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Marine C2 in Support of HA/DR: Observations and Critical Assessments Following Super-Typhoon Haiyan

Topics:
Topic 1: Concepts, Theory, and Policy
Topic 2: Organizational Concepts and Approaches

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Abstract

This paper presents observations and critical assessment of the current Marine Corps capabilities in terms of distributed Command and Control (C2), expeditionary power, and the feasibility of larger Enhanced Marine Air Ground Task Force (MAGTF) Operations (EMO) with regard to current and emerging technology-enabled capabilities as applied to small unit operations such as those in support of disaster response missions. Observations are limited to the scope of the team's viewpoint from deployment to multiple locations within the disaster zone in support of 3d Marine Expeditionary Brigade (MEB) and subsequent Joint Task Force (JTF) 505 operations. It is intended to guide discussion among leaders in the research and acquisitions communities guiding the modernization of the Marine Corps.

As a result of the Naval Postgraduate School (NPS) Hastily Formed Networks (HFN) Center's experiences in Guiuan and Tacloban, the authors have identified a startling disconnect between the stated priorities of Marine Corps expeditionary strategy and concepts and the demonstrated capability to conduct distributed command and control. Specifically, there was a demonstrated lack of equipment and capability in terms of data connectivity on the tactical edge of operations. While the Marine Corps continues to show exceptional expeditionary maneuver from the sea, its ability to gain the maximum benefits of operational tempo and information dominance from that maneuver is shorted by its available C4I tools. This paper seeks to address these shortfalls by

offering potential strategic technological solutions for investigation and testing in the acquisitions cycle.

The report reflects the viewpoints of the authors and does not necessarily reflect the position of the Naval Postgraduate School, the U.S. NAVY, the USMC, or the DoD.

1. **Introduction**:

On 7 November 2013, Typhoon Haiyan made landfall in Guiuan, Eastern Samar, Philippines with sustained winds at 315 km/h, making it the strongest tropical cyclone in recorded history. The number of confirmed fatalities rose to over 5,500, with an additional 1.9 million people homeless and 600,000 displaced. Upon request from the government of the Philippines and on behalf of the US State Department, the Department of Defense (DoD) was directed to respond to the disaster zone and assist in disaster relief operations. The principal task force during the initial phase of the military operation was centered on the Third Marine Expeditionary Brigade (3d MEB). This force would later evolve into a Joint Task Force (JTF).

At the request of 3d MEB and III Marine Expeditionary Force's Science & Technology (3 MEF/S&T) division, the Naval Postgraduate School HFN Center deployed a small communications team to assist in the establishment of critical communications links using commercially available equipment. The team deployed to Manila and subsequently to Tacloban, Cebu, and Guiuan, as shown in Figure 1, to provide limited expeditionary C2 support and technology assessments on behalf of the JTF and the government of the Philippines.

