initial site surveys of the six locations pre-determined to be assessed using the RTAT process later in the week. The NPS RTAT Advance Team was met at the Legazpi Airport by the Bicol University personnel who were to be our hosts for the RTAT week. After checking into the hotel, the team and commenced the site surveys at three of the six pre-determined RTAT locations, briefing Barangay Captains (local communities and the senior elected official in each community) on what RTAT is and what we would be doing later in the week with the full RTAT assessment effort with about 50 RTAT assessors in 6 teams of 7–8 people.

Figure 1 - Bicol University Welcoming Party

Figure 2—RTAT Team receives a local briefing by the Oro Barangay Captain

22 September, Legazpi City, Bicol Province, Philippines

The U.S. NPS RTAT Advance Team continued site surveys at the final three Barangays, briefing Barangay Captains on RTAT concepts, and training Bicol University and Barangay personnel on the operation of RTAT applications.

Figure 3 - Major Beeson briefing local Barangay leadership on RTAT

Figure 4 - Barangay Captain using RTAT Android App

23 September, Legazpi City, Bicol Province, Philippines

Full RTAT participation group from Manila transit to Legazpi City from Metro Manila and are greeted by our Bicol University hosts. The RTAT participants transiting to Legazpi City from Metro Manila included personnel from the Armed Forces of the Philippines, Manila Observatory, University of the Philippines, Department of Science and Technology, Office of Civil Defense, National Disaster Risk Reduction Management

Center, and Philippine National Police. After checking everyone into the hotel (The Oriental) there was an all hands orientation and training session on the use of the RTAT application (combination of NPS's Lighthouse data collection app and android phones).

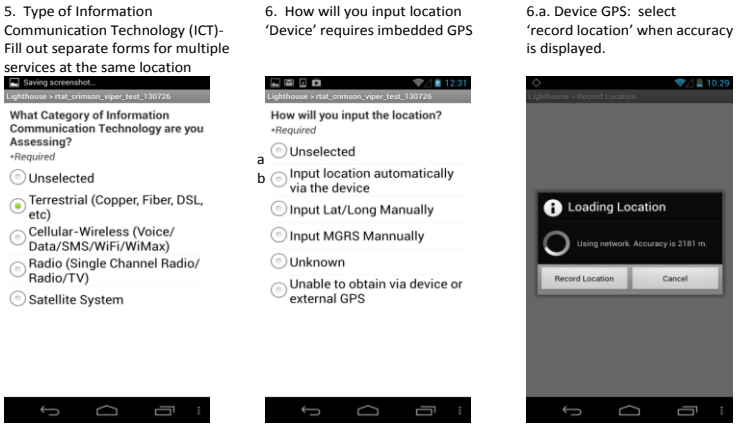

Figure 5 - NPS Lighthouse Android RTAT Data Collection Application

24 September, Legazpi City, Bicol Province, Philippines

The full contingent of RTAT assessors (U.S., Filipino, other international volunteers) was now in place in Legazpi City and ready to commence the actual RTAT assessments.
The 24th started with an RTAT kickoff session at Bicol University in which the Albay Province representative made opening comments. The Legazpi City Mayor welcomed everyone to town and thanked everyone for conducting the RTAT assessments in his city and the Bicol University President welcomed everyone. Then the NPS faculty lead, and RTAT overall coordinator, Brian Steckler, provided a RTAT presentation and the week's concept of operation plan. Major R. Travis Beeson (USMC) finished the meeting by providing detailed RTAT application training to all attendees. The participation at this initial RTAT meeting was very impressive and very well attended and included 81 participants from 42 organizations.

Figure 6 - Mr Steckler (NPS) presents RTAT to local community at RTAT Kickoff Meeting

After the opening meeting, participants were divided into 6 teams of 7–8 people. Each team received assignments of which Barangay to go to for their RTAT assessments. EACH team van had working cell phones, and cellular and or on-the-move satellite Internet connectivity. Command & control between the lead van (Brian Steckler) and the team van leadership was enacted primarily through Skype chat, with cell phone and text as back up. This enabled real time coordination for all team movements.
The evening of the 24th featured a Welcome Dinner hosted by the Legazpi City Mayor.

25–26 September, Legazpi City, Bicol Province, Philippines

The teams rotated through the different Barangay sites on the 25th and 26th to conduct their baseline RTAT assessments and to brief the local Barangay leadership. The teams got together nightly for next day planning and hot wash. Lasting up to two hours, the teams went over all of the lessons learned, command and control issues, site assessment discoveries, and identified several RTAT application areas for improvement.

Figure 7 - RTAT Hot wash 26 September

The evening of the 26th was a farewell dinner hosted by the Governor's office (he was unable to attend as he was unable to make it back to the area from Manila).

SUMMARY

The RTAT baseline ICT assessment effort conducted from 24–26 September was very successful. We had the full support (and participation) of national, regional and local leadership from the very beginning. The U.S. RTAT leadership from NPS and the MEC were well received and welcomed throughout the week by all levels of leadership and everyone understood how this RTAT effort could significantly enhance their disaster preparedness and improve their key capabilities in disaster risk reduction and resilience. The event was very well attended with as many as 81 participants coming from 42 different entities including those from academia, industry, UN, NGO, U.S. government, military, and law enforcement as well as Philippines national, regional and local leadership and other government agencies. U.S. participants made up about 20 percent of the people for the overall event. Defense related entities (U.S. and Philippines) made up about 15 percent of the total entities.

The RTAT effort successfully began a much longer and far reaching process of base-lining ICT infrastructure in this community and provided experience and understanding of the RTAT process to key leaders up and down myriad national and local government organizations. The RTAT baseline assessment process conducted this week also enhances the overall RTAT program by providing many lessons learned and identifying many tweaks to the Lighthouse RTAT data collection application that will help with all future RTAT missions around the globe.

APPENDIX J. TYPHOON HAIYAN AFTER ACTION REPORTS

Appendix K is an internal RTAT after action report written by both RTAT waves during Typhoon Haiyan (Steckler, 2013). This supporting information is not available by any other means. Figures, photos, supporting after action/experimental results are contained within this document.

After Action and Lessons Learned Report:

RTAT Lighthouse Application Deployment in Support of Typhoon Haiyan (Yolanda)

Republic of the Philippines

28-29 November 2014

R. Travis Beeson

11 February 2014

On 8 November 2013 Typhoon Haiyan (Yolanda) made land fall in the Republic of the Philippines (ROP). "Typhoon Haiyan (Yolanda) was one of the strongest typhoons (cyclones) to strike land on record. Over a 16 hour period, the 'super typhoon,' with a force equivalent to a Category 5 hurricane and sustained winds of up to 195 mph, directly swept through six provinces (Lum & Margesson, 2013). This storm affected over 16 million people displacing 4.1 million people through the destruction of 1.1 million homes and resulting in over 6,200 deaths (United States Agency for International Development, 2014).

Background

Prior to Typhoon Haiyan, a team from Naval Postgraduate School (NPS) traveled to the Legazpi City, ROP in order to introduce, test and validate the Rapid Information and Communication Technology (ICT) Assessment Team (RTAT) concept and a developed mobile data collection form (more below) for ICT assessment. Bicol University, as well as, numerous other volunteers from academia, government officials, representatives from the Armed Forces of the Philippines (AFP) and experts from the disaster response community helped refine the RTAT concept and the ICT assessment form.

The resultant mission of RTAT became "To conduct and distribute baseline and post-disaster ICT infrastructure assessments, in order to facilitate host nation and international disaster relief efforts," (Steckler, 2012). To 'facilitate' now included the management and dissemination of a shared common operational picture and ICT recovery prioritization recommendations. To facilitate the common operational picture aspect, data collected from Lighthouse on NPS servers would be shared with the Pacific Disaster Center (PDC) to be displayed on their Emergency Operations DisasterAware website.

The RTAT Concept of Operations was refined to be:

Deploy ICT experts to the disaster zone

Obtain local support/volunteers

Assess the ICT with Lighthouse

Aggregate the data on servers back at NPS

Share (manually/automated) this data with Pacific Disaster Center for display on their disaster website

Disaster responders could then access this website to obtain the latest ICT status information to aid in disaster recovery efforts.

The aforementioned mobile data collection form is based on the Open Data Kit suite of tools. "Open Data Kit (ODK) is a free and open-source set of tools which help organizations author, field, and manage mobile data collection solutions. ODK provides an out-of-the-box solution for users to:" Build data collection forms (surveys), collect the results from mobile platform to a central server, and aggregate/transform the data into other useful format (http://opendatakit.org/, accessed 2/13/14). ODK is facilitated through the NPS developed Lighthouse application and is compatible with any Android based device. The RTAT concept and Lighthouse was refined during/after the September 2013 Legazpi City test in preparation for a future disaster deployment. The ODK developed form residing on the Android device and facilitated through the Lighthouse application will be referred commonly in the rest of this report as 'Lighthouse' or 'Lighthouse application'.

Overarching concept of operations is: Deploy a team of competent IT experts and obtain local support/volunteers. Assess ICT infrastructure utilizing Lighthouse.

