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Memo of Transmittal

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CC: David M. Merchant, Project Facilitator
From: Jon Wages
Subject: Analytical Report for Feasibility of Faulty Military Communications Research
Date: February 17, 2010

Summary

On January 19 I submitted a research proposal to you that detailed the current situation of military communication devices and how that situation is affecting human error and loss of human life on the battlefield. This problem within the field of military communications is of critical interest to those that are serving in the United States Armed Forces as this issue could potentially affect their life expectancy. Due to the intense nature of the field and the extreme benefits that could possibly result from advances in military communication devices, I chose this area of research.

Discussion

To examine the feasibility of further research and development within this field, I first had to gather and analyze existing research relevant to the field of military communications. I initially carried out research by looking to peer-reviewed scholarly texts, such as journals and reputable government funded websites that pertained to the area of military communications. The next task was to examine these research sources for possible solutions to the problem of loss of human life and human error due to faulty military communication devices and to ascertain the reason the devices were faulty and ineffective.

By compiling and analyzing the research sources, I was able to find three possible solutions to the military communication issue. The first of these three solutions is the use the Doherty Power Amplification System. The Doherty Power Amplification System would allow radios to contain two amplifying devices that are used in parallel in order to combine their output. This would result in much higher levels of power output for the device when the power was actually needed for the device. The second possible solution involves the use of a new antenna for a nuclear powered satellite. This antenna would allow for a larger communication network and for better power usage of military communication devices.

The third possible solution that was rendered by the research was the use of envelope tracking as a way to preserve energy for the communication device. In traditional communication devices, the devices can only use a set amount of energy and the remaining energy is converted to heat. This can potentially result in circuits being melted and the device itself overheating. In communication devices that use envelope tracking, the device's output of energy is made to reflect the amount of needed power for transmission of the signal. Therefore, since the amount of energy that is used by the device is not disproportionate to the amount actually needed, the amount of energy converted to heat is also much less. The distribution of heat saves the battery life of the devices themselves as well as ensures the safety of the circuits and components within the device.

Conclusion

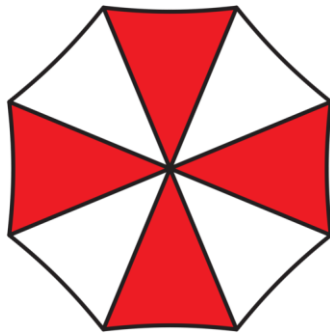
After completion of the research was finished, the results yielded much insight into the problems associated with military communications and allowed for the presentation of many possible solutions to the faulty military communications issue. The research showed that the research and development of new forms of military communication devices is not only beneficial but also feasible and implementable.

Considering the findings of my research, I suggest that the Umbrella Corporation should move forward with the development of new and innovative military communication devices that use the proper power amplification system and thereby ensure the safety and effectiveness of military personnel both on the battlefield and off. If you any questions or further inquiries, please contact me at WagesJ@UmbrellaCorp.net. You may also reach me by phone at (555) 777-4321. Once again, thank you for providing me with the opportunity to carry out this research.

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Umbrella Approved Research Project

February 17, 2010



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Analytical Report for Feasibility of Faulty Military Communications Research

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February 17, 2010

Abstract

Analytical Report for Feasibility of Faulty Military Communications Research

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This technical report addresses the very important issue of human error and loss of human life on the battlefield due to faulty military communications. This report is intended to help resolve this issue by providing three possible solutions and finally recommending the best solution for further research. Within this report, one will find a description of the problem as well as the presentation of three possible solutions to the problem: the Doherty Power Amplification System, a nuclear powered satellite with improved antennas, and an envelope tracking system. A conclusion of the findings and a recommendation for further research and development of specific solution will also be presented.

Keywords: **Doherty Power Amplification system, nuclear powered satellite, envelope tracking system, human error, loss of human life**

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Executive Summary

The following technical report examines the issue of human error and loss of human life on the battlefield due to faulty military communication devices. The issue of human error and the loss of human life have long been a major problem in military communications. This research seeks to alleviate that problem and enable military personnel to have communication devices that are efficient and effective. My methodology for this research involved gathering information specific to the topic of research, analyzing the collected information, and comparing the possible solutions that I found in accordance with the criteria of size, weight, and power usage of the communication device after the solution was implemented. From my research, I was able to propose three solutions to the issue of faulty military communications. The three solutions dealt specifically with the areas of size, weight, and power usage of military communication devices. The three solutions ranged from advancements in satellite technology to advancements in the power amplification systems of pre-existing military communication devices. After a comparison of these three possible solutions is made, I offer a recommendation for further research and development of one of the primary innovative solutions. This recommendation allows the Umbrella Corporation to make a well-informed decision about this critical area of research.

Introduction

This technical report reviews the findings of a study I conducted that explored the problem of human error and loss of human life on the battlefield because of faulty military communication devices. The problem of human error and loss of human life on the battlefield has been an issue that has plagued humankind for centuries. Weapons technology has improved and become more advanced as time has passed; however, the technology involved within the area of military communications has always developed more slowly. The gap between powerful, new weaponry and aged, ineffective military communication devices has caused many issues for not only the command centers of the armed forces that issue orders, plans, and commands but also for the troops that are on the ground in the midst of battle.

As my family has a rich history of military service ranging across various branches of the United States Armed Forces, the issue of human error and the loss of human life on the battlefield is very close to me. Every day that this issue is ignored by research and development teams is another day that soldiers can possibly die due to faulty communication. The last ten years have produced little advancement in military communications; however, the civilian market has seen numerous innovations in the area of communication devices and has been experiencing an all time high in advancements. Communication research has shown a lack of development of proper military communication technologies, and the world is asking for new solutions to come onto the scene.

My education has taught me the value of communication and the importance of identifying faulty communication patterns that hinder the ability to communicate effectively. While interning for the Umbrella Corporation, I am also pursuing my Bachelor of Arts in Speech and Communications. Because this is my senior year and I will be graduating in the spring, I have completed almost all of my undergraduate work. My studies in the discipline of communications have equipped me with an increased ability to analyze communicative patterns ranging from everyday communication to organizational communication to communication that takes place on the battlefield. My discipline has taught me that a large part of communications is affected by where that communication takes place. The communication in the office is not the same as on the battlefield, and as such, different communication issues have different solutions based on their respective environments. This shows the need for military communication devices to be more effective than other devices as well as more durable and more powerful.