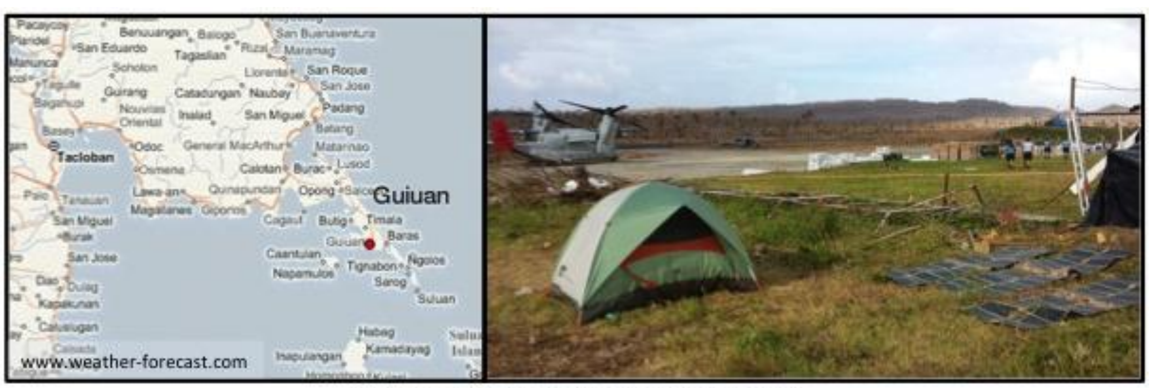

Figure 1: NPS deployment site at Guiuan, Philippines

The primary author deployed as a member of the NPS HFN team and was able to experience the Marine Air-Ground Task Force (MAGTF) concept in its true form. The members of the team were enthusiastic to see what sort of capabilities the Marines would bring to the crisis as this is, at its heart, the core mission of the Marines: power projection from the sea in crisis response.

The HFN team's initial involvement with the MEB and JTF was positive. The team trained and equipped public and civil affairs teams on the use of the Broadband Global Access Network (BGAN) ground terminals. These terminals, about the size of a small laptop, provided Internet access to the teams as they maneuvered throughout the area of operations (AO). Their small size and limited power requirements were perfect for these small unit deployments, despite their limited, ~200 kbps, bandwidth.

In the spirit of distributed operations doctrine, the primary author and a fellow Marine from the NPS HFN team formed a two-person team that rapidly pushed forward to Guiuan in order to fill a communications gap while the principal Marine force in Guiuan completed their turnover with the local government as well as the substantial NGO presence, which by then had arrived. It is this small two-person team activity that will be the focus of this document.

2. Leveraging Expeditionary Power Projection Phasing to Satisfy C2 Requirements

"Marine Corps Vision and Strategy 2025" explicitly states the Marine Corps of the future must be prepared to live in austere environments and retain the ability to operate as the Nation's "expeditionary force in readiness" for potential crises regardless of time and location (USMC, 2007). This is especially poignant for Marines today as they pivot their strategic priorities to the Pacific theater of operations. Marine Corps Warfighting Laboratory (MCWL) has been conducting a campaign of experiments in Camp Pendleton, 29 Palms, and Hawaii to test the tactics, techniques, and procedures necessary to making this vision a reality (MCWL, 2010). This family of experiments has centered on the Enhanced MAGTF Operations (EMO) concept and, specifically, the employment of a Company Landing Team (CLT). EMO essentially means being able to deploy multiple self-supporting small units at a company level or below in a widely distributed manner from an expeditionary sea base aboard the amphibious fleet in a rapid, flexible manner. In all cases reviewed for this paper, line units involved in these experiments accomplished the objective warfighting functions of maneuver and fires. This is due to the fact that the Marine Corps has been successfully conducting operations in this distributed manner for the past 12 years in support of the Global War on Terror (GWOT). The thought of having platoons and companies geographically separated by large distances and with greater firepower and lift assets than doctrine specifies is not news to any officer deployed to Iraq or Afghanistan in the past 12 years. Marine units are no longer *attempting* to operate in a distributed manner; rather, they are *expected* to do so. It is with this expectation that we return to Guiuan.

The initial phases of opening the airstrip at Guiuan went according to the best-laid plans for US military deployment to a disaster or combat zone. Elements of US Army Special Operations Forces (SOF) were inserted to secure a landing site for follow-on forces. In Guiuan, a small SOF team was able to provide security for the town's primary airfield, conduct local reconnaissance, make initial assessments, and provide terminal guidance for the first wave of conventional forces. The C2 systems that allowed for this capability were the standard-issue communications suite carried by a SOF team. The basic gear included satellite phones, data terminals for both encrypted and open communications using the Voice over Internet Protocol (VOIP) capability, and traditional Very High Frequency/Ultra High Frequency military, or "green-gear," communications equipment.

The follow-on Marines employed an impressive array of organizational capabilities. An airspace control team was inserted to provide air traffic control for military and civilian aircraft. A Marine Wing Support Squadron (MWSS) team was inserted to establish a forward refueling point (FARP) to allow for rotary wing aircraft to push further inland into Samar Province and other remote areas. A Civil Affairs Team (CAT) was also included to identify and assess relief efforts and facilitate transition to local government control of the relief operations. This deployment pattern is consistent with the over-the-horizon ship-to-objective maneuver doctrine embodied by the EMO concept. Moreover, it worked! This methodology allowed the Marines to facilitate an impressive outpouring of support to the area despite the adverse, tragic conditions. However, the functioning of these USMC teams was initially hampered by a lack of C2 communications support.