Typhoon Relief Efforts

Prior to typhoon Haiyan making land fall on 8 November, US forces were already responding in anticipation of the damage resulting from the extremely high wind and storm surge. Within days of the response, a team from Naval Postgraduate School was requested to aid in the US DOD relief efforts then known as Operation Damayan. Providing initial satellite communication support to 3rd Marine Expeditionary Brigade, the team was re-tasked to support Joint Task Force JTF-505 on approximately 25 November and assign to assist the Armed Forces of the Philippines. Upon transitioning to the JTF, the NPS team was joined by a group from the Roddenberry Foundation and faculty from Bicol University, who participated in the September RTAT event, in order plan and execute the first real world deployment of RTAT and the developed Lighthouse

application. On 26 November the entire team moved to Mactan Air Base, near Cebu City, ROP in order to be better positioned for operations in the Tacloban City disaster area. In Mactan, RTAT operationally supported Brigadier General (BGen) Santiago (AFP). Not coincidently BGen Santiago participated in the September Legazpi City event and was a proponent of the RTAT concept and was ready to get RTAT into the disaster zone to help with assessments. Connections with BGen Santiago and a local volunteer group known as 'Team Patola' netted over 40 volunteers that showed up for training on the 27th. Training consisted of approximately three hours of classroom instruction and two hours of practical application utilizing the Lighthouse tool. Classroom training included: What is RTAT and the Roddenberry Foundation, how to visually identify ICT and Power infrastructure and conduct ICT assessments, what to expect in a disaster zone, life support and safety and how to utilize the Lighthouse tool. Two hours of practical application paired five (+-) students with a trained person and walked around the local area practicing the collection and transmission of assessments. Lessons learned from the training:

Local Audio/Video and power compatibility was an issue with the presentation. Brings lots of power plug and HDMI to XX adapters.

Volunteers for the training were acquired through a Team Patola Facebook post. 24-48 hour notice would be optimal, but the 12am post still netted more volunteers than we could handle at the 12pm training (15 + volunteers).

Many Volunteers had no idea how to identify various ICT equipment and technical background/expertise highly varied amongst the volunteers. As a result an ad hoc class was added to the curriculum and given after the practical application training. A handbook with pictures of antennae and power infrastructure should be developed for use by inexperienced volunteers. One weatherproofed handbook per team should suffice.

Education certificates are a big deal in the ROP and certificates should be printed, signed and given out to those participating in the training.

On 28 November the 14 RTAT personnel were transported on a South Korean C-130 into Tacloban City. This Military Air (MILAIR) flight was arranged through BGen

Santiago. The personnel were organized into 2 main teams with one team having the option to further split into two teams. Two main teams were led by the Roddenberry Foundation and the optional team was led by Bicol University. The teams started out visiting the local government officials, the Philippine National Police (PNP) local headquarters, AFP contingent, and the United Nations (UN) Non-Governmental Organization (NGO) coordination center. Each of visited locations netting critical local conditions, security and needs information. Minimally courtesy visits should be paid to each of the above before operating in the area. The UN updated local ICT conditions and requested assessments be made in the local area and to the south of Tacloban City along Maharlika/Pan-Philippine Highway to Abuyog, see Figure 1.

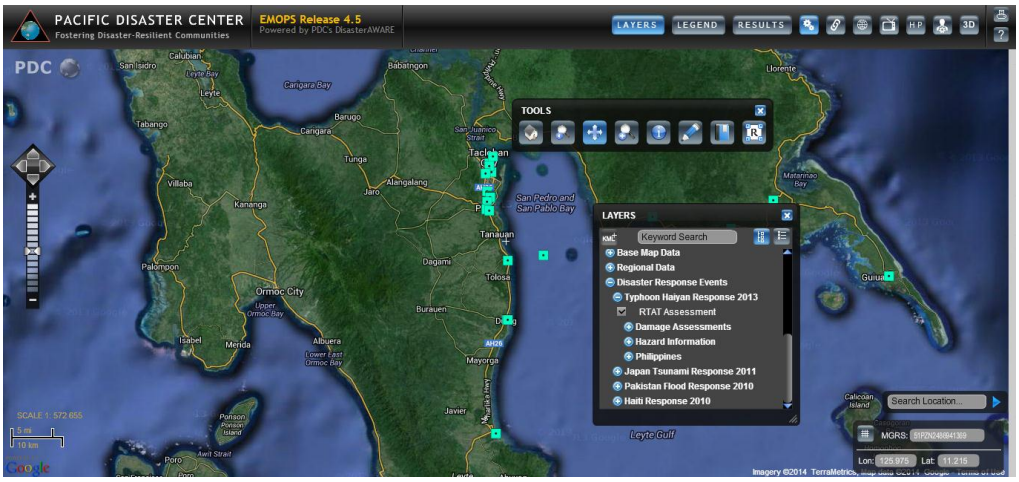

Figure 4 Screen shot from PDC EMOPS with RTAT Assessments accessed 2/13/14

Transportation and shelter in an available gym was arranged through Team Patola. Security was a layered approach-A loose courtesy over watch was arranged through the PNP with AFP personnel organic to each team. Each van had a local guide and the numerous local volunteers provided the needed language interpretation. There was one team member that remained behind in Mactan to coordinate team evacuation should the need arise. Lessons learned.

Cultural differences in regards to diet and expectation led to a couple of faux pas that could be avoided. Tell the driver to ‘pack lunch’ and he’ll bring his own food. You are expected to stop for lunch, not eat on the way between locations. Local diet consists

mainly of rice with some vegetable and maybe a little meat. The RTAT carried powerbars and heavier meat rations were not as well received as thought.

Water was a significant issue. Teams carried water purification bags and a couple of liters each into Tacloban, but there were no fresh water procurement sources and the teams didn't have 8 hours in a secured sunlit area to use while the bags purified the water if fresh water was available. Unfortunately the RTAT had to rely on another NGO for water.

Communication was an issue as the Broadband Global Area network (BGAN) satellite data system was left in Mactan and the local cellular data collection was intermittent. Data from the Android devices could not be uploaded to the NPS servers until they returned to Mactan hotel on 29 November.

Tracking the team was difficult via intermittent text and voice. However, the Spot GPS tracker was used as a tertiary means of tracking the teams and worked quite well.

Figure 5 Spot GPS tracking of Team 1

Data transfer to PDC was thwarted by form changes and the lack of server Letters of Agreements to share data in an automated fashion. PDC was able to post data to their website Late in December after the data from two separate forms were joined to a single submission. The process of putting a data set onto the website takes minimally 3 hours and adding a new form requiring a new website layer could take up to 3 weeks with the current PDC work load. Bottom line the form needs to be finalized before PDC can commit to creating yet another RTAT layer on the DisasterAware website and this process needs to be automated to meet end user expectation.

Lighthouse application feedback.

Users were a little frustrated with the order of questions. Assessors could get the GPS location early in the form but then have to remain at the location, often in the rain, until the end of the form to snap a photo before completing the form.

Assessments could've been completed when enroute to the next location if the form was more efficiently structured. While interviewing the local expert or caretaker for the ICT site there were long breaks between questions that needed their input. This resulted in awkward pauses requiring another team member to carry the conversation, to keep the person from leaving, while the assessor answered other form questions.

Query structure was such that only one type of ICT infrastructure could be assessed per form. This lead to lengthy pauses at one location when for example a cellular tower also held a VHF radio antenna and was linked via fiber optic cable. This example would require three separate assessments for the physical structure.

Weather was a significant factor. One phone (Lighthouse application device) was lost due to rain. The devices need to be waterproof. The Otterbox Defender cases worked well to ruggedize the cases, but were not water proof.

Power to charge the phones was an issue. CrisisSignal.apk was installed on the phones to aid in another post disaster assessment project. The application would send the cell signal strength and send data to an aggregate server on a regular basis. The settings should have been modified to lower the power usage and only one phone per team should have been running CrisisSignal in order to conserve battery strength. Additionally, the teams didn't think until late on day one to keep all the phones off except the one in use to elongate their ability to assess. Power to recharge was available on a limited basis, but would require a team member to stand 'gear guard' while the phones charged at a public recharging point (see Figure 3).

Figure 6 Public Charging Station

Specific recommendations for improving the Lighthouse application and the utilized Android devices were:

GPS should start sensing as soon as the application opens, not when the user selects the 'GPS' option on 'How will you record the location' question. This led to significant delays.

Place the Picture and GPS (location) at the beginning of the form.

Restructure the form to be able to assess more than one type of ICT infrastructure on each form.

Form needs to be rapid and more focused to the point. Where are you, what's wrong, what do you need to fix it.

Remove redundant questions. For example there is no need for the address if you have the GPS coordinates, and no need to assess, primary, secondary and tertiary power if none of them work.

Waterproof/ruggedize the device. Continue to use the Otterbox defender phone case to protect the phone, but switch the device to the Samsung S4 Active (waterproof Android based phone), or utilize a clear touchscreen compatible waterproof bag for optimal protection in wet conditions.

Phone should have AM/FM broadcast radio receiver capability to assess where the broadcast are able to reach.

Extra batteries with a means to charge them off grid needs to be procured before the next mission. Vehicle cigarette lighter adapter with enough cell phone charge cables (10+ USB outlets) should also be procured.

Bibliography

USAID (2014). PHILIPPINES—TYPHOON YOLANDA/HAIYAN. Fact sheet #20 Fiscal Year 2014, dated 24 January, 2014. Department of State. Washington, DC. http://www.usaid.gov/sites/default/files/documents/1866/01.24.14_USAID-DCHATyphoonYolandaHaiyan_FactSheet20.pdf, accessed 2/11/14

Lum, T., and Margessen, R. (2013). Typhoon Haiyan (Yolanda): U.S. and International Response to Philippines Disaster. Congressional Research Service. Washington, DC.

http://www.fas.org/sgp/crs/row/R43309.pdf, accessed 2/11/14.