Current Situation

While it is beneficial to know what a problem is, that information is useless unless a cause for that problem can be identified. The primary cause of human error and loss of human life on the battlefield is faulty communication devices. Most current military communication devices only account for audio and data transmission. The coming generation of military communication devices will be able to transmit audio, video, and data throughout the battlefield and is being called Net-Centric communications. Though there have been new developments in this area by the United States' Joint Tactical Radio System program, these advancements have come at the price of size, weight, and efficiency. As stated by Shaun

Cummins, "Power density of the new radios can be worse than the established frequency hopping AM/FM technology by a factor of four, with a negative impact on the Size, Weight and Power envelope of the communications systems a vehicle-borne or dismounted unit needs to carry" (Cummins 30). While the advances in military communications are needed, they must be practical. This is not to say that advances are not being made in the areas of size, weight, and power usage; however, the advances that have been implemented almost always result in a lessening of the device's ability to operate at an effective capacity (30). An effective solution would then offer maximum efficiency and operating capacity while still being of practical size, manageable weight, and effective power usage.

Context of Research

In order to gain a more in-depth look at the area of military communications, I researched the subject of military communications. The primary focus of this research was on the area of military communications with a focus of the size, weight, and power usage of military communication devices. Most of the research came from peer-reviewed military communication-based journals and reputable online government-based sources. This ensured a high level of valid information regarding the topic of research. The research gave new light to the importance of managing the size, weight, and power usage of communication devices as well as provided possible solutions for these issues. The research also provided a firm foundation for further research into the size, weight, and power usage of military communication devices.

Scope

As this research has many possible avenues for development and further inquiry, it was necessary to limit the extent of the research to the most beneficial areas of development for both the company's interests and the interests of the intended users of such new developments. It was important that the research affect areas that are most relevant to the problem; therefore, the research only covered the area of size, weight, and power of military communication devices. As many of the current innovations in military communication devices are making leaps and bounds in the area of technological success, greater attention needs to be given to making these new technologies more practical to the typical military unit. This focus of research and development allows for increased productivity of military units at a earlier time and therefore result in fewer human errors and less loss of human life.

Available Solutions

Research and development teams have been examining innovative solutions in an effort to produce the most effective military communication devices. While no one solution is perfect, these solutions are showing promise in the field of military communications. Furthermore, these solutions appear to need only more time and money to become effective and practical.

The first of these new solutions is to focus more on the actual network itself, rather than on the devices that military units carry. This approach focuses on making advances in satellite technology that has a greater reach and output capability and therefore can lessen the demand

for new innovations in military communication devices by optimizing the use of already available technologies. An example of this type of solution would be research and development of a more efficient satellite antenna. This solution recommends the usage of satellite stabilization techniques and high-gain antennas that would increase the satellite's possible transmission abilities but also increase the weight of the satellite and therefore require a more durable power source such as nuclear energy (Johnston 103). While this solution is not directed at individual communication devices, it would enable more effective military communication as a whole to units that must have reliable satellite data in order to organize effective battlefield tactics (103).

The next possible avenue of research pertains to the usage of Net-Centric military communications. The primary issue with these forms of communication is that the power density is much lower than traditional AM/FM radio systems. Some research and development teams are addressing this issue by suggesting the use of Doherty Power Amplifier (PA) configurations. This kind of PA configuration suggests that radios contain two amplifying devices that are used in parallel in order to combine their output. This sort of PA configuration uses only one of the available two amplifying devices in order to conserve energy. For more advanced military communication needs, the second of the two amplifiers is turned on automatically, doubling the efficiency of the radio, and therefore adding to the usefulness of the radio. This solution would minimize the amount of power usage and improve battery life of radios by not using the full power of the radio to always emit a maximum range when the communication device is not needed (Cummins 36).

The third of the possible solutions that is being currently researched and developed in the realm of military communications is using envelope tracking as a form of modifying the power efficiency of a military communication device. This solution suggests that the easiest way to minimize the amount of energy used in communication devices is to track the amount of power used with the radio signal envelope. This dynamic power adjustment suggests that the amount of power that the device uses depends on the radio signal being sent forth. The way that envelope tracking operates prohibits the additional power that is normally put out by the radio from being converting into heat. The radio puts off a definite amount of power, while the amplifier is only able to use so much of the power that is put out. By causing the amount of power used to mirror the usage of necessary amplification, the overall use of power is decreased and the battery life of the device is prolonged (36). As envelope tracking can be a difficult concept to grasp, I have included an extended definition of this interesting concept.

Definition of Innovation

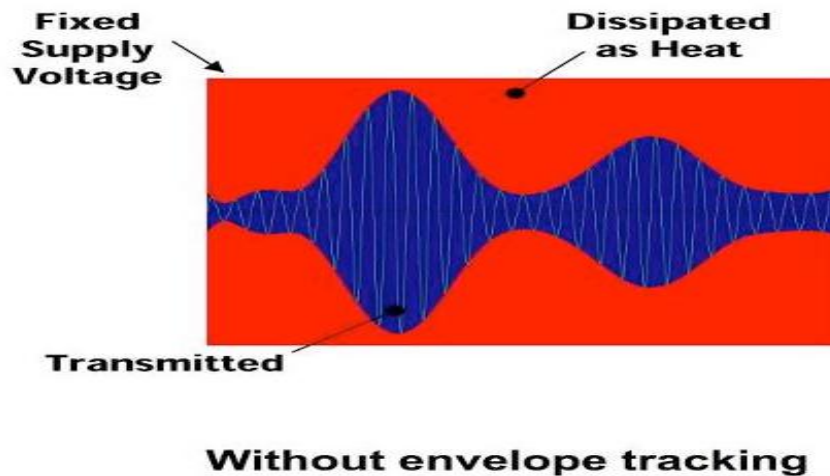
Envelope tracking is a technique that improves power usage of radio frequency power amplifiers by matching the amount of voltage with the radio frequency output waves (Cummins 36). Before this exploring this concept, one must understand what power amplifiers and radio frequency output waves are and how they are related to one another.

Power amplifiers are devices that intensify the amount of voltage sent throughout a communication device and are primarily responsible for the way communication devices use energy (35). Radio frequency output waves are the actual waves of energy that the

communication device emits when the device is being used to transmit audio, video, and data (35).

In order to more properly understand envelope tracking, the following explains the function of a traditional military communication device that does not use envelope tracking:

In traditional military communication devices, the power amplifier uses a constant supply of energy to enable the communication devices to function at 100% power output at all times. While the power amplifier is putting out 100% of available power, the communication device is only able to use a limited amount of the available power in order to transmit radio frequencies. If the radio frequency output wave is only able to use 45% of the available 100% of fixed supply voltage then 65% of the supply voltage is not going to be used productively. This extra 65% of unused energy will be converted to heat. This heat is not enabling further degrees of functionality for the device and can actually cause negative effects to the communication devices. These negative effects can range from simply overheating to serious critical damage to circuits within the device. An example of basic traditional functionality of military communication devices is provided below. The section identified as "Transmitted" represents the radio frequency output waves. The area outside of the "Transmitted" section displays the supply of power to the device and the amount of the device's power that is converted to heat.