After the USMC forces attempted to relieve the SOF team, the C2 shortfall quickly became apparent. The Marines arrived without the ability to maintain a data link to higher headquarters or to maintain uninterrupted communication (voice) over their struggling Demand Assigned Multiple Access (DAMA) satellite network in the difficult environmental conditions of the tropical monsoon season. As a result of the shortfall, the air control units were unable to receive the air tasking order (ATO), which caused some potentially dangerous airspace deconfliction situations as military and civilian air traffic had to be spotted visually (again, in tropical monsoon season) and contacted on open channels. Unfortunately, aircrews did not consistently monitor those channels. Further, the CAT was unable to push products back to higher headquarters or get orders or guidance on the role of US military involvement for this nuanced period of transition to local government forces.

The operational impact of the C2 shortfall required the SOF team to be retained on site so as to leverage their communications capability, thereby preventing the SOF team from prosecuting their mission to deploy further into remote areas to reconnoiter relief efforts needed there. This would become the case with the other three SOF teams in country where the Marines were sent to relieve them. The larger, more robust Marine presence essentially relied on an eight-man Army Special Operations Team because the Marines' deployment package lacked the critical C2 capability necessary to meet mission requirements.

3. **NPS Involvement**:

There is an Infantry adage that states, "Without communications you're just camping." The NPS team, composed of two graduate students, arrived with a camping tent, and two pelican cases. Within 30 minutes of its arrival, the team deployed a 300+ Watt solar-farm (Figure 1), established Internet access over commercial satellite service

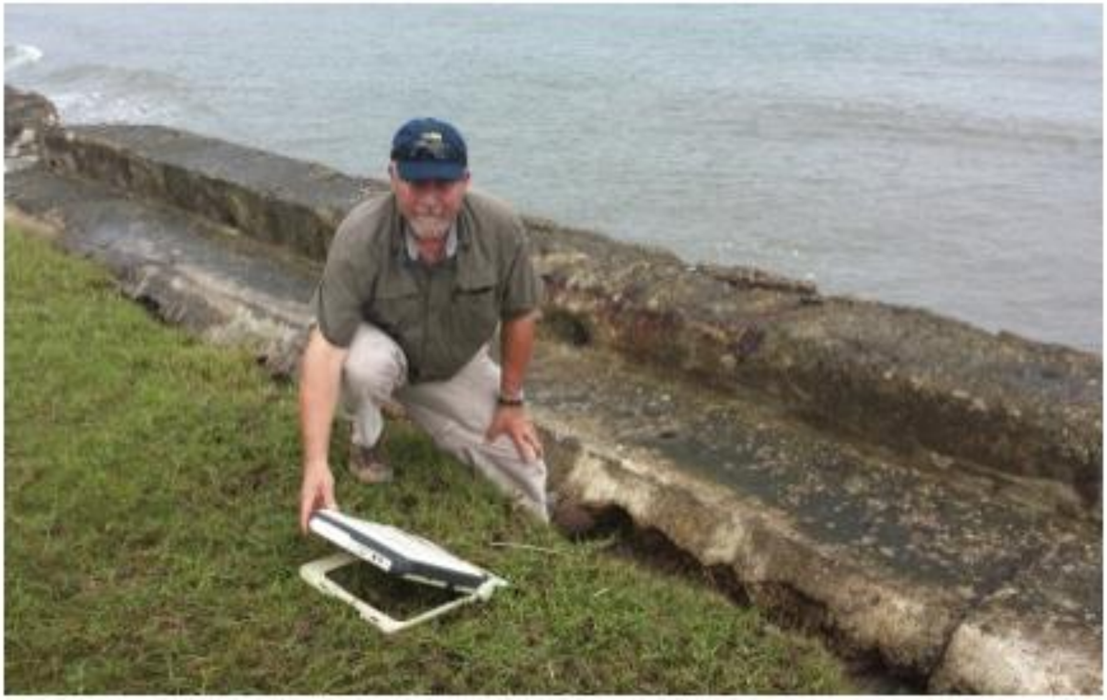

Fig 2 – HFN Leader, Brian Steckler, Setting up a BGAN in Tacloban, Philippines

(Figure 2), and configured a wireless local area network (WLAN) extending the Internet access to the Marine CAT in Guiuan.