CONCEPT OF OPERATIONS
RAPID INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) ASSESSMENT TEAMS (RTAT)
FOLLOW-ON ASSESSMENT - CEBU, TACLABON AND LEYTE PHILIPPINES
RTAT IN THE PHILIPPINES 8-11 DEC 2013:
Mr. Brian Steckler

WHO: Led by the Naval Postgraduate School's Hastily Formed Networks (HFN) Center, this initiative, which will take place from Dec 8th to Dec 11th, and is designed to conduct continued assessment of the Information and Communication Technology (ICT) from Tacloban to Borongan in the aftermath of Typhoon Haiyan (Yolanda). The assessment teams will consist of US DoD personnel, a number of civilian personnel from Manila, local government agencies from Tacloban, Armed Forces of the Philippines (AFP) and Philippine National Police (PNP) entities.

WHAT: The group will divide into 2 teams of 5-6 people with vans/drivers and the teams will feature mixed Subject Matter Expertise (SME) to conduct the ICT assessments in the areas still suffering communication gaps from Typhoon Haiyan (Yolanda). The SMEs will conduct assessments of the primary nodes which are significantly degraded or none operational to include cellular, UHF/ VHF, land lines such as copper and fiber, Internet service provider provided access, satellite communications, meshed WiFi, wireless bridges with WiMAX or LTE, and alternate power systems to better prepare the community for the next catastrophic event. Assessing the ICT within this area will help

evaluate the network and provide vital information for future responses during real world disaster(s). The local/regional government will have critical information on the degradation of the communications infrastructure as well as an assessment of where to focus resources to restore communications and provide valuable information on what infrastructure needs to be hardened in the event of future disasters.

WHEN: The ICT assessment will be conducted in vicinity of Tacloban up to and may include Borongan between 8 and 11 December 2013.

WHERE: The Tacloban airport will be the base of operations for the assessment teams. The assessment team will arrive at Cebu on 8 December and conduct training at the Marriot in Cebu from 1830 to 2130. On 9 December the assessment team will depart Cebu/Mactan Airbase and travel to Tacloban city. Due to DoD restrictions prohibiting DoD personnel traveling on foreign military aircraft all DoD personnel will depart Cebu utilizing commercial aircraft. Civilian assessment team members will depart utilizing military aircraft. They will all meet up at the Tacloban airport. The assessment team will billet at Tacloban airport on December 9th utilizing established tents on premises. On December 10 the assessment team will depart Tacloban airport and proceed north on Pan-Philippine Highway (AH26) by vehicle to Guiuan via Basey, Marabut, Balangiga, Gilorlos, Quinapondan turning southeast after Quinapindan towards Salcedo to Guiuan. From Guiuan the teams will proceed back north to Salcedo to General MacArthur, Llorente Balangkayan, Maydolong to Borongan City. All teams will travel east to Guiuan and then proceed north towards Borongan. At the conclusion of assessments on December 10 all teams will retrograde to a designated location along the route and billeting. All members will be billeted in tents with security provided by PNP personnel. The location of the billeting area will be dependent on assessment teams progress.

WHY: RTAT has limited exposure to post-disaster ICT assessments in this area, this opportunity to do a real world, real area assessment is very important to the overall RTAT development process. The RTAT ICT assessments to be conducted also coincided with one of the agreed upon projects of the year-old Kabalikat Science and Technology Innovation Initiative (STI2) that involves the following organizations NDRRMC, DOST, OCD, Manila Observatory, AFP, PNP, UP, Bicol University. For this specific assessment the AFP has requested us to travel in and around the Tacloban area gathering information in order to understand the vulnerabilities present within their communication infrastructure in order to properly prepare for future disasters

HOW: The RTAT effort will utilize a US Naval Postgraduate School created hardware/software application system called Lighthouse to do the data collection and dissemination. This Lighthouse application is Android based, and we will heavily leverage standard Android smart phones and tablet computing devices during the week to document the ICT status and information collected. The data will be sent in real time or near real time (via WiFi or cellular connections) up to the CORE Lab's data server housed at the Naval Postgraduate School in Monterey, California, USA. The CORE lab will then process the data and forward all data to Pacific Disaster Center (PDC) who in turn will populate all data on their website (www.pdc.org).s All data will then be accessible for official use to registered users utilizing their user name and password.

RTAT Background and Executive Summary

Overview.

Information and Communication Technology (ICT) and power sectors are critical to the response after major disasters. Currently existing post disaster assessments focus on areas other than ICT, power and Information Sharing. A rapid assessment of the ICT status will enable the host nation and the International humanitarian community to provide a targeted allocation of resources and result in a reduction of gaps and duplication of effort. The Rapid Technology Assessment Teams (RTAT) concept seeks to provide a pool of multi-disciplinary experts who will rapidly deploy to the disaster zone to provide this information. The RTAT concept is supported by many organization and individuals within the ICT disaster response community and is in the process of obtaining further funding. A crucial part of the development of the initiative is to gather support for the adoption of the concept by key disaster prone countries. Their involvement will enable RTAT to tailor responses based on specific country needs and to ensure that processes and operations will be as effective as possible.

The Problem:

The first hours and days after the onset of major global disasters are typically fraught with chaos and lack of situational awareness. While disaster assessment teams exist from major organizations that deploy to such events, these teams primarily focus on sector specialty areas other than ICT and Information Sharing. The ICT sector is critically important as it enables and supports all other relief efforts.

Arrival of the global response community usually brings a welcome and powerful ICT capacity, but sometimes their arrival and the accompanying ICT equipment and capabilities do not link effectively with the host nations ICT or each other. This means that the effectiveness of the combined available resources are not maximized, leading to gaps and duplication.

Additionally, the host country often does not request international assistance after a disaster. In this case, the disasters have often been managed internally with international requests only made for specific assistance which can cause the host nation's resources to be stretched and unable to provide an accurate assessment of ICT and power needs thus creating a significant gap in ICT assessments. Complete ICT information is critical to obtaining targeted support that will enable the response, business recovery, and minimize the effects of the disaster on the population.

Specific problems include:

- In the immediate aftermath of a major disaster there is often a gap in the knowledge of ICT infrastructure and a lack of communication between the International Humanitarian Community (IHC) and the host nation's national infrastructure.
- We do not know how to get the overall ICT infrastructure Common Operating Picture in the hands of the affected state and the IHC as well as to the ISP/GSM/Telecom Ministers, etc.
- We do not know how to discover the methods and resources being used in a disaster for sharing information between the national, government, and infrastructure providers.

- There is no coordinated approach today of establishing a Common Operating Picture (COP) of this ICT infrastructure.
- Current assessment methods are limited as no single agency has the resources to perform a comprehensive assessment of the ICT situation.

What Exists Now:
There are teams that currently perform some very basic ICT assessment functions. Some of these teams are on standby to deploy rapidly in 12 -24 hours.

1. The United Nations Disaster Assessment and Coordination (UNDAC) international emergency response system whose core mandates are assessment, coordination and information management to assist the UN and governments in an emergency.
2. The Emergency Telecommunications Cluster (ETC)
3. The International Federation of Red Cross/Red Crescent (IFRC) First Assessment and Coordination Teams (FACT)
4. ICT based NGO's such as NetHope and TSF have some assessment responsibilities.

The Requirement:
The proposed solution would create the ability to rapidly deploy small, nimble, multi-organizational, multi-national integrated assessment teams of specialists in key ICT areas such as wireless data communications, voice communications, radio technologies, power, information sharing, social networking, etc. The real niche this program represents is that the teams can be made up of experts from a variety of different organizations such as industry, UN, NGO, academia, International Organizations, affected nation government/military, and international governments/militaries.
Once a comprehensive overview of the ICT situation has been established, a priority list of ICT needs can be drawn up in coordination with the host nation.
The RTAT teams can also be requested to provide specific ICT disaster assessments in the event that full international assistance has not been requested by the host nation.
The Teams Will Provide:
Field data containing both host nation and IHC information as well as communications technology and power needs and capabilities.
Quality assessment of this information by experts and the distribution of *reliable, trusted* information.
This Initiative does not seek to duplicate any existing process but to reinforce and ena*ble the existing internationally* accepted processes by meeting a need that is recognized but that is not currently being effectively met. By concentrating on human interfaces and not technology, the team of highly trained inter-organizational personnel will identify and find answers to specific questions, compile a common operating picture and link with the host nation and the IHC enabling fast early recovery.

Specific requirements or capabilities include:

- Having the ability to quickly deploy (within 24 hours)
- Having direct links to local industry and government

- The ability to stay in the disaster zone 1-2 weeks, then reassess need to remain longer or to rotate in new teams
- The team having access to ICT expertise across the functional spectrum (ISP, cellular, data networks, power, etc.) with both the international technical community as well as local/national citizen experts
- Understanding the need to work in close collaboration with existing teams on the ground

Team Makeup:
Ideally these small teams of experts would be composed of 1-2 representatives from each of the following organization types: UN, NGOs, International Government Organizations IGOs, academia, industry, military and government agencies from around the world. The formal/legal/business organizational makeup of the overall program and teams themselves would be determined by the founding member organizations.
The leadership of the teams should be:

- Team Leader (from either the global or regional technical community)
- National affected state Member (such as National Disaster Management Agency, Ministry of Communications or equivalent affiliated organizations)

We still need to determine:

- Skill sets, qualifications and exact number of people to make up each team
- Current thinking is to have government and/or industry experts from the Internet Service Provider (ISP) industry, the GSM/other cellular/landline industry, the power infrastructure industry, the wireless broadband industry, and the satellite communications industry.