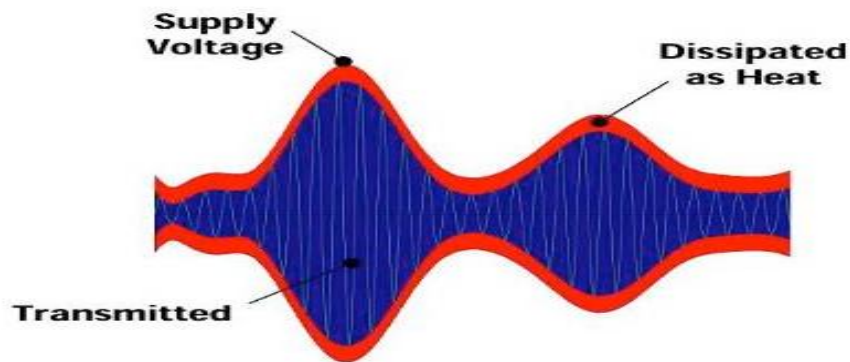
Source: Purden, Keith. "From State of the Art RF Power Technology for Defense Systems." *Nujira.com*. 2009. Web. 24 Jan. 2011.

As one can see from examining the previous illustration, traditional military communication devices have suffered from using too much power that does not serve a helpful purpose. The solution of merely giving the communication device more power is not a valid solution as the increased power will only result in an increased amount of heat to the device itself. Even the addition of a larger antenna in order to transmit radio frequency output waves more effectively does not solve the problem for two reasons. First of all, this solution adds more weight. In addition, this solution, while able to use more energy, still does not address the issue of excess energy that produces heat. As a result of this heating problem, communication

devices have had to add extra cooling systems that can compromise the device's ability to withstand harsh environments.

A useful metaphor for understanding a device that does not use envelope tracking is football. In football, the team is often motivated by the cheerleaders, coaches, and the crowd. An example of a device that does not use envelope tracking would be the crowd yelling loudly, the cheerleaders constantly cheering, and the coach encouraging the team from the sidelines throughout the entire game with absolutely no breaks in their efforts. The players on the field would only be able to handle so much of this noise before it overwhelmed and distracted them. It is not an appropriate during a timeout for the crowd and cheerleaders to yell and scream uncontrollably. The players only need the encouragement when it is necessary. Like the football players, a device that does not use envelope tracking has a constant supply of energy that is not necessary and can even be harmful to the device itself. This is not the case, however, with devices that use envelope tracking.

An innovative solution to the problem of excessive use of power in military communication devices is the use of envelope tracking within the device itself. Envelope tracking is used to improve the power usage of radio frequency amplifiers. This concept was first developed in 1937 by Bell Labs; however, as with many ideas at that time, the technology researchers had access to was not able to convert this concept into reality (Cummins 30). It was not until recently that mankind has had the technology necessary to make the concept of envelope tracking into a practical reality. The way that envelope tracking operates is by adjusting the amount of voltage that the communication device is using to meet the required amount of energy needed to put out the signal. This means that as the radio frequency wave fluctuates, the energy required to send the signal also fluctuates and saves energy. This concept is demonstrated in the illustration below. As with the other illustration, the section identified as "Transmitted" represents the radio frequency output waves. The area outside of the "Transmitted" section displays the supply of power to the device and amount of the device's power that is converted to heat.



With envelope tracking

Source: Purden, Keith. "From State of the Art RF Power Technology for Defense Systems." *Nujira.com*. 2009. Web. 24 Jan. 2011.

Based on the illustration above, it is easy to notice the difference between a device that does not use envelope tracking and a device that does use envelope tracking. Envelope tracking minimizes the amount of heat put off by communication devices by limiting the amount of voltage used to transmit the radio signal. By doing this the communication device is able to experience prolonged battery life in any situation. The device is also able to withstand harsh environments better due to the lack of intense heat within the device itself.

It is evident that there are great differences between devices that use envelope tracking and those that do not use envelope tracking. Devices that use envelope tracking are like a football game in which the crowd, cheerleaders, and coaches only yell and scream at times when the football team really needs the extra encouragement and energy. This results in the team noticing that the crowd, cheerleaders, and coaches are paying attention to them and attempting to pump them up. Like the football players' amount of motivation and energy, the supply of energy in a device with envelope tracking is dictated by the device's need to send a signal and as a result functions more efficiently and effectively.

With a strong understanding of the primary problems related to human error and loss of human life on the battlefield, as well as, a brief understanding of the solutions to the problems associated with the issue of human error and loss of human life on the battlefield, it is then possible to move forward to a description of the methodology used to address this critical issue.

Methods

The list of tasks below is the plan that I followed in order to research the possible solutions to faulty military communication devices and also the benefits that the Umbrella Corporation will gain by researching this problem.

- *Task 1: Research use of current military communication devices*
For this task, I used peer-reviewed scholarly journal sources as well as government-endorsed websites to research current military communications devices. These sources supplied me with the information on benefits of current military communications devices. My sources detailed both the benefits and the shortcomings of current devices.
- *Task 2: Research current and innovative solutions to size, weight, and power issue*
In this task, I focused on using military technology journals in order to find the most relevant and innovative solutions to current issues plaguing military communication devices. Solutions currently being used to solve military communications device issues were researched.
- *Task 3: Compare current and innovative solutions to military communication device issues*
This task compared and contrasted current and innovative solutions to military communication device issues based on the following three equally important criteria:
 1. Power Usage: While many solutions have come forth, most do not maintain high efficiency of power usage.
 2. Weight: If a possible solution adds weight to current devices, the solution might need to develop further in order to be efficient.
 3. Size: A solution must be small enough to help minimize the carrying space.
- *Task 4: Compare usefulness of solutions analyzed in Task 3*
This task used the information gained from Task 3 to compare and contrast the possible innovative solutions. The comparison of these solutions enabled the researcher to continue forward in the most efficient manner and will also be featured later in this paper.
- *Task 5: Suggest best solution to military communication devices issue*
Later in this report, I will make a recommendation as to which solution should be pursued via further research and development. Should a solution be found viable, I will suggest that the Umbrella Corporation proceed in researching said solution and continue on to its development.

In order to understand the criteria that I used for comparison of the three possible solutions, I have included a detailed description of the three criteria used for the purposes of this study.

The first criterion that I used in order to compare and contrast the three available solutions is the effect that the solution has on the size of the military communication device itself. Size is

a very important issue. This factor determines the amount of space that military personnel will have to make available in order to carry the device. As most communication devices are already small, the technology that is used should not in any way add to the actual size of the communication device itself. The size of a device should not take up more space than what is necessary, and therefore allow for more available space for other possible equipment. That being said, the size of a military communication device is often directly related to the overall weight of the device.

