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COTS Solution for Adaptive Communications Paths Using Tactical Handhelds

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NPS NRP Executive Summary

Title: COTS Solution for Adaptive Communications Paths Using Tactical Handhelds

Report Date: 10/15/19 Project Number (IREF ID): NPS-19-M244-B

Naval Postgraduate School / Graduate School of Operations and Information Science (GSOIS)

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COTS SOLUTION FOR ADAPTIVE COMMUNICATIONS PATHS USING TACTICAL HANDHELDS

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EXECUTIVE SUMMARY

Project Summary

The use of COTS (commercial off the shelf) handheld devices in the tactical environment is increasing every year; however, the Marine Corps leverages very little of their wireless capability. By leveraging the use of such radio waveforms and protocols such as Bluetooth, WiFi Direct, WiFi, and cellular, the "tactical handheld" could change the communications domain, as our next engagement is likely to be in a satellite denied, bandwidth limited environment. This study seeks to ease the burden of the warfighter, while maximizing the use of lightweight, portable devices by demonstrating how information and communications can be shared across various waveforms and standards, routing information to the intended recipients, all in a fully automated fashion. In this research, we considered a particularly promising new architecture: Named Data Networking (NDN) (NDN, 2019) (Jacobson, Smetters, Thornton et al., 2009). The central observation of NDN is that users are primarily interested in content, rather than machines or end-points. Of particular interest to our problem domain, researchers have developed a multi-user, serverless, infrastructure-less, peer-to-peer text chat application, ChronoChat (Zhu, Afanasyev, 2013). For these reasons, we chose to evaluate NDN and ChronoChat further to characterize their performance suitability by installing and testing the software. The purpose of this project is to provide the Marine Corps with both a concept of employment and also the tools, processes, and procedures required to engineer and support tactical wireless communications.

Keywords: *infrastructure-less communications, handheld devices, commercial off the shelf devices, COTS devices*

Background

There is a tremendous opportunity to exploit the advanced capabilities of mobile devices, including networking, processing and sensing, in order to increase the safety of our troops and to reduce the loss of life and property during missions. Our military often operates in austere environments which lack computing and communication infrastructure, with little or no ability to access or share vital information. This frequently leaves them in dangerous situations; however, by exploiting the new capabilities of mobile devices, we can overcome these challenges.

This project aims to capitalize on the advancements of networked mobile devices to enable our military personnel to operate without having to rely constantly on external infrastructure. Therefore, our research explores how mobile devices can self-organize into peer-to-peer networks that transmit signals among themselves, but do not reply on external wireless or cellular infrastructure. Our focus on austere network environments and military needs is unique.

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The acute need for infrastructure-less communication begs the question as to whether the Internet Protocol (IP) fundamentals and network architectures are appropriate for military applications. For instance, IP assumes the availability of a contemporaneous and reliable end-to-end path, name lookup services, and routing and forwarding infrastructure (Clark, 1988). As one military example where these assumptions may not hold, a deployment of troops may: i) experience connectivity disruptions as they move; ii) not have the ability to resolve names to addresses; or iii) not have a connection to dedicated network infrastructure.

Such challenges are not wholly unique to the military, as ad-hoc vehicular networks (VANETs) may be important in a world of autonomous transportation, or when consumers lose infrastructure service during natural disasters and emergencies, and further, many regions of the world simply have no infrastructure. Emerging research reconsiders the ways in which networks are used, and will be used, in order to develop new architectural paradigms to accommodate such challenges.

Findings and Conclusions

IP was developed in an age of time-shared machines where users needed to login to a specific machine to accomplish work. Whereas the IP architecture is centered on sending packets addressed to specific machines, in today's network, we are generally agnostic about where the content comes from, and instead, rely on search engines, e.g., Google, to find content, and Content Distribution Networks (CDNs), e.g., Amazon Web Services (AWS) and Akamai, to replicate and serve data. In this model, a user does not necessarily care about what machine (or machine IP address) she obtains a copy the content from, but rather is willing to receive it from any replica so long as it is authentic and unaltered.

NDN is an architecture that fundamentally changes the network service from delivering packets to a specified destination machine address, to fetching data with a specified name: so content, rather than end hosts, is named. This architecture has many potential benefits, including the ability to support infrastructure-less communication.

Consider, for example, two users on a subway train who wish to download the day's New York Times newspaper. Today, the mobile devices of these users must find a network attachment point (e.g., the cellular network), find the hostnames responsible for hosting the New York Times (e.g., via a Google search), lookup the machine address corresponding to these names (e.g., via the Domain Name System), and fetch the content from the machine on the wired Internet. Instead, with NDN, if one user already has a copy of the newspaper, the second user could simply obtain a copy of the newspaper directly using a point-to-point transfer; thus, nodes can be both consumers and producers of data, and there is no assumption of infrastructure or server support. Indeed, similar to a military situation of deployed troops without connectivity, the two users on the subway may not have any cellular connectivity while underground, but the user can still obtain the newspaper from her peer.

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As a National Science Foundation (NSF)-sponsored project (NSF, 2010), NDN is open-source and available for testing and evaluation (and refinement).

Thus, NDN meets several of our desired criteria. It is:

i) link-layer agnostic (such that communication between two nodes can be through a third, and the links need not use the same technology);
ii) does not require infrastructure or servers to run;
iii) can tolerate disruptions and disconnections;
iv) is open-source licensed; and
v) has an existing chat application.

Recommendations for Further Research

There are several opportunities for future research. For example, work to support field testing of NDNs could explore the ability to employ NDNs under conditions of military operations and develop a detailed concept of employment of NDNs. Also, while portions of this research indicated that NDNs would be useful for military operations, military specific extensions to the basic architecture of NDN should be investigated.

References

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Acronyms

Commercial Off the Shelf	COTS
Internet Protocol	IP
Named Data Networking	NDN
National Science Foundation	NSF
Transmission control protocol	TCP