Teams Readiness Status:
Small teams of qualified/trained experts from across the ICT spectrum on 24 X 7 stand-by to deploy as soon as possible but likely for 1-2 weeks in shifts.
We believe that before deploying to a specific disaster zone there should be a BASELINE ICT/Info Sharing assessment capability in place. These assessments should be accomplished well ahead of time in each country prone to regular disasters. Such assessments could be done by RTAT supporting entities such as industry and academia. The benefits for such assessments, which would be provided to the host nation government, would go well beyond the RTAT concept and be able to point out potential general ICT vulnerabilities and resilience gaps to all concerned parties.

Team Locations:
RTAT teams would be stationed at key locations around the world, perhaps modeled after the UN Disaster Assessment and Coordination Teams program, or possibly as associate members of NetHope, the UN Emergency Telecommunications Cluster (ETC Cluster) or other similar teams. These teams could be called on by the host nation, UN agencies such as OCHA, WPF , or a regional entity such as ASEAN.
Timeline of RTAT Concept Development: In late 2011 we began work on a process of developing the concept, identifying founding member organizations, outlining team

member qualifications forming the teams, training and exercising these teams, and iteratively refining the program. We believe that if a real-world disaster event happens any time in the near term future, and if the teams have been identified and the roles, responsibilities and operating procedures are sufficiently advanced that an opportunity to "jump start" the entire process by deploying to that real -world event is possible. Caution of course would be needed to ensure this would not hinder but rather enhance the overall response efforts.

Organizations That Have Helped Develop the RTAT Concept:

UN/NGO Community:

- UN (UN-OCHA)
- UN (UN-World Food Programme/ FITTEST)
- UN (Emergency Telecommunications Cluster (ETC))
- NetHope
- Demining NGO community
- Telecoms Sans Frontieres
- -New Zealand Red Cross
- InSTEDD
- CrisisMappers.Net

Industry:

- Cisco Systems
- Microsoft
- Global VSAT Forum
- Delorme
- Inmarsat Government Services, US, Inc
- Oceus Networks
- -MEDWEB

Academia:

- Naval Postgraduate School (US)
- University of Texas
- San Diego State University
- National Defense University (US)

Government/Military Community:

- US Department of Defense
- Pacific Disaster Center
- -Japan Resiliency Initiative
- International Association of Emergency Managers (IAEM)

Point of Contact:
Brian Steckler, US Naval Postgraduate School, Monterey CA USA
Cell: 831.402.1584 - Work: 831.656.3837 - steckler@nps.edu

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APPENDIX K. JOINT INTER-AGENCY FIELD EXERCISE 2014–04 AFTER ACTION REPORT

Appendix L contains an internal draft after action report written by the RTAT team after JIFX 2014–04 written by Dr. Rebecca Goolsby and Mr. Brian Steckler (2014). This supporting information is not available by any other means. Figures, photos, supporting after action/experimental results are contained within this document.

JIFX After Action Report (AAR)

JIFX Experiment Number (*X-00*): B- 11

Experiment Title: Socio-Technical Information Operations (STIO) and Hastily Formed Networks (HFNs) in Austere Environments

Organization:—Naval Postgraduate School(NPS), Office of Naval Research(ONR), Arizona State University(ASU), and Pacific Disaster Center (PDC)

Experiment Lead/Point of Contact: Brian Steckler (+1.831.402.1584, steckler@nps.edu); Dr. Rebecca Goolsby (+1.phone.number, preferred@email)

Quantitative Results : N/A

- 208 synthetic tweets successfully merged into a secure twitter environment using CrisisTracker technology for deployment into the environment
- 50 synthetic tweets and 20 "live" tweets were injected into the scenario itself
- 1 alternative power demonstration (wind and solar) accomplished
- 7 remote wireless networks established
- 7 Rapid IT Assessments conducted using the RTAT mobile data collection tool
- Rapid, on-the-fly training in communications and power were accomplished for five new users who had no benefit of previous exposure to HFN or RTAT processes.

Qualitative Results (please be as descriptive and detailed as possible): The Socio-Technical Information Operations and Hastily Formed Networks in Austere Environments Project has three different areas of focus: (1) Crisis Tracker—Led by ASU; (2) Hastily Formed Networks (HFN)—Led by NPS; (3) Rapid IT Assessment Tool (RTAT)—Led by NPS.

CrisisTracker Effort. This effort successfully trained 17 people in the use of a novel technology for communications, information sharing and coordination. The technology enabled the development and initiation of a novel exercise concept that integrated real-time rapid IT assessment, alternative power team deployment, and alternative

communications (mesh-networks) in an austere field setting. Crisis Tracker overcame initial obstacles in connectivity in an austere environment; the technology was able to be used to start, stop and coordinate team activities in the field over two days of experimentation.

Hastily Formed Networks. This effort put into practice pre-event training on the deployment of alternative power and communications in austere tactical or Humanitarian Assistance/Disaster Relief (HA/DR) environments. A variety of communications techniques were used for command and control, coordination, trouble-shooting, and reach-back, including radios and CrisisTracker with mobile phones. Intense hands-on field training for new users who lacked the pre-event training was successfully accomplished on site, with five entirely new users to all of the technologies.

RTAT assessment. Experienced and novice users demonstrated the capability to perform rapid assessments of the information and communication technology (ICT) environment at 25 locations under austere conditions.

Scenario Development. A full, 208-Tweet scenario divided into 4 Master Scenario Events List (MSEL)s (subdivided into multiple, flexible vignettes) was developed for this effort. Since this was a highly novel integration with brand new technologies, it was not expected that the full 208 tweet scenario would be played. Many vignettes within the scenario were developed to accommodate from 10 to 100 participants. The 208 synthetic tweets were available and demonstrated to be easily launched to assist in developing a flexible scenario environment. Tweets were available for review; other participants could have submitted synthetic tweets for this event if desired.

Note: generating synthetic tweets by hand is very difficult and requires quite a bit of training and knowledge. Developing a full exercise, even as small as this, requires weeks of effort. A full three to six months of lead time is ideal, depending on the size and scope of the exercise. A year's lead time for an advanced exercise would be recommended.

Monday 11 AUG 2014 Objectives: Set up of communications equipment, initial deployment and tear down of alternative power equipment, preparation for follow-on exercise events.

1. Crisis Tracker
    - Set up of mobile Crisis Tracker platform in the command station.
    - Training of new users.
    - Registration and testing of mobile phones (note: Crisis Tracker could be used by all mobile smart phones, regardless of brand. No download needed).
    - Initial test uses and communications checks.
    - Initial tests of information flows with the protected Twitter account.
    - All synthetic tweets were made available within Crisis Tracker for pushing out to exercise participants as "injects."
    - Synthetic test tweets were initialized and pushed into the Crisis Tracker environment.

Hot Wash Issues: The main problem for Crisis Tracker was connectivity. Local WiFi capabilities were constantly being challenged by the number of users at Camp Roberts McMillan Field NPS location and the load these users placed on the radio frequency spectrum and WiFi channels. A number of minor bugs were discovered and fixed on the fly, including problems in connecting people to chat rooms, problems in sending and receiving Short Messaging System (SMS) messages, and general issues of dropping off the WiFi. Later use of a Very Small Terminal Aperture Terminal (VSAT) satellite broadband connection on the following day predominantly solved this issue.

2. Hastily Formed Networks (HFN)

- Alternative power sources were set up:RENEWS–a wind turbine, flexible solar panels, rigid solar panels, and fossil fuel generators.
- **COMMUNICATIONS: VIA SATS / (HOW MANY) WAVE MESH NETWORKS WERE ESTABLISHED**
- Six working radios were tested.

Hot Wash issues: Difficulties in range of the radios—several times the range of the radios was not adequate due to a lack of line of sight. In addition, a problem was discovered in frequency assignments—2 of the 6 radios were on the wrong frequency.

2. Rapid ICT Assessment Tool (RTAT)
   - Set up beforehand, **SIX ANDROID DEVICES WERE CHARGED AND READY**

   Hot Wash issues: Android devices were not able to send/receive SMS due to lack of Subscriber Information Module (SIM) cards. Personal phones had to be used for Crisis Tracker. The VSAT brought with the team did not have built in WiFi capability bringing the SIM card issue to light.

Tuesday 12 AUG 2014Objective: Have all systems up and running for scenario injects/ deploy teams in scenarios

1. Crisis Tracker
   - Thirty-five synthetic tweets were successfully sent out over CrisisTracker as injects
   - Chat and sms were utilized to further push scenario events.
   - Synthetic tweets also sent out to Protected Twitter account.
   - CrisisTracker connectivity was intermittent.
   - Crisis Tracker successfully sent out SMS messages, tweets, and chats.
   - Skype Chat room established as per scenario requirements; very useful for trouble shooting.

Hastily Formed Networks (HFN)

- Problems with Via Sat (brand) VSAT terminal; careful examination showed primary issues were cable connections.