The second criterion that I used in order to compare and contrast the three available solutions is the weight of the communication device after the solution has been implemented. Weight is a factor that is of utmost importance to a military communication device. Weight determines how much extra weight military personnel will have to carry aside from the weight of equipment that is already on their person. As weight of a unit increases the effectiveness of the unit often decreases; this is especially true with ground units. Most devices already take this into account but oftentimes the weight is still noticeable. The ideal improvement to military communication devices would minimize weight and result in an apparently weightless addition to the military personnel's equipment.

The third criterion that I used to compare and contrast the three available solutions is the power usage of the device. The power usage of a military communication device is a very real and very important issue. Military units depend on their communication devices to relay important information to and from units on the battlefield. Oftentimes, military troops are on mission for longer than a few days at a time. In these prolonged missions, the power supply of their communication devices matter greatly. If a device does not possess an adequate power supply, then the communication device cannot affectively do what it is designed to do. This is often an issue because new developments in technology are seldom immediately practical in this area. The sooner that technology is able to be made practical and useful in the area of power usage, the sooner that troops will be better equipped for real tactical situations.

Results

Below is an explanation of the tasks that have already been completed.

Task 1: Research use of current military communication devices

The results of this task were the collecting and analyzing of twelve research-oriented sources. Of the twelve, five were Internet sources, five were journal sources, and two were book sources. The Internet sources were all from reputable, research focused government agencies or from reputable organizations that specifically deal with the area of military communications. The journal sources were obtained from peer-reviewed military communication journals. The two book sources dealt with the area of military communications and are authored by experts within said field. Each of the twelve sources focused on the area of military communications and current problems and advances within that industry. These sources were also annotated, as this allows for a brief summary of the relevance of each of the sources.

Task 2: Research current and innovative solutions to size, weight, and power issue

This task was completed by using the sources that were collected and analyzed in Task 1. The result of further research into current and innovative solutions to the size, weight, and power issue associated with military communication devices brought forth three possible solutions to this important issue. The following is a list of the possible solutions.

1. A New Nuclear Powered Satellite would improve existing military communication device efficiency by increasing the size and power of the currently used military communication network.
2. The Doherty Power Amplifier would allow military communication devices to have a more effective use of power by switching between two power amplifiers within the same communication device when necessary.
3. Envelope Tracking would provide dynamic power adjustment to the military communication device and thereby save energy for the device by matching the power usage with the output wave frequencies.

Task 3: Compare current and innovative solutions to military communication device issues

This task provided an examination of the three possible solutions in reference to how they affect the size, weight, and power usage of military communication devices. Below is a detailed analysis of the three possible solutions and the ways in which the solutions affect the ever-important issue of size, weight, and power usage.

1. Nuclear Powered Satellite

This solution focuses more on the network that makes military communication possible than the actual communication devices themselves. A new satellite system would allow for the empowerment of pre-existing military communication devices rather than merely the advent

of new devices. An example of this type of solution would be research and development of a more efficient satellite antenna that runs off nuclear energy. This solution recommends the usage of satellite stabilization techniques and high-gain antennas that would increase the satellite's possible transmission abilities but also increase the weight of the satellite and therefore require a more durable power source such as nuclear energy (Johnston 103). While this solution is not directed at individual communication devices, it would enable more effective military communication as a whole to units that must have reliable satellite data in order to organize effective battlefield tactics (103).

For the purposes of this research, the use of a new nuclear powered satellite will be analyzed by examining the way in which it addresses the issue of size, weight, and power usage of military communication devices. In the area of size, a new nuclear powered satellite would increase the overall communication network size and would by doing so allow for greater communication between pre-existing military communication devices and new satellites; however, this solution does nothing to minimize the actual size of current military communication devices. In the area of weight, a new nuclear powered satellite would do nothing to decrease the amount of weight that military personnel already have to carry. In the area of power usage, a nuclear powered satellite would possibly offer a more expansive communication network and thereby cause communication devices to use less power to transmit the same signal as beforehand. This would in a way affect the overall power usage of a communications device.

2. Doherty Power Amplifier

The second possible solution to the issue of human error and loss of human life pertains to the usage of Net-Centric military communications. The primary issue with Net-Centric communications is that the usage of power within communication devices is greatly affected, as the power usage is much greater than traditional AM/FM radio systems. One way to address this issue is by using Doherty Power Amplifier (PA) configurations. This kind of PA configuration suggests that radios contain two amplifying devices that are used in parallel in order to combine their output. This sort of PA configuration uses only one of the available two amplifying devices in order to conserve energy. For more advanced military communication needs, the second of the two amplifiers turns on automatically, doubling the efficiency of the radio and therefore adding to the usefulness of the radio. This solution would minimize the amount of power usage and improve battery life of radios by not using the full power of the radio to always emit a maximum range when the communication device is not needed (Cummins 36).

In order to examine how the Doherty Power Amplifier configuration would operate on the battlefield, it is necessary to compare the configuration system to the issue of size, weight, and power usage. In the area of size, the Doherty Power Amplifier would possibly increase the size of a military communications device, as it requires two separate power amplifiers as opposed to the traditional use of just one amplifier. In the area of weight, the Doherty Power Amplifier would increase the weight of the communications device, because the configuration system adds an extra power amplifier and therefore, more weight. In the area of power usage, the Doherty Power Amplifier actually saves energy to some extent. The way that this is

accomplished is by the use of the two power amplifiers. One amplifier is used for short-range communication while the other is used for long-range communication. This allows for differing power outputs for different tactical situations.

3. Envelope Tracking

The third solution is using envelope tracking to modify the power efficiency of military communication devices. Envelope tracking suggests that the easiest way to minimize the amount of energy used in communication devices is to track the amount of power used with the radio signal envelope. The way envelope tracking is implemented results in the amount of power that the device uses matching the frequency of the radio signal being sent forth. The dynamic power adjustment associated with envelope tracking prohibits the additional power that is normally put out by the radio from being converted into heat. The radio puts off a definite amount of power while the amplifier is only able to use so much of the power that is put out. By causing the amount of power used to mirror the usage of necessary amplification, the overall use of power is decreased and the battery life of the device is prolonged (Cummins 36). As envelope tracking can be a difficult concept to grasp, I have included an extended definition of this interesting concept.

To understand the overall usefulness of envelope tracking, one must examine how envelope tracking compares to the areas of size, weight, and power usage. In the area of size, envelope tracking would not create a smaller military communication device, as the envelope tracking technology would take the place of the already used power amplifier system. In the area of weight, envelope tracking would minimize the overall weight of communication devices, as the envelope tracking technology is smaller and weights less than existing power amplifiers currently within military communication devices. In the area of power usage, envelope tracking dynamically adjusts to match the needed level of power for the frequencies to be transmitted effectively and thereby has a better power usage.