However, it would be unfair to say the NPS solution solved all the connectivity problems. For example, the BGAN and its associated power supply were not sufficiently hardened to military specifications to allow for constant operations even in the driving rains of the tropical monsoon season we experienced, which is representative of environmental challenges faced by military forces operating in the Pacific theater of operations. However, these systems clearly demonstrated the utility of lightweight commercial-off-the-shelf assets for rapid establishment of critical C2 capability. Nor was this system's success in any way a testament to our technical prowess. Rather, it highlights an important point: the efficient, rapidly deployable solutions to many of the Marine Corps' C2 problems are already available. So much so that NPS HFN team's little setup was rendered obsolete when Cisco's TacOps team arrived in the following days and established a satellite communications (SATCOM) site with two 2.4-meter inflatable dishes and a small, relatively quiet generator. This increased the available reach-back bandwidth from our 200kbps BGAN to 2-3 Mbps with the deployment of the Cisco Ground Antenna Transmit and Receive [GATR] system. Further, the TacOps package included support for a larger diameter wireless local area network (WLAN), providing greater freedom of movement for users accessing the GATR capabilities. All of the Cisco gear came in a set of about two pelican cases per dish system. The array of potential C2 solutions provided by this TacOps suite in such an austere environment was staggering. However, the portability and low power requirements of the initial NPS-HFN suite demonstrate the potential to support a system proportioned for small tactical units.

These small form-factor systems stand in stark contrast to the suite of equipment being pushed to the operating forces. While there is a place for robust, military-grade tactical networks such as those formed by the Advanced Networking Wireless Waveform (ANW2) capable suite of tactical radios coupled with Panasonic Toughbooks, the result is an incredibly cumbersome, difficult to use, and large form-factor system driven by requirements established to support a maneuver force less suited for distributed, small-unit, extended MAGTF operations.

Efforts have been undertaken by the Joint Program Executive Office (JPEO) to test and field a new family of systems, specifically the Joint Tactical Radio Systems' (JTRS) Handheld Manpack Small Form Fit (HMS) family of hardware (GAO, 2013). While this program is going into its full-rate decision phase of acquisitions, we must admit to ourselves that we have allowed our C2 to be out-cycled by technological advances, most of which have become mainstream in the last decade. This lag in acquisitions, as a result of systemic problems that prompted the JPEO to undergo a major reorganization of JTRS, has caused the military to lag far behind the competitive edge of technological innovation with regard to distributed C2 and data capabilities (Brannen & Hoffman, 2011).

A paradigm shift in thinking is required to move us away from the cumbersome hardware thought to support a maneuver force, which in actuality is more appropriate to a "portable" force that is maneuverable mostly in the sense that it periodically relocates its forward operating location but has extremely limited on-the-move capability. Further, these current systems require extensive training to be able to operate in the most basic conditions and do not lend themselves to an expeditionary load-out of tactical units, particularly in operations being conducted in inhospitable environments, such as the tropical regions of the South Pacific.