- Radios—intermittent due to the large number of other ongong projects during JIFX. These issues dealt with signal transmisstion, line of sight issues, and range deconfliction.
- TWO MULTI-PERSON TEAMS DEPLOYED, WERE ABLE TO SET UP TWO WIFI "HOT SPOTS" WITH VIA SAT AND ONE WITH 3G CELLULAR ENHANCED HFN
- Reassessed situation at operations meeting at noon—afternoon was executed more effectively**. TWO TEAMS WERE AGAIN DEPLOYED, ESTABLISHED THREE HOT SPOTS?**

2. Rapid ICT Assessment Tool (RTAT)
    - Six RTAT assessments were made & successfully submitted

Hot Wash issues. Connectivity issues continued to be a problem for Crisis Tracker (a six month old technology) but were ironed out by the end of the day by switching to a fast VSAT Internet environment versus a much slower 3G cellular Internet connection. This enabled the movement from the main site to the mobile site (Nemesis van) from which Crisis Tracker was easily deployed and stable (using the ViaSat connection). ***Lesson learned:*** *Crisis Tracker will not always have stable connectivity; in the real world, Crisis Tracker is just as likely to be deployed from a field station as from a more robust communication or command center.*

Novice users especially—but everyone needed to be reminded to check gear and cables. Crisis Tracker successfully used to solicit assistance needed to overcome novice problems. Injects were successful in directing activities and moving scenario forward. Skype Chatroom meeting was especially useful in sorting out issues and problems. Crisis Tracker and Skype overlapped but were not redundant; they handled different problems. Crisis Tracker security (using SMS) enabled real-time communications but was limited by connectivity issues in the morning events.

Wednesday 13 AUG 2014Objectives: Execute Scenarios with Small, Novice Team; In-Depth After Action Meeting (Since most of the NPS students were required to return to NPS for class Wednesday, the exercise went forward with a single small team of six people (total), incorporating untrained personnel (ASU students) who previously had no experience. This day's activities built on the performance of the previous day, with remaining students now showing new proficiency and giving them the opportunity to train others "on the fly" as part of the exercise, just as they might do in a real disaster).

1. Crisis Tracker
    - Novice dispatchers had no trouble in sending injects and managing the smaller cadre of deployed users.
    - Connectivity issues were largely solved.
    - 25 more injects were sent out using Crisis Tracker.
    - Sms issues were largely solved.

- Teams reported back using photographs posted on Protected Twitter.

2. HFN
    - **HFN SET UP OF MESH NETWORK WAS EASILY ACCOMPLISHED BY SMALLER TEAMS, EVEN WHEN INCORPORATING NOVICE ASSISTANTS AND TRAINING THEM AT THE SAME TIME**
    - **SET UP ONE MESH NETWORK (WIFI HOTSPOT) UTILIZING THE CISCO RAPID RESPONSE KIT (RRK).**

3. RTAT
    - **ONE RTAT ASSESSMENT COMPLETED WITH NOVICE TEAM MEMBERS ASSISTING.**

In Depth After Action Meeting / Hot Wash with Collaborators
Crisis Tracker

- A "fly away kit" (FLAK) for Crisis Tracker is needed. FLAK should contain instructions for registration, use, trouble-shooting, and instructions for dispatchers as well.
- Crisis Tracker may have real utility in mobile command settings but needs to be able to deal with spotty connection problems more gracefully.
- Still uncertain whether the SMS capability as useful as the Internet-based communications capability; needs more testing. Users noted that options are good; data connection may not be available, but SMS may be more robust. SMS often was better than the radio—nice to have both in case one fails.
- Many people wanted a "proper app" rather than a web service.
- Notifications when one got an sms would be useful; perhaps this can be done if made into a "proper app."
- Incorporation of **Ops View application** would be helpful, was suggested by a partner collaborator—to check on network capabilities and load.

4. Hastily Formed Networks (HFN) (Lessons Learned)
    - Collaborators needed more pre-exercise introduction.
        i. Introduction of PEOPLE
        ii. Introduction of GEAR and GEAR capabilities and limits
        iii. Introduction of the SCENARIO
        iv. Introduction of each team's SPECIFIC and GENERAL OBJECTIVES

- ViaSat instructions needed to be updated.
- Pre-event preparation was adequate but would have been greatly improved with more time spent doing set ups and teardowns.
- More documentation for gear (serial number, weight, support information) should be included with the cases for each item. Current spreadsheet method good for in-lab monitoring but not sufficient for deployment monitoring of equipment.
- Advance labeling of fly away kits would be a distinct advantage.
- **MESH GEAR SOP—FLASH THEM BACK TO A BASIC CONFIGURATION**
- Need a logistics package - including contact list for exercise participants AND for the collaborators; phone numbers, email lists needed to be distributed ahead of time to promote pre-exercise planning and coordination.
- Pre-event travel plan also needs to be developed and distributed pre-event.
- Two operations being prepped at the same time created challenges (one group was packing for Nepal and one was packing for JIFX). This accounts for some of thedisconnects in planning. In future, methods for coordinating multiple operations might be addressed.
- BGANs would be the recommended equipment for future exercises of this kind.
- Discussion on frequency management was substantive.
    i. Recommendations: Use a WiFi analyzer to de-conflict. JIFX participants were stepping on each other on WiFi channels.
    ii. Communication frequency manager for JIFX should include pro-active WiFi management.

5. **Observations & Comments:**

Collaborative member from CISCO provide the CISCO Rapid Response Travel Kit (RRK). It was very well received and added value to the event. Comment was made that there should be photos of the different levels to assist in repacking this gear in pelican case.

Only two people signed up to participate in Crisis Tracker; every one was pretty busy with their own experiments. However, interest in the use of Protected Twitter was high. In the future, perhaps a white paper could be circulated to (1) explain Protected Twitter; (2) provide instructions on how to use it; and (3) consider use of Protected Twitter in a short demo prior to the event, to enable people to try it out for themselves during the weeks leading up to the JIFX event.

Additional Questions:

Did you receive constructive end-user feedback on technology?

- End users had many questions about the Crisis Tracker technologies and showed considerable interest in the Protected Twitter concept of operations. HFN and

RTAT teams were often in the field and thus, got less feedback. In the future, more outreach might be considered for explaining, demonstrating, and interacting with users.

Did you perform any on the fly development of your technology during the JIFX week?

- HFN and RTAT were able to collaborate with CISCO, ViaSAT, TrustComm, while the Joint Vulnerability Assessment Branch team (JVAB) did a wireless environment threat assessment of the systems used. These collaborative efforts assisted in the development of improved concepts of operations and greater understanding of how technologies could be used in tandem or in substitution for one another (such as when one system failed or had issues).

Were you provided with additional data necessary to conduct your experiment?

- No.

Were you provided with support services necessary to conduct your experiment?

- The tent provided was extremely useful. The tent provided a cool place for the computers and other devices we used and functioned as headquarters for our exercise.

Did you engage in ad-hoc experimentation or collaboration with other experimenters? If so, include names of those experiments for purposes of identification.

- We collaborated with Rakesh Bharania from Cisco and were able to set up a network at the remote site.
- Progeny Systems and ASU developed a concept of operations for integration of their systems that will be pursued in future; actual code hacking was prevented due to firewall issues. If firewall issues had not presented themselves, those two systems would have had data flowing between them

Did members of the JVAB look at your experiment? If so, please describe the interaction.

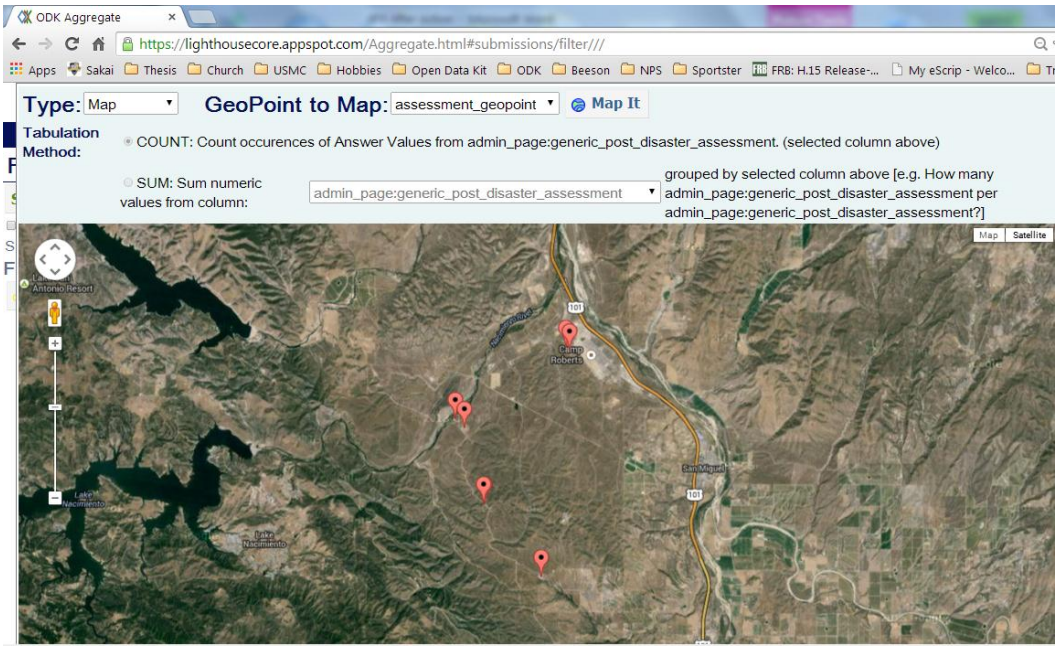
- Yes, Joint Vulnerability Assessment Branch conducted a vulnerability assessment of the Rapid Response Kit (RRK). POC David Rohret do89261@jricp.osis.gov, drohet@csc.com, 210-925-4477.