Conclusion

With the results of the research having been compiled and presented, it is now possible to assess the usefulness of the three possible solutions. The usefulness of a solution is determined by how well a given solution aligns itself with the three criteria presented earlier in the report: size, weight, and power usage. Size is a very important part of examining the usefulness of a solution to military communication devices because military personnel have limited space to hold onto their communication devices. Weight is important because military personnel need to be able to move effectively with their communication devices without getting slowed down. Power usage is necessary to the usefulness of military communication devices. Power usage determines if a communication device is able to remain in contact with directing forces outside and inside the battlefield environment. If this critical component is not useful, then the device is most oftentimes not feasible.

The solution of using a new nuclear powered satellite is an interesting solution to consider. A nuclear powered satellite with enhanced antennas would allow for a larger communications network and could possibly affect the power usage of military communication devices; however, the satellite itself does not address the issues of size and weight of already bulky and heavy military communication devices nor does it guarantee a decrease in power usage.

The Doherty Power Amplifier configurations offer some insightful benefits to military communication devices. The Doherty Power Amplification system allows for two power amplifiers to be within a single device. One amplifier is used for short range communication while the other is used for long range communication. This solves the problem of excessive power usage to some extent but can still result in excessive use of power in some situations. The size and weight issue are also affected by the use of the Doherty Power Amplification system; however, the way in which the Doherty Power Amplification system affects communication devices is not a positive thing. The Doherty Power Amplification system uses more space and also adds another power amplifier to military communication devices. This means that more weight is added to the device, making it heavier and larger to carry.

Envelope tracking is an interesting and innovative way of dealing with issues specific to the size, weight, and power usage of military communication devices. Envelope tracking uses a system that adjusts the amount of power put out to the frequency that is required to send a transmission via the communication device, which allows the communication device to only use as much power as is necessary in order to transmit the proper signal. This means that very little of the power is converted into heat which can be harmful to the device. Envelope tracking properly regulates power usage and also minimizes weight of a communications device. The only area that is not affected by the use of envelope tracking is the area of size. The envelope tracking system will take the place of the existing power amplifier and add no additional size to the communication device.

Recommendations

Now that the results of the comparison and contrast of the three possible solutions have been presented and analyzed, I am now able to present my recommendations for further research and development in one of the three possible solutions. The solution with the most promising benefits in the areas of size, weight, and power usage will be presented in this section. As I have been researching this subject for some time now and have been studying the subject of communications for four years, I am adequately qualified to suggest further research and development into the solution that is most feasible.

When examining the possibility of a nuclear powered satellite that could be used to improve the quality of military communication devices, problems were raised when dealing with the usefulness of such a technology. While advancements in this kind of technology would no doubt be beneficial on a wide scale, the issue of faulty military communication devices would not be greatly affected by development of this technology. The satellite systems that are already in place offer a great range of ability to the armed forces, but the communication devices themselves have yet to tap into the potential of the network that is available to them. As this solution does not properly address the issues of size, weight, and power usage of military communication devices, I must recommend that the Umbrella Corporation does not move forward with research and development of this solution.

The second of the three possible solutions is the implementation of the Doherty Power Amplification system. The Doherty Power Amplification system would save in the area of power usage of military communication devices by allowing for differing levels of power usage for different ranges of communication; however, this still results in excess energy being used in order to transmit radio frequencies. While initially this solution displayed promise, the way in which the Doherty Power Amplification system affects the areas of weight and size of military communication devices was unsettling. As the Doherty Power Amplification system involves the use of two power amplifiers as opposed to the traditional setting of one power amplifier, the Doherty Power Amplification system increases both the weight and size of military communication devices. These two areas are critical to military personnel in the field of battle and should not be a point of compromise. As the Doherty Power Amplification system does not properly meet all of the required criteria of size, weight, and power usage, I must recommend that the Umbrella Corporation does not move forward with research and development of this solution.

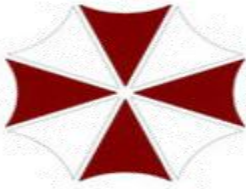
The third and final possible solution is an innovative solution known as envelope tracking. Envelope tracking holds up very well when compared with the criteria of size, weight, and power usage. Envelope tracking increases power usage by dynamically adjusting the amount of power output to the frequencies that are being emitted by the communication device. This minimizes the amount of power usage of the communication device and also increases battery life of the device. In the area of size, the envelope tracking system would take the place of the current power amplifier systems within communication devices and would not decrease the size of the device. It is important to note that the device's size would also not be increased as most power amplifiers are the same size as the envelope tracking system. In the area of weight, the envelope tracking system is significantly lighter than current power amplifiers and would therefore

decrease the weight of communication devices. As the envelope tracking system measures high in the three areas of size, weight, and power usage, I must recommend that the Umbrella Corporation seriously and strongly consider the envelope tracking system for further research and development. This technology could quickly and efficiently benefit military personnel both on and off the battlefield and would also benefit the Umbrella Corporation financially and philanthropically. The sooner that this system is further developed the sooner that human error and loss of human life can be greatly minimized on the field of battle.

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Appendix A: Internal Proposal Memo



UMBRELLA
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Internal Memo

Date: January 19, 2011
To: Dr. William Birkin, Director of Research and New Innovations
cc: David M. Merchant, Facilitator for Proposal Project
From: Jon Wages, College Intern
Re: Proposal for Feasibility Study on Military Communications Research

Purpose

The purpose of this proposal is to report on the problem of human error and the loss of human life on the battlefield and to request permission and funding for further research into this very important area.

Introduction

This memo is seeking approval and authorization to conduct a study into the problem of human error and loss of human life on the battlefield because of faulty military communications. The problem of human error and loss of human life on the battlefield has been an issue that has plagued humankind for centuries. Technology of weaponry has improved and became more advanced as time has passed; however, the technology involved within the area of military communications has always developed more slowly. The gap between powerful, new weaponry and aged, ineffective military communication devices (MCDs) has caused many issues for not only the command centers of the armed forces that issue orders, plans, and commands but also for the troops that are on the ground in the midst of battle.

As my family has a rich history of military service ranging across various branches of the United States Armed Forces, the issue of human error and the loss of human life on the battlefield is very close to me. Every day that this issue is ignored by research and development teams is another day that soldiers can possibly die due to faulty communication. The last ten years have produced little advancement in military communications; however, the civilian market has seen numerous innovations in the area of communication devices and has been experiencing an all time high in advancements. This has shown a lack of development of proper military communication technologies, and the world is asking for new solutions to come onto the scene.

