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Joint Fires in Support of Distributed Maritime Operations

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Background

This research addresses the potential use of Joint Fires (JF) in support of DMO, exploring options and concepts for employment of joint assets in support of maritime operations and enabled maritime calls for fire, supported by air- and land-based assets in the degradation and denial of Red Force reef island outpost capabilities. Specifically, we explored how well a small adaptive force composed of the Army, Air Force, Navy, and Marines can coordinate a limited strike on key enemy assets and how utilization of a wireless mesh network affects those operations. Networks that automatically adapt to dynamic situations and still provide robust capability are critical to mission effectiveness. We compared a traditional Star network against a multilayered Mesh network and quantified how the arrangement of those links impacted operational effectiveness.

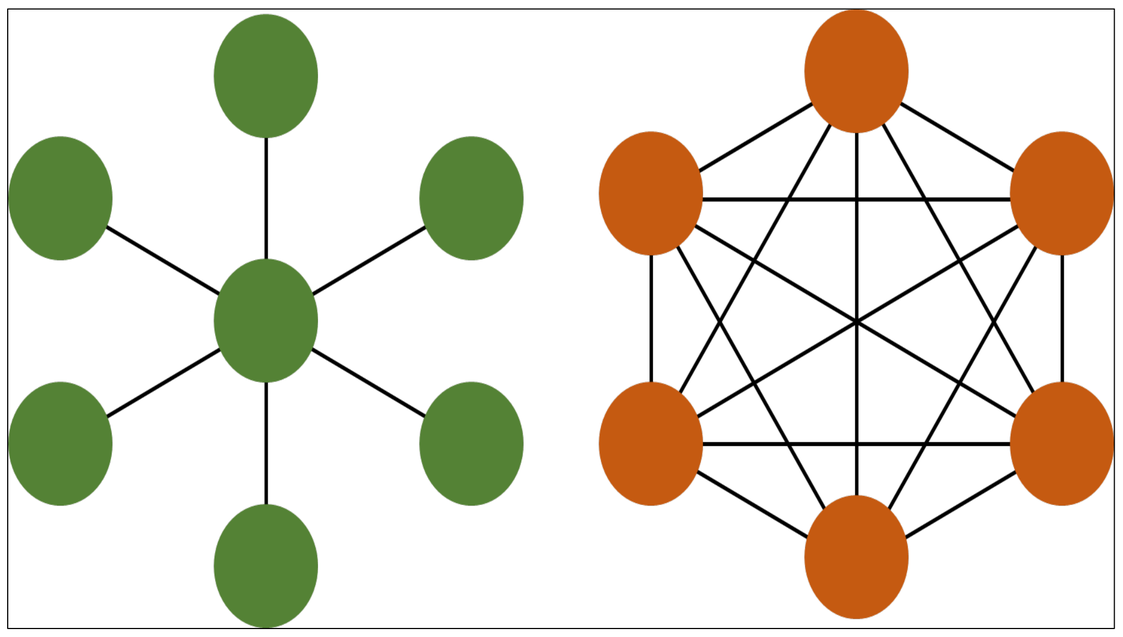

Figure 1. Star Network Topology (Left) and Full Mesh Topology (Right).