What, if any, are the uniquely valuable aspects of this event?

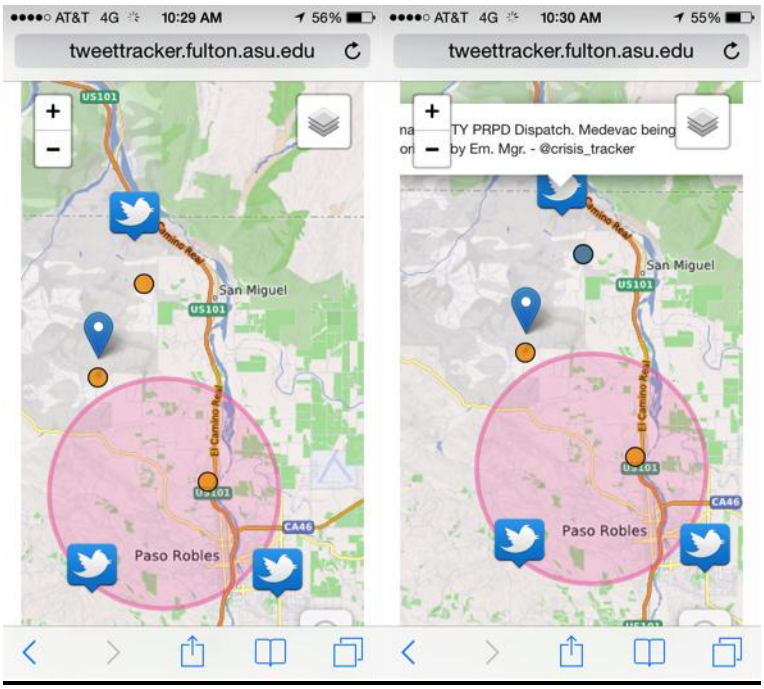
- The ability to collaborate on the fly among many kinds of innovators (technical, software, and end-user innovators).

- The interaction with end users and discussions
- The ability to try out highly novel, likely-to-not-work-the-first-time, bleeding edge technologies in a realistic environment.
- JIFX is a significant boon to education, training, and innovation research with a practical, real-world domain and environment.

Photo/Graphics:



Antennae Hill—RTAT Assessment



CrisisTracker Screen Shots

CrisisTracker Screen Shots from an iPhone (above images). Pressing on an icon reveals information, such as the tweet message in the right image. This is from day 3, Aug 13, 2014. This deployment used a Cisco Rapid Response Kit 101 satellite device. It did not have as good of signal strength as using the Cisco Explorer 500 for partly unknown reasons. Rakesh said that the Kit 101 had lower bandwidth service compared to the Explorer 500. The available AT&T 4G signal was used at times to

confirm that the Kit 101 had a bad signal and not a problem with the Crisis Tracker loading pages in this instance. This does show the functionality of the Crisis Tracker First Responder application that shows first responder locations, event locations, and tweets. Also available to show are medical centers in the area.

Deployment team in the afternoon of Aug 12, 2014 (above photo). Team leader …Anibal… configured a correct Wave Rider wifi device for a mesh network (upper right) while Rakesh from Cisco showed the ease of setting up the Cisco Explorer 500 digital satellite antenna (next to the left tail light of the SUV). Also shown on the ground in the middle is a flexible solar panel. This configuration had excellent Wi-Fi reception.

Day 3 Deployment, Aug. 13, 2014, Team leader Major Beeson on a radio device. Most of the Cisco Rapid Response Kit 101 parts are out of the travel cases and ready to be connected. At this point a member of the team posted in a message that the team arrived at the assigned destination. In this simulation the destination is a location in Pink Rhino City to give network connectivity to a medical team. The Kit

101 is later placed out of the shade in the background to try to improve signal strength.

Day 3 deployment. A USB device is being connected to the Kit 101. The Kit 101 is then connected to the device on the batter using a standard Ethernet cable.

Deployment of the Cisco Rapid Response Kit 101 on day 3, August 13, 2014. This device allowed a phone for voice over IP to be connected. Also shown is Goal Zero battery.

Part of the deployment team of day 3, August 13, 2014, along with part of the network vulnerability team working in the background. The Cisco Rapid Response Kit 101 on the Goal Zero battery can be seen in the background to the right.

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LIST OF REFERENCES

Akyildiz, I., Wang, X., & Wang, W. (2005). Wireless mesh networks: A survey. *Computer Network*, *45*, 445–487.

Alberts, D. & Hayes, R. (1995). *Command arrangements for peace operations*. Washington DC: Department of Defense Command and Control Research Program.

Alberts, D. & Hayes, R.. (2002). *Code of Best Practice for Experimentation*.Washington DC: U.S. Department of Defense Command and Control Research Program.

Alberts, D. & Hayes, R. (2003). *Power to the edge: Command and control in the information age*. Washington, DC: U.S. Department of Defense Command and Control Research Project.

Alberts, D. & Hayes, R. (2005). *Campaigns of experimentation: Pathways to Innovation and Transformation*. Washington, DC: CCRP.

Aurea. (2014). Business process management: Savvion. Retrieved from http://www.aurea.com/technology-solutions/business-process-management/

Bharania, R. (2014). Rapid response kit. Retrieved from www.nps.edu/fx

Barangay. (2014). *Wikipedia.* Retrieved from http://en.wikipedia.org/wiki/Barangay.

Beeson, R. (2013). Rapid Information and Communication Technology Assessment Team (RTAT) enterprise assessment (EA) (unpublished). Naval Postgraduate School, Monterey, CA.

Beeson, R., Gladem, J., & Gonzalez, J. (2014). Rapid Information Communication Technology Assessment Team Savvion business process modeling (unpublished). Naval Postgraduate School, Monterey, CA.

Cannon, C., Beeson, R., Mitchell, K., Spencer, P., & Liguori, M. (2012). Command & control case study of the response to Hurricane Katrina (unpublished). Naval Postgraduate School, Monterey, CA.

Chang, S. (2013). RTAT quick look Republic of the Philippines September 2013 v2 (Unpublished). U.S. Marine Forces Pacific Experimentation Center, Camp Smith, HI.

Chopoorian J., Witherell R., Khalil O., & Ahmed M. (2001). Mind your business by mining your data. *Society of Advanced Management Journal*, 66(2), 45–51.

Creveld, M. (1985). *Command in war*. Cambridge, MA: Harvard University Press.

CyberTracker. (2014). Getting started. Retrieved from http://www.cybertracker.org/software/getting-started

Davenport, T., Harris, J., De Long, D., & Jacobson, A. (2000). *Data to knowledge to results–building an analytic capability*. San Jose, CA: Institute for Strategic Change. Accenture Consulting.

Denning, P. (2000). Hastily formed networks. *Communication of the ACM*. 49(4). 15–20.

Denning, P., & Hayes-Roth, R. (2006). Decision making in very large networks. *Communication of the ACM 49*(11), 19–23.

Department of Defense. (2005). *Military support for stability, security, transition and reconstruction (SSTR) operations.* (DOD Directive 3000.05). Washington, DC: U.S. Government Printing Office.

Department of Defense. (2006). *Joint Communications System* (Joint Publication 6–0). Washington, DC: U.S. Government Printing Office.

Department of Defense. (2011). *Department of Defense support to foreign disaster relief (handbook for JTF commanders and below)*. Washington, DC: U.S. Government Printing Office: James Schear.

Department of Defense. (2014). *Foreign humanitarian assistance* (JP 3-29). Washington, DC: U.S. Government Printing Office: David Goldfein.

Department of Homeland Security. (n.d.). Wrapping up the exercise. Retrieved on September8, 2014, from http://emilms.fema.gov/IS921/921_Toolkit/downloads/NPPD_HotWash.pdf

Department of Homeland Security. (2011). *National Preparedness System*. Washington, DC: U.S. Government Printing Office.

Department of Homeland Security. (2013). *National response framework* (2nd ed.). Washington, DC: U.S. Government Printing Office.

Dienes, Z. & Perner, J. (1999). A theory of implicit and explicit knowledge. *Behavioral and Brain Sciences*, *22*, 735–808.

Donahue, A., & Tuohy, R. (2006). Lessons we don't learn: A study of the lessons of disasters, why we repeat them, and how we can learn them. *Homeland Security Affairs*, *I*(2). Retrieved from http://www.hsaj.org/?article=2.2.4.

Dourandish, R., Zumel, N.,& Manno, M. (2007). Adapting C2 to the 21st century. *2007 Command and Control Research & Technology Symposium.* Newport, RI.

Fulcrum. (n.d.). Plans. Retrieved on September 6, 2014, from http://fulcrumapp.com/plans/.

Goal Zero. (n.d.). Goal Zero Yeti 1250 Solar Generator. Retrieved on September 10, 2014, from http://www.goalzero.com/p/140/goal-zero-yeti-1250-solar-generator/.

Goolsby, R., & Steckler, B. (2014). JIFX after action report (Unpublished). Naval Postgraduate School, Monterey, CA.