My education has taught me the value of communication and the importance of identifying faulty communication patterns that hinder the ability to communicate effectively. While

interning for the Umbrella Corporation, I am also pursuing my bachelors of arts in Speech and Communications. Because this is my senior year and I will be graduating in the spring, I have completed almost all of my undergraduate work. My studies in the discipline of communications have equipped me with an increased ability to analyze communicative patterns ranging from everyday life to organizational communication to communication that takes place on the battlefield. My discipline has taught me that a large part of communications is affected by where that communication takes place. The communication in the office is not the same as on the battlefield, and as such, different communication issues have different solutions based on their respective environment. This shows the need for MCDs to be more effective than other devices as well as more durable and more powerful.

Current Situation

While it is beneficial to know what a problem is, that information is useless unless a cause for that problem can be identified. The primary cause of human error and loss of human life on the battlefield is faulty communication devices. Most current MCDs only account for audio and data transmission. The coming generation of MCDs will be able to transmit audio, video, and data throughout the battlefield and are being called Net-Centric communications. Though there have been new developments in this area by the United States' Joint Tactical Radio System program, these advancements have come at the price of size, weight, and efficiency. As is stated by Shaun Cummins, "Power density of the new radios can be worse than the established frequency hopping AM/FM technology by a factor of four, with a negative impact on the Size, Weight and Power (SWaP) envelope of the communications systems a vehicle-borne or dismounted unit needs to carry" (Cummins 30). So while the advances in military communications are needed, they must be practical. This is not to say that advances are not being made in the area of size, weight, and power usage; however, the advances that have been implemented almost always result in a lessening of the device's ability to operate at an effective capacity (Cummins 30). So an effective solution would then offer maximum efficiency and operating capacity while still being of practical size, manageable weight, and effective power usage.

Possible Solutions

Research and development teams have been examining innovative solutions in an effort to produce the most effective MCDs. While no one solution is perfect, these solutions are showing promise in the field of military communications. Furthermore, these solutions appear to need only more time and money to become effective and practical.

The first of these new solutions is to focus more on the actual network itself than on the devices that military units carry. This approach focuses on making advances in satellite technology that has a greater reach and output capability and therefore can lessen the demand for new innovations in MCDs by optimizing the use of already available technologies. An example of this type of solution would be research and development of a more efficient satellite antenna. This solution recommends the usage of satellite stabilization techniques and high-gain antennas that would increase the satellite's possible transmission abilities but also increase the weight of the satellite and therefore require a more durable power source such as

nuclear energy (Johnston 103). While this solution is not directed at individual communication devices, it would enable more effective military communication as a whole to units that must have reliable satellite data in order to organize effective battlefield tactics (Johnston 103).

The next possible avenue of research pertains to the usage of Net-Centric military communications. The primary issue with these forms of communication is that the power density is much lower than traditional AM/FM radio systems. Some research and development teams are addressing this issue by suggesting the use of Doherty Power Amplifier (PA) configurations. This kind of PA configuration suggests that radios contain two amplifying devices that are used in parallel in order to combine their output. This sort of PA configuration uses only one of the available two amplifying devices in order to conserve energy. For more advanced military communication needs, the second of the two amplifiers is turned on automatically, doubling the efficiency of the radio, and therefore adding to the usefulness of the radio. This solution would minimize the amount of power usage and improve battery life of radios by not using the full power of the radio to always emit a maximum range when the communication device is not needed (Cummins 36).

The third of the possible solutions that are being currently researched and developed in the realm of military communications is using envelope tracking as a form of modifying the power efficiency of a MCD. This solution suggests that the easiest way to minimize the amount of energy used in communication devices is to track the amount of power used with the radio signal envelope. This basically suggests that the amount of power that the device uses depends on the radio signal being sent forth. This prohibits the additional power that is normally put out by the radio from being converting into heat. The radio puts off a definite amount of power while the amplifier is only able to use so much of the power that is put out. By causing the amount of power used to mirror the usage of necessary amplification, the overall use of power is decreased and the battery life of the device is prolonged (Cummins 36).

Scope

As this research has many possible avenues for development and further inquiry, it is necessary to limit the extent of the research to the most beneficial areas of development for both the company's interests and the interests of the intended users of such new developments. It is important that the research affect areas that are most relevant to the problem; therefore, the research will only cover the area of size, weight, and power (SWaP) of military devices. As many of the current innovations in MCDs are making leaps and bounds in the area of technological success, greater attention needs to be given to making these new technologies more practical to the typical military unit. This focus of research and development will allow for increased productivity of military units at a sooner time and therefore result in fewer human errors and less loss of human life.

Context of Research

In order to gain a more in-depth look at the area of military communications it is important to include the procedure for further examination into this area. The primary focus on the research will be on the area of military communications with a focus of the size, weight, and power usage of MCDs. Most of the research will be coming from peer-reviewed, scholarly, military communication-based journals and reputable online government-based sources. This will ensure a high level of valid information regarding the topic of research. This research will give new light to the importance of managing the size, weight, and power usage of communication devices as well as provide possible solutions for these issues. This would provide a firm foundation for the Umbrella Corporation is in its further research into the size, weight, and power usage of MCDs.

The following sections of this proposal will include a project plan that will outline what I intend to accomplish through this research: a qualifications section that will detail the skill sets that make me capable to perform this project, a cost section that will state a proposed budget for this research, and the benefits that the Umbrella Corporation and military units will gain from further research into this area.

Project Plan

The list of tasks stated below is a plan that I intend to follow as I research the possible solutions to faulty military communications and the benefits that the Umbrella Corporation will gain by researching this problem.

- ***Task 1: Research use of current MCDs***
For this task, I will use peer-reviewed, scholarly journal sources as well as government-endorsed websites to research current military communications devices. These sources will also supply me with the benefits of current military communications devices. While showing the benefits for current devices, my sources will also detail the shortcomings of current devices.
- ***Task 2: Research current and innovative solutions to SWaP issues***
In this task, I will focus on using scholarly, military technology journals in order to find the most relevant and innovative solutions to current issues plaguing MCDs. Solutions currently being used to solve military communications device issues will also be researched.
- ***Task 3: Compare current and innovative solutions to MCD issues***
This task will compare and contrast current and innovative solutions to MCD issues based on the following three equally important criteria:
 4. Power Usage: While many solutions have come forth, most do not maintain high efficiency of power usage.
 5. Weight: If a possible solution adds weight to current devices, the solution might need to be developed further in order to be efficient.
 6. Size: A solution must be small enough to help minimize the carrying space.

