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Extended MAGTF Operations Aerial Layer Communications Experimentation

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EXTENDED MAGTF OPERATIONS AERIAL LAYER COMMUNICATIONS EXPERIMENTATION (NPS-N16-M579-A)

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EXECUTIVE SUMMARY

Project Summary

USMC doctrine embodies the concept of combined arms: the integration of air and ground combat capability to achieve maximum effect on the battlefield. The expeditionary nature of the USMC requires tight integration of its combat capabilities and effects, to include during transit of forces to the objective area. However, with the extended range offered by the MV-22 Osprey over that of rotary wing insertion aircraft the distance over which MAGTF forces may be inserted under the cover of a single period of darkness places an extreme burden on communications required to maintain effective command and control (C2) over those forces, particularly in satellite-access denied environments. This research effort extends previous thesis work regarding the use of commercial-off-the-shelf (COTS) radios in combination with small unmanned aerial systems, such as positive-controlled, untethered high-altitude balloon based platforms. In particular, two separate thesis efforts were executed exploring different aspects of this issue: the use of free space optics to provide extremely high bandwidth communications in radio frequency stressed environments and the efficacy of low-data-rate high-altitude balloon relay for support to distributed, dismounted, small-team combat elements.

Background

The communications needs of tactical maneuver elements are driven by the mission tasking levied on them. Foremost is a need to establish and maintain situational awareness of the area of operations. The data to maintain this tactical awareness can range from intelligence reports, including high definition imagery and video feeds, to inter- and intra-squad communications that provide voice or text (chat) updates on status or requests for assistance.

With respect to free space optics (FSO), this study extended the previous research of Capt Casey that sought to determine the potential for using FSO to extend tactical communications as a step toward beyond line of sight communications in satellite denied environments. However, Capt Casey's results were severely limited by equipment malfunctions experienced during the field experimentation. (Casey, 2014) Mr Lai identified other vendors in the FSO arena and arranged for one of them, SA Photonics, to participate in a Joint Interagency Field Experiment (JIFX) hosted by NPS in

August 2016. The system demonstrated by SA Photonics was significantly more mature than that used by Capt Casey, resulting in link performance holding significant promise for reducing reliance on wired or RF-based data links between forward operating bases and associated antenna fields. (Lai, 2016)

The research sponsor specifically requested we explore the use of abiity to pass simple text-based messages between small ground units using tactical government or commercial-off-the-shelf (GOTS/COTS) radios leveraging radio signal relay over an untethered high-altitude-balloon system. The specific balloon system used was the Space Data Corporation's SkySat, as these platforms were in the I MEF inventory. The basic capability was demonstrated during a previous NPS field experiment in 2007 using the Space Data Corporation StarFighter, the predecessor of the SkySat, in conjunctioin with a ViaSat Data Controller (VDC-600) and the Thales Multi-band Inter-/Intra-squad Tactical Radio, known as the MBITR (TNT 08-1). The goal of this research was to determine the ability to interoperate the two principal handheld radios in use by the USMC, the MBITR (PRC-148) and the Harris Falcon-III handheld (PRC-152A), in order to provide a tactical chat capability between units that operate these radios. LT Stokes experimented with interfacing these two radios in a lab environment with limited success. As the PRC-148 is an analog radio it requires the use of a MODEM to connect it to a laptop. Though the PRC-152A is a digital radio and can directly connect to a laptop via a special Ethernet cable, in order to be compaticble with the PRC-148 setup a similar MODEM must also be used. The ViaSat-850 Data Controller, recommended by Space Data Corporation as part of the system design, also included the ViaSat chat program (vMail). Space Data Corporation launched a SkySat system from their facility at Chandler, AZ, with two mobile ground teams configured to exchange chat text and small files over the SkySat enabled ultra-high frequency (UHF) radio relay. Frequent drop-outs between the Thales and Harris radios were experienced, requiring the associated laptop to be rebooted. Initial indications are that the timing between the two radio types is sensitive to the range associated with connecting to the ballooon-borne radio. The Space Data engineer extensively explored such timing issues following the field experiment but subsequent attempts by the NPS researchers could not successfully connect the radios. (Stokes, 2017)

Findings and Conclusions

The field experiment results reported by Lai with respect to free space optics included sustainment of a 10-kilometer link at nearly 9.5 gigabits per second. While this distance will not support beyond line-of-sight communications relative to supporting remote insertion of fire teams by the MV-22, it could support rapid setup of high bandwidth links between forward operating bases and their remote locations of antenna emplacements, within the eye-safety constraints determined during the coordination of the field experimentation laser usage. However, to extend the use of FSO in support of combat team insertions the range of the link would need to be increased by at least a factor of 10. So doing would reduce the received signal power by a factor of at least 100 resulting in a theoretical reduction of data rate by a factor of 7, assuming the signal remains detectable, which remains to be seen. A significant part of this effort was the establishment of a process to seek approval for the use of lasers by NPS researchers from the Naval Medical Review Board, in conjunction with the NPS Safety Officer.

While the previous results regarding extending low data rate text/chat and small file transfers between remote users across a SkySat-hosted radio relay was very successful, the difficulty associated extending those results by inter-connecting the two different dominant tactical radios over such a connection proved quite difficult, with timing constraints between the two radio systems causing significant system dropouts. As reliable communications between supporting ground combat teams is essential to effective maneuver operations, further exploration as to the difficulty with connecting user devices, such as laptops or tablets, across a long-range link provisioned by these two diverse radios is warranted.

Recommendations for Further Research

As FSO communications are limited by a line-of-sight requirement, achieving ranges needed to support remote combat team insertions requires airborne relay capabilities. However, size-weight-and-power (SWAP) constraints associated with mounting an FSO transceiver on an unmanned aerial platform suggest exploring other options for making such link connections. Two possible research extensions include the use of small dirigible platforms capable of lifting FSO transceiver systems to effective heights (altitude) sufficient to support long-range links and the use of modulating retro-reflector devices on small, unmanned aerial vehicles.

Text-based messaging, such as chat programs, remains an effective communications tool in bandwidth-constrained environments. However, limited compatibility between radio systems constrains the ability to reliably connect remote units. Exploration of configuration settings between the two dominant G/COTS radios in use by USMC small-

unit operations is needed to further evaluate the potential utility of lighter-than-air-platform hosted tactical chat between geographically-isolated units.

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