We need to leverage the fact that we are living in the age of the information revolution. It is just as disruptive and innovative as the industrial revolution was at the turn of the 19th century (Alberts, Garstka, Stein, 1999). While we are not advocating that the military, and specifically the Marine Corps, take part in a technology race such as the one between Samsung and Apple with new models being adopted quarterly, we are advocating that we take a hard look at the potential value added by modernizing our C2. We already know that our Marines are exceptionally talented. They are also incredibly technically savvy due to the fact that most grew up within the past two decades; our Marines have been operating smartphones and other devices in their daily lives for some time, if not most of their lives. They expect to be able to see their GPS location on a satellite map with a list of locations around them with consumer reviews of local services, while simultaneously streaming music over Internet radio and getting pushed updates on the NFL game they are missing. Why then do they have to 'dumb themselves down' to the information systems of the past to operate in the modern military? Admittedly, it must be noted that there are design challenges inherent and unique to the military. The imperatives of operational security and necessity for physical ruggedness will continue to place strains on the engineering and design process. However, from a user-focused perspective, when a young Marine intuitively knows how to access route data on Google Maps on a smartphone yet needs a weeklong course to be basically proficient with CPOF (command post of the future, the C2 software suite used in most Marine operations centers), the institution has failed in its product design.

Critics, and in fact DoD cyber security forces by behavior and policy, would argue that the DoD has to limit themselves due to the security concerns inherent in the emerging global cyber threat. With the rise of state and non-state cyber-crime and espionage, this is a valid concern. This emerging security environment is one that must be faced with both eyes open, but faced nonetheless, instead of avoiding the issue or cowering before the enormity of the problem. It is time we saw cyber security in a similar light as force protection. We don't always give an infantry platoon its own 9-foot pre-fabricated Hesco outpost barriers to operate behind for additional protection. The operational commander scales his force protection strategy to the probable threat and accepts a certain element of manageable risk. All the systems advocated for herein as part of a C2 modernization can be encrypted and “zeroed” in much the same way as any piece of communications hardware in our inventory today. Vendors have already begun to attack this problem, as well. An example is the Harris SecNet 54 system, even now an “old capability” by commercial evolution comparison, which allows NSA-certified type-1 encryption over wired and wireless communication (Harris, 2014). While a determined adversary might eventually break this encryption, it would be a tremendous waste of their limited resources given the data is more than likely very perishable anyway. Leaders should stop being paralyzed by the weight of cyber security, and instead learn how to responsibly manage the risks as military leaders have always done in other domains. In cases such as the typhoon where rapid, open communication was required, these less-secure systems could be a viable solution. In military operations against technologically adept adversaries leaders could scale to more secure C2 solutions vetted through NSA and DoD cyber standards.

4. Way Forward

In untold after action reports, operators showcase their frustration at the current family of systems being fielded for data-rich C2. Frequent references are made expressing the need for an ‘iPhone equivalent’ for use in tactical units (Infantry Officers Course, 2013). While the realities of combat information networking are yet at to be realized at that level, namely because of the need to create an LTE-equivalency[1] without the expansive cellular tower infrastructure enjoyed in CONUS, there are a few ways we could leverage the advantages of the current generation of information technology and scale those systems to accept future advances.

The first step in modernizing Marine expeditionary C2 would be looking to create a true battlefield network, specifically a TCP/IP based wireless network that is as mobile as the force element being supported – networking-on-the-move. This would create the ecosystem in which all other tactical devices would be interacting in order to provide information to warfighters and decision-makers. The HFN center at NPS has found multiple systems that it has tested in real world scenarios that are commercially available

[1] Noteworthy are current efforts such as the Kearsarge ARG LTE-pilot program under NAVAIR (http://gcn.com/articles/2013/03/11/navy-4gs-ship-to-ship-communications.aspx)

‘off the shelf’ (COTS). At the very least, these COTS systems could provide Internet-enabled communications in humanitarian assistance and disaster relief scenarios. They might well be leveraged for the tactical realm, as well. Two promising areas of research for creating this network are the use of mobile LTE base-stations and the Mobile Ad-Hoc Networking (MANET) family of radios being developed by various vendors.

In the cellular solution, base-station devices, which are essentially man-portable cell towers, could be carried by units, which would interconnect all the peripheral devices (tablets, smartphones, etc.) in that unit to a larger network. These base-stations would, in turn, talk to each other and scale-out to create a larger information network, coordinating and managing device-access thereby enhancing the information security posture. In the absence of base-station (“eNode/RAN”) devices, individuals could leverage other organic handset communications capabilities, such as WiFi or Bluetooth radios to connect to available IP networks, or as peripheral devices for mobile commercial satellite servers. Such is the advantage of multi-radio capable devices, such as most COTS tablets or smartphones.