- **Task 4: Compare usefulness of solutions analyzed in Task 3**
This task will use the information gained from Task 3 to compare and contrast the possible innovative solutions. This will enable the researcher to continue forward in the most efficient manner.
- **Task 5: Suggest best solution to MCD issue**
Once the research is complete, I will make a recommendation as to which solution should be pursued via further research and development. Should a solution be found viable, I will suggest that the Umbrella Corporation proceed in researching said solution and continue on to its development.
- **Task 6: Develop analytical report**
Should my proposal to research current and innovative solutions be approved, I have a finished version of an analytical report within six weeks.

Gantt Chart Timeline

The following chart illustrates the dates by which tasks are expected to be completed.

Research Schedule						
Tasks	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
1-Research use of current MCDs						
2-Research current and innovative solutions to SWaP issues						
3- Compare current and innovative solutions to MCD issues						
4-Compare usefulness of solutions analyzed in Task 3						
5-Suggest best solution to MCD issue						
6-Develop analytical report						

Qualifications

I am qualified to research this topic and write on this issue due to numerous factors. First, I am a senior at Louisiana Tech University and my major is in Communications with a minor in English. This has prepared me to address issues that arise in such situations involving research and development. My researching abilities have been honed through many quarters

that have forced me to research detailed topics within the field of communications. I have been actively involved in research since my first year of college. My English minor has also enabled me to be an effective writer also. I have always earned As in my English classes, and this has in large part been due to my writing ability. I am skilled in effective problem solving and enjoy challenging situations as well. My education at Louisiana Tech University has equipped me with problem solving skills by immersing me in challenging and innovative classroom learning exercises. I am also skilled specifically in the area of communications as I have been studying it for four years. My discipline has equipped me with knowledge that is specific to the field of research that this project is focused on. All of these qualifications combined enable me to be an effective researcher in the field of military communications.

Cost and Benefits

Cost

The budget table below shows the expected expenses associated with continued research into these areas should the proposed research be found favorable to the Umbrella Corporation. The labor section is to account for the cost of hiring additional qualified researchers that are familiar to the military communications field. The travel section of the budget will include a round trip plane ticket from Monroe, Louisiana to Rapid City Regional Airport, South Dakota, a rental car, and gas. The lodging section of the budget will account for the hotel room and food for the three days. The technology section of the budget is for a laptop to help conduct research.

Budget	
	Cost
Labor	\$1000
Travel	\$1250
Lodging	\$500
Technology	\$1000

Benefits

While cost is a very important factor in research, the benefits of research are equally as important. The benefits that are associated with pursuing these innovative solutions in the area of MCDs are two fold. Should research into the proposed area be successful and development of innovative solutions is viable, the Umbrella Corporation would be in a position that few other companies are in and this would allow the Umbrella Corporation to pave the way in innovative MCDs. Furthermore, this would also mean a sizable amount of money being made from possible successes in this field. While the fiscal benefits to the Umbrella Corporation are obvious and fairly immediate, the benefits to the United States Armed Forces would also be very great. Improvements in MCD technology would allow for greater flexibility of maneuvers, a decrease in human error, and ultimately and most importantly a drop in loss of human lives due to faulty military communications.

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19 Jan. 2011.

Appendix B: Extended Definition

Extended Definition Assignment

E303-005

Envelope Tracking

Jon Wages

January 25, 2011

What is Envelope Tracking?

Envelope tracking is a technique that improves power usage of radio frequency power amplifiers by matching the amount of voltage with the radio frequency output waves (Cummins 36). Before this exploring this concept, one must understand what power amplifiers and radio frequency output waves are and how they are related to one another.

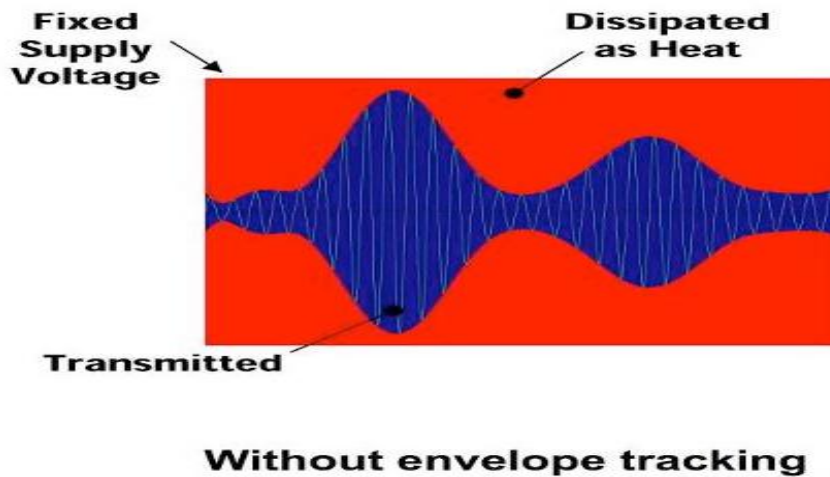
Power Amplifiers and Radio Frequency Output Waves

Power amplifiers are devices that intensify the amount of voltage sent throughout a communication device and are primarily responsible for the way communication devices use energy (35). Radio frequency output waves are the actual waves of energy that the communication device emits when the device is being used to transmit audio, video, and data (35).

Traditional Communication Devices

In traditional military communication devices, the power amplifier uses a constant supply of energy to enable the communication devices to function at 100% power output at all times. While the power amplifier is putting out 100% of available power, the communication device is only able use a limited amount of the available power in order to transmit radio frequencies. If the radio frequency output wave is only able to use 45% of the available 100% of fixed supply voltage then 65% of the supply voltage is not going to be used productively. This extra 65% of unused energy will be converted to heat. This heat is not enabling further degrees of functionality for the device and can actually cause negative effects to the communication devices. These negative effects can range from simply overheating to serious critical damage to circuits within the

device. An example of basic traditional functionality of military communication devices is provided below. The section identified as "Transmitted" represents the radio frequency output waves. The area outside of the "Transmitted" section displays the supply of power to the device and the amount of the device's power that is converted to heat.



Source: Purden, Keith. "From State of the Art RF Power Technology for Defense Systems." *Nujira.com*. 2009. Web. 24 Jan. 2011.