The Guardian. (2014). The NSA files. Retrieved from http://www.theguardian.com/world/the-nsa-files

Gupta, A., Thapar, J., Singh, A. Singh, P., Srinivasan, V., & Vardhan, V. (2013). Simplifying and improving mobile based data collection. *Information and Communications Technologies and Development Vol. 2*, 45–48. DOI=10.1145/2517899.2517929 http://doi.acm.org/10.1145/2517899.2517929

Hartung, C., Anokwa, Y., Brunette, W., Lerer, A., Tseng, C., & Borriello, G. (2010). Open Data Kit: Tools to build information services for developing regions. *Information and Communication Technologies and Development, 2010*, article 18, 12 pages. DOI=10.1145/2369220.2369236. Retrieved from http://opendatakit.org/wp-content/uploads/2010/10/ODK-Paper-ICTD-2010.pdf

Hawthorne S. & Lush, R. (2002). Clearing the confusion about spiral/evolutionary development. *CrossTalk,* (08). Retrieved from http://www.crosstalkonline.org/storage/issue-archives/2002/200208/200208-Hawthorne.pdf

Humanitarian Data Toolkit. (2014). About the Humanitarian Data Toolkit. Retrieved from http://humanitariandatatoolkit.org/

Huang, J., & Lien,Y. (2012). Challenges of emergency communication network for disaster response. *Communication Systems (ICCS), 2012 IEEE International Conference on Disasters*, 528–532. doi: 10.1109/ICCS.2012.6406204. http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6406204&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6406204

Headquarters, Department of the Army. (2012). *Field knowledge management operations* (FM 6–0.1). Washington, DC: author.

Headquarters, U.S. Marine Corps. (2002). *Marine Corps Warfighting Publication Information Management* (MCWP 3-40.2) Quantico, VA: U.S. Government Printing Office. Retrieved from http://www.marines.mil/Portals/59/Publications/MCWP%203-40.2%20Information%20Management.pdf

Humanity road. (2014). About. Retrieved from http://humanityroad.org/aboutus/

Hyman, P. (2014). “Peace technologies” enable eyewitness reporting when disasters strike. *ACM 57, 1*, 27–29. DOI=10.1145/2555808 http://doi.acm.org/10.1145/2555808

Inter-Agency Standing Committee. (2006). *Guidance note on using the cluster approach to strengthen humanitarian response*. New York: author https://www.humanitarianresponse.info/clusters/space/document/iasc-guidance-note-using-cluster-approach-strengthen-humanitarian-response.

Inter-Agency Standing Committee. (2011a). What is the IASC? Retrieved from http://www.humanitarianinfo.org/iasc/downloaddoc.aspx?docID=6050&type=pdf

Inter-Agency Standing Committee. (2011b). *Operational guidance for coordianted assessments in humanitarian crises*. New York: author. Retreived from http://www.who.int/hac/network/interagency/news/ocha_operational_guidance_coordinated_assessments_v7.pdf

Inter-Agency Standing Committee. (2012a). Multi-cluster/sector initial rapid assessment (MIRA). New York: author. Retrieved from https://docs.unocha.org/sites/dms/CAP/mira_final_version2012.pdf

Inter-Agency Standing Committee. (2012b). Reference module for cluster coordination at the country level. New York: author. Retrieved from http://www.humanitarianinfo.org/iasc/downloadDoc.aspx?docID=6461

Jung, J. (2011). *Mobile Data Collection Systems A review of the current state of the field*. Retrieved from http://humanitarian-nomad.org/wp-content/uploads/2013/03/NOMAD-MDC-Research.pdf

Kennerley, M. & Mason, S. (2008). *Use of information in decision making literature review for the audit commission*. Cranfield, England: Cranfield School of Management. Retrieved from http://archive.audit-commission.gov.uk/auditcommission/sitecollectiondocuments/AuditCommissionReports/NationalStudies/Cranfield_Information_use_review.pdf

Levine, B. (2014). Android hits 85 percent smartphone market share. Retrieved from http://www.toptechnews.com/article/index.php?story_id=0030003DMG66

Longley, C. (2010). *The Field Information Support Tool (FIST)*. (Master’s thesis). Naval Postgraduate School, Monterey, CA.

MapAction. (2011). *Field Guide to Humanitarian Mapping* (2nd ed.). Retrieved from http://www.mapaction.org/index.php?option=com_mapcat&id=2426&view=download&fmt=pdf

Meeds, H. K. (2006*). Communication Challenges During Incidents of National Significance: A Lesson from Hurricane Katrina*. (doctoral dissertation). U.S. Army War College. Carlisle Barracks. PA.

Merriam-Webster. (2014). Data. Retrieved from http://www.merriam-webster.com/dictionary/data

Microsoft. (2014). Excel. Retrieved from http://office.microsoft.com/en-us/excel/

MobileActive. (2010). *Mobile Data Collection Tools–Comparison Matrix* [Excel]. Retrieved from https://docs.google.com/spreadsheet/ccc?key=0ArG7kkc9mE75dEdNNktocmVwT0hNbHVjTXl2ZU1VMXc&hl=en_US#gid=0

Moffat, J. (2008). *The Response to Hurricane Katrina: A Case Study of Changing C2 Maturity*. Hampshire, United Kingdom: Crown. Retrieved from http://www.dodccrp.org/files/case_studies/Katrina_case_study.pdf

NetHope. (2014a). About us. Retrived from http://nethope.org/about/

National Geospatial Intelligence Agency. (2014). *Geospatial intelligence (GEOINT) basic doctrine*. Washington, DC.

Naval Postgraduate School (n.d.). Field experimentation: Background. Retrieved on September 9, 2014, from http://my.nps.edu/web/fx/what-is-jifx-

NetHope. (2014b). Emergency response. Retrived from http://nethope.org/programs/emergency-response/

Nissen, M. & Burton, R. (2011). Designing organizations for dynamic fit: System stability, maneuverability, and opportunity loss. *Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions on., vol.41, no.3,* 418–433. doi: 10.1109/TSMCA.2010.2084569

Humanitarian Operations Mobile Acquisition of Data. (n.d.-a). Online selection assistant Android. Retrieved onAugust 19, 2014, from http://humanitarian-nomad.org/online-selection-tool/#

Humanitarian Operations Mobile Acquisition of Data. (n.d.-b). Online selection assistant iPhone. Retrieved onAugust 19, 2014, from http://humanitarian-nomad.org/online-selection-tool/#

Humanitarian Operations Mobile Acquisition of Data. (2012). *The NOMAD project*. Retrieved from http://humanitarian-nomad.org/wp-content/uploads/2013/03/Flyer_NomadServices_July2012.pdf

Humanitarian Operations Mobile Acquisition of Data. (2014). Welcome. Retrieved from http://humanitarian-nomad.org/

Office for the Coordination of Humanitarian Affairs. (2011). *OCHA on message: Inter-Agency Standing Committee*. Retrieved from https://docs.unocha.org/sites/dms/Documents/120229_OOM-IASC_eng.pdf

Office for the Coordination of Humanitarian Affairs. (2013a). *Humanitarianism in the network age*. New York, New York: Christina Bennet. Retrieved from http://www.unocha.org/hina

Office for the Coordination of Humanitarian Affairs. (2013b). *United Nations disaster assessment and coordination UNDAC field handbook* (6th ed.). New York, New York. Retrieved from https://docs.unocha.org/sites/dms/Documents/UNDAC%20handbook%20-%20English.pdf

Office for the Coordination of Humanitarian Affairs. (2014a). *Developing humanitarian data standards: an introduction and plan for 2014*. Retrieved from http://docs.hdx.rwlabs.org/wp-content/uploads/HXL_Paper-forsite.pdf

Office for the Coordination of Humanitarian Affairs. (2014b). History of OCHA. Retrieved from http://www.unocha.org/about-us/who-we-are/history

Open Data Kit Collect. (2014). About. Retrieved from http://opendatakit.org/about/

Open Handset Alliance. (2014). Open Handset Alliance. Retrieved from http://www.openhandsetalliance.com/

One Platform Foundation. (2014). *Appstores* [infographic]. Retrieved from http://www.onepf.org/appstores/#opf-list

Oracle. (2014). A relational database overview. Retrieved from http://docs.oracle.com/javase/tutorial/jdbc/overview/database.html

Osmundson, J. (2014, April). *4.0 government & other standards* [PowerPoint slides]. Presented at Naval Postgraduate School, Monterey, CA.

Patnaik, S., Brunskill, E., & Thies, W. (2009). Evaluating the accuracy of data collection on mobile phones: a study of forms, sms, and voice. In *Proceedings of the third international conference on Information and communication technologies and development* (pp. 74–84). Piscataway, NJ: IEEE Press. Retrieved from http://www.cs.cmu.edu/~ebrun/patnaik-ictd09.pdf

Pacific Disaster Center. (n.d.). DisasterAWARE. Retrieved on August 19, 2014, from http://emops.pdc.org/emops.

PreventionWeb. (n.d.). United States of America—Disaster statistics. Retrieved September 3, 2014, from http://www.preventionweb.net/english/countries/statistics/?cid=185

Reed, B. (2014). On BlackBerry 10's 1st anniversary, BlackBerry's U.S. market share hits 0%. Retrieved from http://bgr.com/2014/01/30/blackberry-us-market-share/

Red Cross. (n.d.). Who we are. Retrived September 3, 2014, from http://www.icrc.org/eng/who-we-are/index.jsp

Ross, J., Weill, P., & Robertson, D. (2006). *Enterprise architecture as a strategy*. Boston, MA: Harvard Business Press.