While discussing the topic of cellular communication, we should also recognize the utility of using military cell phones on an existing host-nation network. Cellular technology is becoming more and more widespread in the developing parts of the world, where the cost of installing cellular infrastructure is often significantly less than wired infrastructures, both in manpower, cost and time. Non-Governmental Organizations (NGOs) and other US international actors often deploy to locations such as the Philippines with phones ready to accept a SIM card for the local network. In our operations with 3d MEB, the JTF, and the Multinational Task Force, we saw simple text and cellular email overshadow the C2 systems brought by the Marine Corps. Text became the most reliable means of communication between C2 nodes. Also, in discussion with disaster crews, we found that many cellular towers remained intact following the typhoon. Replacing the cellular antennas on these towers allowed the cell network to rapidly come back online. From a military perspective, this allows opportunities to use a host nation network to assist in coordination in the uncontested arenas, such as HA/DR operations, as well as the possibility of co-opting an adversary network to use encrypted virtual private network (VPN) technology to exploit the connectivity of an existing cellular system (Kaul, Makaya, Subir, Shur, Samtani, 2011).

In Mobile Ad-Hoc Network (MANET) solutions each radio in the network essentially acts as a repeater for every other radio, directly or indirectly. This type of communication is sometimes referred to as mobile mesh networking, where a limited number of Internet access points are directly reachable by a subset of the users, each of which participate with all associated users to form an autonomous multi-hop intra-network connecting every user to the Internet (or reach-back network in the case of a private enterprise network). Essentially, these emerging systems have man-portable units which act as limited routers for data and voice. In simple terms: if A can talk to B, and B can talk to C, then A can talk to C through B. These units also offer simultaneous voice and data broadcast and connectivity to peripheral devices via Bluetooth or traditional 802.11 Wi-Fi. When compared with conventional military doctrine, such as the use of tactical connecting files used to maintain position information between adjacent maneuver elements, overwatch positions, and support by fire positions, it is easy to see how this networking scheme lends itself to military formations. With MANET systems, each of these tactical units can become retransmission nodes and create an internetworked-whole, which will scale and self-heal as units move and terrain changes.

Once the ecosystem is created, we must find a way to create a reliable data trunk to the network. This is our means of accessing an outside network, such as the Secret Internet Protocol Router (SIPR) or Non-Classified Internet Protocol Router (NIPR) networks in DoD. Several options are available to achieve this dynamic reach-back capability, to include, satellite (SATCOM), power-UAV, and lighter-than-air (non-powered) UAVs such as high altitude balloons or dirigibles. Several factors must be considered when employing any of these options, to include impact on maneuver operations, endurance, ease of set-up and recovery, payload/data capacity, reliability, availability and assured access. In the expeditionary environment, where there is no existing infrastructure, on-the-move SATCOM offers significant advantage. While we have performed several UAV-based communications-relay field experiments, the architecture's reliability and availability is uncertain, impacted by mission priorities and asset attachment, that is, organizational control. While existing commercial services, such as the BGAN systems used above, offer both portable and on-the-move solutions, the data rates are insufficient to support enduring communications requirements beyond the most limited C2 needs, emerging systems such as the INMARSAT GlobalXpress, and O3b (Other 3 Billion) networks purport higher data rates to be measured in tens to hundreds of megabits per second (INMARSAT, 2014; O3B, 2014). The military has also begun to launch its own MUOS (multiple user objective system) satellite constellation to provide a similar, secure capability, despite its vastly lower data rates (Lockheed Martin, 2014). A SATCOM solution evolves and scales, as well, with initial forces simply conducting voice communications over the netted Iridium systems being currently tested by MCWL. Then after an initial foothold is established, a unit could quickly set up the static systems necessary for higher bandwidth data, much as they would have done in the past with HF radio systems and their associated antenna array. While their current form-factor needs militarization and testing in a man-portable format, systems such as the very small aperture (VSAT) terminals from ViaSat and the phased-array self-tracking systems such as those by Phasor Solutions should be closely evaluated for future military use. The latter may well be suited for on-the-move operations, too. When bridged to the existing tactical network and leveraging the ubiquitous IP deployment, these systems would allow data transfers not only between networked tactical units but also between them and offshore or distant higher headquarters and their servers.