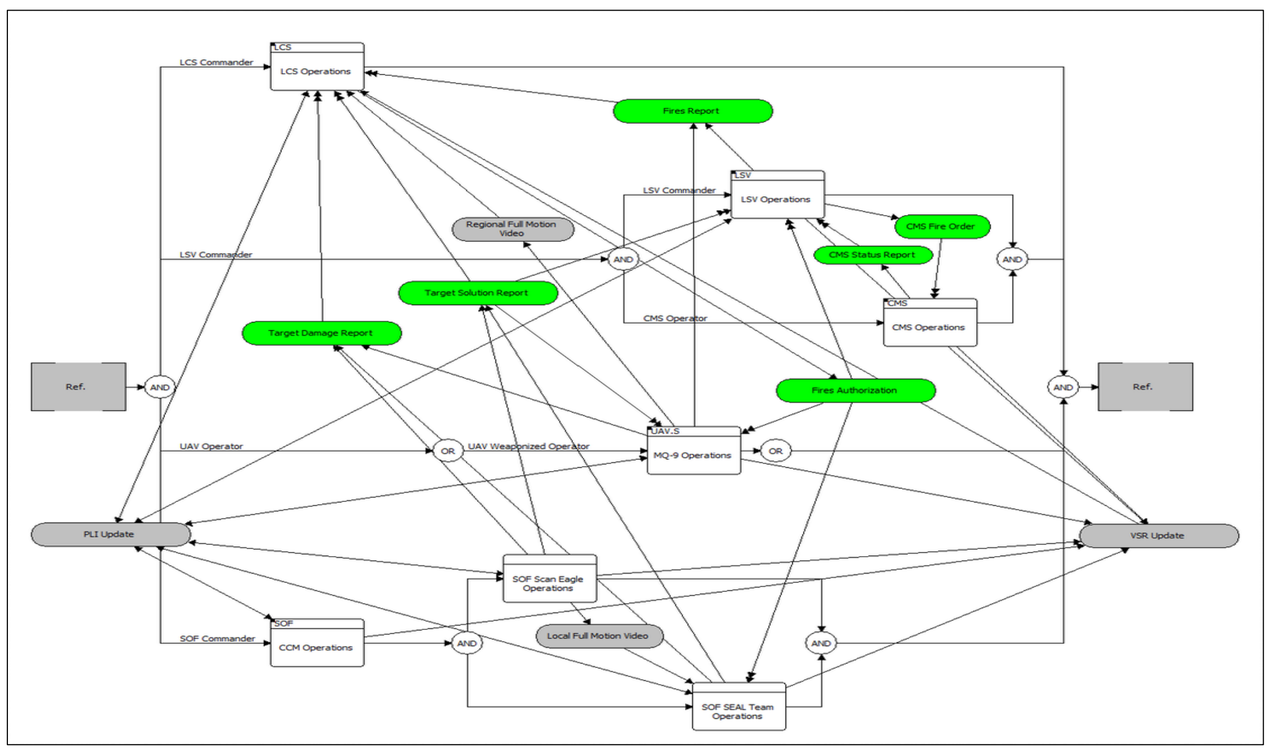

Figure 2: Enhanced Functional Flow Block Diagram

Communication Architectures

Two communication architectures were modeled based on line of sight (LOS). To be LOS, there must be little to no obstructions between the transmitter and the receiver. Beyond line of sight (BLOS) architectures were used for over the horizon communications and have the advantage of poor detectability by near-peer LOS detection systems. Two types of BLOS communications architectures were bent-pipe or hub-relay structures. Both architectures accounted for time delay inherent in each for a message to reach its intended target node or hub. For evaluation, both LOS and BLOS threshold models were created in Microsoft Excel. The simulation results were then used to determine the desired message completion rates (MCR) and network parameters for ExtendSim simulations. ExtendSim was used to model discrete network performance and evaluate user demands introduced by changing network and parameters.

Operational and Systems Analysis

Systems analysis focused on modeling the impact of different communications network configurations on reliability and operational effectiveness of JF in support of DMO. The models and simulations were created to determine how well each network configuration could support similar data types. Assessment focused on the ability of mesh networks to provide benefits versus star networks in a littoral environment. The backdrop of this study was a series of three JF DMO scenarios designed to degrade the radar capabilities on a Country Red reef island outpost. The scenarios used a combination of air and sea assets with varying capabilities. Scenario #1 was a direct assault on the target radar by a SEAL squad in cooperation with a Combat Craft Medium (CCM), a Navy Littoral Combat Ship (LCS), an Air Force MQ-9, and a Scan Eagle. Scenario #2 removed the MQ-9 but inserted an Army Logistics Support Vehicle (LSV) outfitted with Containerized Missile Systems (CMS). Scenario #3 combined all assets of Scenarios #1 and #2. Figure 2 shows the enhanced functional flow block diagram for Scenario 3. This diagram shows the flow of communication functions needed to perform the mission. Each gate illustrates the performer of that function. The white boxes identify the functions. The green boxes are the triggers that are needed to start a certain event and grey boxes are constant outputs.

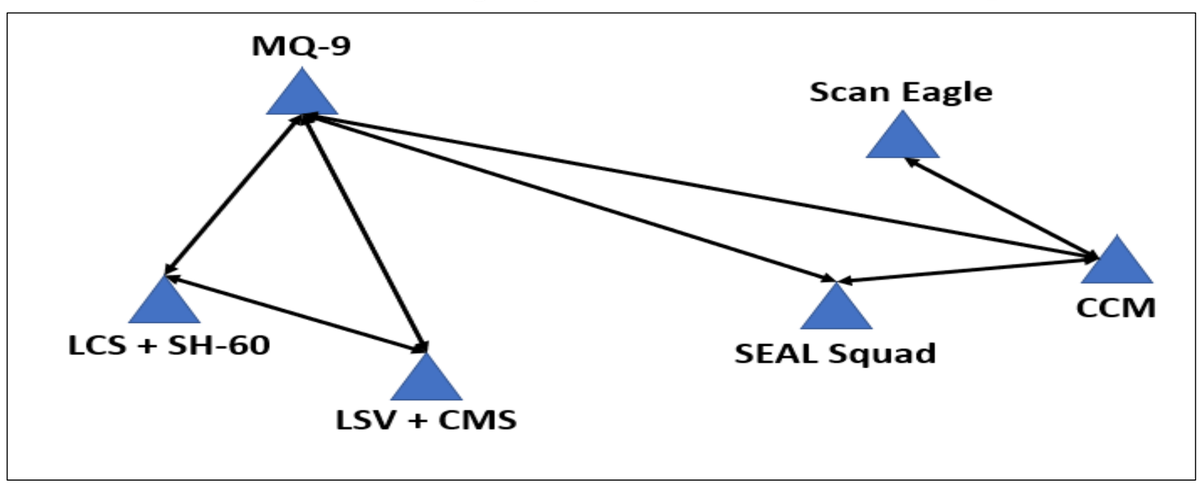

Figure 3. LOS Communication Architecture

Conclusions and Future Research

Network design considerations need to support the data requirements for applications and services to be effective. To enhance JF DMO, strong consideration should be given to the messaging between assets to improve the amount of data that needs to be transmitted. The message size directly impacts the network configuration performance. Network responses are based on how it handles messaging transmission, data rates, location of network controllers, and how external data is injected and distributed over the network. We recommend that future researchers determine appropriate battlefield reporting for higher confidence in human decision making based on situational awareness and research scalable SATCOM networks to support larger user bases into the thousands.

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