Satzinger, J., Jackson, R., & Burd, S. (2011). *Systems analysis and design in a changing world* (6th ed). Independence, KY: Cengage Learning

Savvion. (2006). Executive summary. Retrived from http://www.techrepublic.com/resource-library/downloads/download-savvion-s-free-business-process-modeling-software/

Steckler, B. (2009). Hastily formed networks (HFNs) [PowerPoint slides]. Retrieved from http://www.cis.upenn.edu/~ngns/docs/Review_09/StecklerMURIReview.ppt.

Steckler, B. (2012). Rapid Technology Assessment Team (RTAT) Executive summary (unpublished). Naval Postgraduate School: Monterey, CA.

Steckler, B. (2013). Concept of operations Rapid Information and Communication Technology Assessment Teams (RTAT) follow on assessment-Cebu, Tacloban and Leyte Philippines (unpublished). Naval Postgraduate School, Monterey, CA.

Striedl, P., Crosson, J., & Farr, L. (2006). *Association of Contingency Planners observations of Hurricane Katrina lessons learned*. Albany, NY. *ACP*.

Telvent. (2014). Relational database concepts for beginners. Retrieved from http://webs.wofford.edu/whisnantdm/courses/cs101/pdf/database/relational_database_concepts.pdf.

Townsend, F. (2006). *The federal response to Hurricane Katrina, lessons learned*. Department of Homeland Security, Washington, DC.

Telecoms Sans Frontieres. (2013). Annual report. Retrieved from http://www.tsfi.org/en/presentation/reports

Telecoms Sans Frontieres. (2014). Important dates in TSF's history. Retrieved from http://www.tsfi.org/en/presentation/origin/46-les-dates-importantes-dans-lhistoire-de-tsf

Tyszkiewicz, J. (2010). Spreadsheet as a relational database engine. In *Proceedings of the 2010 ACM SIGMOD International Conference on Management of data* (pp. 195–206). New York, NY: ACM. DOI=10.1145/1807167.1807191. Retrieved from http://doi.acm.org/10.1145/1807167.1807191

United States Agency for International Development. (2005). *Field operations guide for disaster assessment and response* (v. 4.0). Washington, DC: U.S. Government Printing Office.

United States Agency for International Development. (2014a). Philippines. Retrieved from http://www.usaid.gov/crisis/philippines.

United States Agency for International Development. (2014b). *Philippines-Typhoon Yolanda/Haiyan fact sheet #22 fiscal year 2014*. Retrieved from http://www.usaid.gov/sites/default/files/documents/1866/philippines_ty_fs22_04-21-2014.pdf

Verge Staff. (2014). iOS: A visual history. The verge, September 16, 2013. Retrieved from http://www.theverge.com/2011/12/13/2612736/ios-history-iphone-ipad

World Food Programme. (2002). *World Food Programme emergency field operations pocketbook*. Retrieved from http://www.unicef.org/emerg/files/WFP_manual.pdf

World Food Programme. (2011). EPIC Emergency Preparedness Integration Centre. Retrieved from http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp225858.pdf

World Food Programme. (2013a). FITTEST Fast IT & Telecommunications Emergency & Support Team. Retrieved from http://ictemergency.wfp.org/documents/10844/45c27de4-e823-40ae-8954-869582078f85

World Food Programme . (2013b). UN-ETC fact sheet. Retrieved from www.ictemergency.wfp.org

World Food Programme. (2013c). *Emergency telecommunications cluster (ETC) Typhoon Haiyan Operation, Philippines, 27 November 2013.* Rerieved from http://ictemergency.wfp.org/web/ictepr/emergencies2013/philippines

Yank, K. (2009). *Build your own database driven web site using PHP & MySQL* (4th ed.). Collingwood, VIC Australia: SitePoint Pty. Ltd.

WORKS CONSULTED

Akyildiz, I. (2011). Sensor networks in challenged environments. *Wireless Technologies for Humanitarian Relief, 3*(3).doi=10.1145/2185216.2185220 http://doi.acm.org/10.1145/2185216.2185220

Alberts, D. & Nissen, M. (2009). Toward harmonizing command and control with organization and management theory. *The International C2 Journal*, 3(2), 1–59. Retrieved from www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA508759

Alberts D., Huber, R. & Moffat J. (2010). *NATO NEC C2 maturity model.* Washington DC: U.S. Department of Defense Command and Control Research Program. Retrieved from http://www.dodccrp.org/files/N2C2M2_web_optimized.pdf

Basu, D. (2006). *A compendium of learnings from engagements in Afghanistan, Iraq, Liberia, Iran, Sudan, Guatemala, Indonesia, Sri Lanka, Pakistan, Lebanon*. Fairfax, VA: NetHope. Retrived from http://nethope.org/images/uploads/casestudies/DisasterRelief.pdf

BelAir Networks. (2008). New public safety interoperable communications solution delivers high-speed wireless broadband for emergency management. *Network Weekly News, 73*. Retrieved from http://search.proquest.com/docview/211495609?accountid=12702

Guillén, K., Mendoza, U. & Santos, L. (2011). Crowdmap and Ushahidi: to obtain and visualize traffic congestion information in Mexico City. *Computational Transportation Science*, 24–27. DOI=10.1145/2068984.2068989 http://doi.acm.org/10.1145/2068984.2068989

Headquarters, U.S. Marine Corps. (2007). *Marine Corps Task List (MCTL)* (Marine Corps Order 3500.26). Quantico, VA: U.S. Government Printing Office.

Hyman, P. (2014). ‘Peace technologies’ enable eyewitness reporting when disasters strike. *ACM 57, 1* (January 2014), 27–29. DOI=10.1145/2555808 http://doi.acm.org/10.1145/2555808

Karaoglan, D., Levi, A., & Savas, E. (2010). A distributed key establishment scheme for wireless mesh networks using identity-based cryptography. DOI=10.1145/1868630.1868633 http://doi.acm.org/10.1145/1868630.1868633

Kasera, S. (2011). Wireless network security. *Wireless Technologies for Humanitarian Relief. 2011*, 32. DOI=10.1145/2185216.2185235 http://doi.acm.org/10.1145/2185216.2185235

Legendre, F. (2011). 30 years of ad hoc networking research: What about humanitarian and disaster relief solutions? What are we still missing? In *Proceedings of the 1st International Conference on Wireless Technologies for Humanitarian Relief (ACWR '11)* 217. New York. DOI=10.1145/2185216.2185279 http://doi.acm.org/10.1145/2185216.2185279

Lancaster, D. (2005). *Developing a fly-away-kit (FLAK) to support hastily formed networks (HFN) for humanitarian assistance and disaster relief*. (Master's thesis). Naval Postgraduate School, Monterey, CA.

Perfetti, M. (2012). *An investigation of commercial off-the-shelf wireless in support of complex humanitarian disaster operations in the Argentine Army*. (Unpublished master's thesis). Naval Postgraduate School, Monterey, CA.

Ramachandran, K., Sheriff, I., Belding, E., & Almeroth, K. (2008). A multi-radio 802.11 mesh network architecture. *Mobile Network. Application 13*(1–2) 132–146. DOI=10.1007/s11036-008-0026-8 http://dx.doi.org/10.1007/s11036-008-0026-8

Rivera, W. (2012). *Distributed agent-based networks in support of advanced marine corps command and control concept*. (Unpublished master's thesis). Naval Postgraduate School, Monterey, CA.

Roberts, N. (2001). Coping with wicked problems: The case of Afghanistan. In *Research in Public Policy Analysis and Management*, Vol.11 Part 2 (pp.353–375). Bingley, United Kingdom: Emerald Group Publishing Limited,. Retrieved from http://www.emeraldinsight.com/doi/abs/10.1016/S0732-1317%2801%2911006-7

Suri, S. (2011). Amateur radio in emergency communications advanced digital communication network. In *Proceedings of the 1st International Conference on Wireless Technologies for Humanitarian Relief* (pp. 29–29). New York, NY: ACM 29–29. DOI=10.1145/2185216.2185233. Retrieved fromhttp://doi.acm.org/10.1145/2185216.2185233

Teague, M. (2007). *The domestic coalition: The C2 relationship between active component and National Guard Forces in defense support of civil authorities operations*. Retrieved from http://www.dtic.mil/dtic/tr/fulltext/u2/a476794.pdf

Tuzhilin, A. (2011). Knowledge management revisited: Old dogs, New tricks. *ACM Transactions on Management Information Systems*, *2*(3), Article 13 (October 2011). DOI=10.1145/2019618.2019619. Retrived from http://doi.acm.org/10.1145/2019618.2019619

Tyler, B. K. (2008). *A comparative analysis of fortress (ES520) and mesh dynamic's (4000 SERIES) networking capabilities during COASTS 2007 field experiments*. (Unpublished master's thesis). Naval Postgraduate School, Monterey, CA.

Wentz, L. (2010). *Haiti information and communications observations trip report for visit 18 February to 1 March 2010*. Washington, DC: Center for Technology and National Security Policy.

Wu, X., & Li, N. 2006. Achieving privacy in mesh networks. *In Proceedings of the Fourth ACM workshop on Security of ad hoc and sensor networks (SASN '06)* (pp. 13–22). New York, NY. DOI=10.1145/1180345.1180348 http://doi.acm.org/10.1145/1180345.1180348

Zhu, X., Fang, Y., & Wang, Y. (2010). How to secure multi-domain wireless mesh networks. *Wireless Network 16* (5), 1215–1222. DOI=10.1007/s11276-009-0198-6 http://dx.doi.org/10.1007/s11276-009-0198-6

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