Finally the core value for leveraging emerging commercial capabilities, both communications systems and handheld/user-access devices involves the establishment of a synergistic application layer, ‘meshed’ together by the integration of a distributed IP–based network. This is an ecosystem of applications for multiple levels of computing that allow all users on a network to add greater value through a shared information environment. The principle driving this is straightforward: survivability and mission success are valued highest by those conducting that mission. We contend that our Marines are intelligent actors capable of leveraging or adapting all available tools to complete their mission in the most force-conserving and asset-efficient manner possible. This applies to information as well. The traditional intelligence cycle relies on information being collected at the tactical edge, transported to higher headquarters, processed, and redistributed according to a set reporting-schedule. With the advent of the company level intelligence cell (CLIC) in OIF and OEF, this process is undergoing a metamorphosis. Companies are conducting intelligence processing typically reserved for battalions, and the Marine Corps is looking at modifying the manning of companies to allow for this expanded capability.

This process could be further revolutionized if each tactical level element was able to access a central intelligence and operations database at will and extract or upload data (often referred to in the literature as “smart push-user pull” or “smart pull-dependable push”) as it becomes relevant to their mission. Time and again edge units rapidly adapt and innovate in response to complex problems. A synergistic application layer would further fuel this phenomenon by creating a free-flow of information among all nodes on a distributed network. Thus, when a squad patrol is re-tasked for another objective it would only take that squad leader a few moments to look up new imagery and intelligence reporting on the new objective through his smartphone or tablet. Units could be queried directly if they are found to have operated in an emerging or evolving area of interest or should higher headquarters require specific, critical, time-sensitive information. Post-strike status of a target could be transmitted to a central database in real or near-real time to reduce the need for repeat raids. Most importantly, Marines will find new uses for the data created not just by higher headquarters but by any Marine using the network.

Just as critical as an agile, interconnected, synergistic application layer is an ability to sustain this system in the presence of a plethora of other devices that Marines are expected to use in the modern operational environment, each requiring consumption of a valuable commodity in austere environments: electricity. One account from the NPS HFN team found the team leader arriving at an airfield to find an officer with an issued Blackberry phone on its last legs frantically trying to get a last email or text out before it died as it was his only way to reach back to higher headquarters and he had no way of recharging it. In this situation, as well as the airfield in Guiuan, the HFN team was able to supply limited continuous power through a collapsible small solar panel system that also charged BA2590 batteries for night operations. The HFN lab has also utilized fuel cell systems using propane as well as other gas sources such as methane; and small wind turbines. The advantage of these systems is their small form factor and ease of setup and breakdown. The solar panels, easily folded and transported, offered peak power of over 300 watts, and could simultaneously charge six batteries for use in other devices or to sustain operations in inclement weather and nighttime. In the case of fuel cells, propane is commonly available in many developing and developed countries and could be acquired in extremis if necessary. Again, a large military generator is not always required for every mission. Small systems like these are just the kind of thing our units should be packing in distributed operations in austere environments.

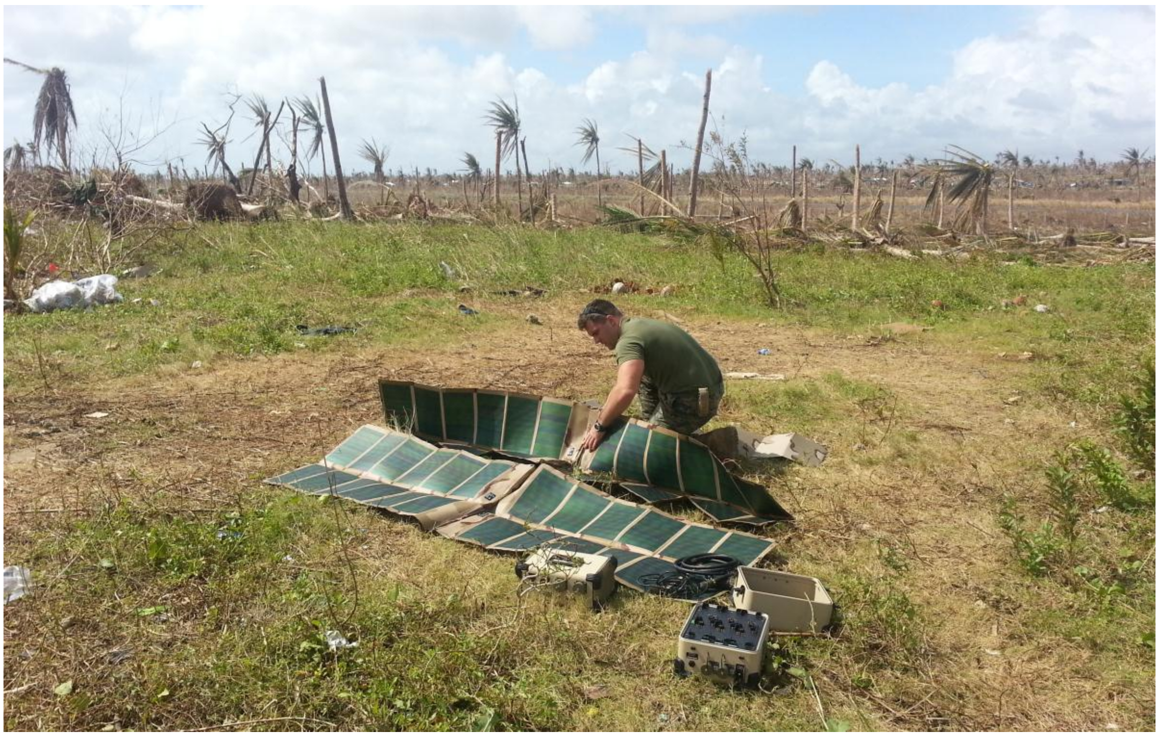

Fig 3 – Bren-Tronics Solar Power System in Guiuan, Philippines

5. **Conclusions and Recommendations:**

The purpose of this paper is to encourage forward thinking by Marine organizations as well as individual Marines. MCWL has conducted multiple large-scale experiments using the same concepts listed above; their results are available through the Marine Corps Center for Lessons Learned. Both MCWL and NPS have tested advanced MANET systems, such as the TrellisWare radio system and Persistent Systems Wave Relay system (MCWL, 2010; Chatzigiannis, 2012). The urgency of equipping Marines with emerging technologies; adapting techniques, tactics, and procedures to leverage the potential of these technologies; and encouraging innovation by our young Marines cannot be overstated. After seeing first-hand how inadequate our distributed C2 capability is in the realities of modern data-driven, austere real world instances, it is frustrating to see the potential for solutions so readily available left under utilized or effectively ignored. The same principal applies to emerging expeditionary power capabilities with advances in solar and fuel cell technology. What is necessary is aggression in the acquisitions process with regard to these emergent requirements, leveraging the technology advancements being fueled by consumer demands, and a radical re-imagining of battlefield C2 architecture. This is an effort that must be DoD-wide, as these problems are not specific to only the Marine Corps. Simultaneously, these technologies should be leveraged to enable interoperability, both within DoD and externally to UN/NATO operations and other government agencies (OGAs) or non-governmental organizations (NGOs). We must transition from constrained radio-nets to a true battlefield *internetwork*. Once we start to do so, efficiencies, emerging opportunities, and unforeseen possibilities will begin to arise at a fast pace, allowing for the innovation critical to the transformation necessary to successfully conduct extended MAGTF operations.

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