As one can see from examining the previous illustration, traditional military communication devices have suffered from using too much power that does not serve a helpful purpose. The solution of merely giving the communication device more power is not a valid solution as the increased power will only result in an increased amount of heat to the device itself. Even the addition of a larger antenna in order to transmit radio frequency output waves more effectively does not solve the problem for two reasons. First of all, this solution adds more weight. In addition, this solution, while able to use more energy, still does not address the issue of excess energy that produces heat. As

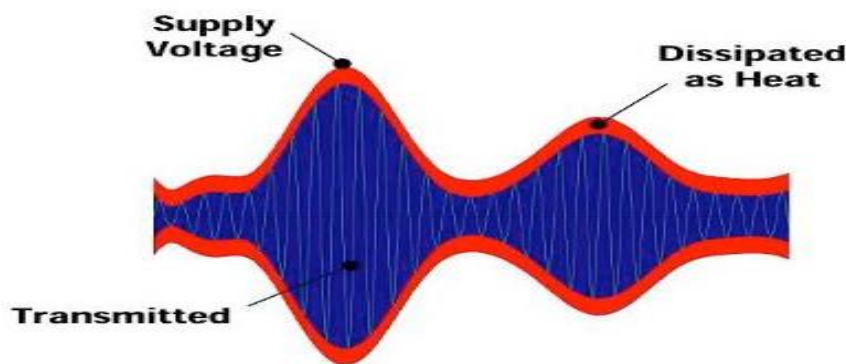
a result of this heating problem, communication devices have had to add extra cooling systems that can compromise the device's ability to withstand harsh environments.

A useful metaphor for understanding a device that does not use envelope tracking is football. In football, the team is often motivated by the cheerleaders, coaches, and the crowd. An example of a device that does not use envelope tracking would be the crowd yelling loudly, the cheerleaders constantly cheering, and the coach encouraging the team from the sidelines throughout the entire game with absolutely no breaks in their efforts. The players on the field would only be able to handle so much of this noise before it overwhelmed and distracted them. It is not an appropriate during a timeout for the crowd and cheerleaders to yell and scream uncontrollably. The players only need the encouragement when it is necessary. Like the football players, a device that does not use envelope tracking has a constant supply of energy that is not necessary and can even be harmful to the device itself. This is not the case, however, with devices that use envelope tracking.

Envelope Tracking

An innovative solution to this problem is the use of envelope tracking within the device itself. Envelope tracking is used to improve the power usage of radio frequency amplifiers. This concept was first developed in 1937 by Bell Labs; however, as with many ideas at that time, the technology researchers had access to was not able to convert this concept into reality (Cummins 30). It was not until recently that mankind has had the technology necessary to make the concept of envelope tracking into a practical reality. The way that envelope tracking operates is by adjusting the amount of voltage that the communication device is using to meet the required amount of energy

needed to put out the signal. This means that as the radio frequency wave fluctuates, the energy required to send the signal also fluctuates and saves energy. This concept is demonstrated in the illustration below. As with the other illustration, the section identified as "Transmitted" represents the radio frequency output waves. The area outside of the "Transmitted" section displays the supply of power to the device and amount of the device's power that is converted to heat.



With envelope tracking

Source: Purden, Keith. "From State of the Art RF Power Technology for Defense Systems." *Nujira.com*. 2009. Web. 24 Jan. 2011.

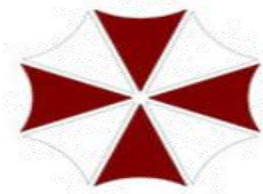
Based on the illustration above, it is easy to notice the difference between a device that does not use envelope tracking and a device that does use envelope tracking. Envelope tracking minimizes the amount of heat put off by communication devices by limiting the amount of voltage used to transmit the radio signal. By doing this the communication device is able to experience prolonged battery life in any situation. The device is also able to withstand harsh environments better due to the lack of intense heat within the device itself.

It is evident that there are great differences between devices that use envelope tracking and those that do not use envelope tracking. Devices that use envelope tracking are like a football game in which the crowd, cheerleaders, and coaches only yell and scream at times when the football team really needs the extra encouragement and energy. This results in the team noticing that the crowd, cheerleaders, and coaches are paying attention to them and attempting to pump them up. Like the football players' amount of motivation and energy, the supply of energy in a device with envelope tracking is dictated by the device's need to send a signal and as a result functions more efficiently and effectively.

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Appendix C: Progress Report



UMBRELLA
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Interoffice Memo

Progress Report

January 25, 2011

To: Dr. William Birkin, Director of Research and Innovations
From: Jon Wages, College Intern
Subject: Progress Report on Faulty Military Communications

Introduction

Since high school, I have always been interested in the area of communications and more specifically the area of military communications. After my research into the area of military communications was approved, I have been diligently gathering all available data on the subject with emphases on minimizing human error and loss of human life on the battlefield due to faulty military communications. The primary purpose of this research has been to examine the feasibility of further research and development of an innovative technology that will enable military communication devices to have a better size, weight, and power usage (SWaP) factor. This is a problem that critically needs an effective and efficient solution. Every day that this problem is not addressed is another day that a military professional could possibly lose his or her life due to faulty military communication. This is a tragedy that can be averted with more research being put into this crucial area of military communications. Currently, the research is moving forward and meeting pre-determined schedule deadlines.

Summary of Activities

At this present time, four primary, research-oriented activities have been completed. These four research-oriented activities are Research, an Internal Proposal, an Extended Definition, and a Progress Report. The Gantt Chart below will provide you with an outline of when certain activities were scheduled to begin and end. The activities in a darker shade of gray are those already completed and the activities in the light shade of gray have yet to be completed. After the chart, you will be provided with information as to what each task sought to accomplish.

	Schedule For Completion					
Task 1: Research						
Task 2: Internal Proposal						
Task 3: Extended Definition						
Task 4: Progress Report						
Task 5: Technical Report						
	4	11	18	25	1	17
	January			February		

Table 1: Scheduled Tasks Gantt Chart

The following is a list of the four tasks that have already been completed:

1. *Research*

This task took exactly one week to be brought to completion. The task involved gathering secondary, reputable sources in order to gain a more knowledgeable understanding of the problems associated with military communication devices and possible solutions to those problems.

2. *Internal Proposal*

This task required one week to complete and offered an internal proposal memo to the Director of Research and Innovations for the Umbrella Corporation, Dr. Birkin, and his facilitator, David. M. Merchant. This task involved presenting a more complete understanding of the problems associated with military communication devices, offering three possible solutions, and presenting the costs and benefits associated with pursuing this line of research.

3. *Extended Definition*

This task required one week to bring to the point of completion. This task involved examining the terms and operations associated with the proposed innovative solution. This was done via sentence definitions, extended definitions, metaphors, and illustrations of how the concept itself operates.

4. *Progress Report*

This task required one week of work. This task details the solution that was presented in the extended definition and gives a report on the tasks that have already been completed in reference to the research that is being done. This task also presents the additional task that remains to be completed, the Technical Report.

Results of Activities

Below is an explanation of the tasks that have already been completed and the results from those tasks being completed.

1. *Research*

The results of this task were the collecting and analyzing of twelve research-oriented sources. Of the twelve, five were internet sources, five were journal sources, and two were book sources. The internet sources were all from reputable, research focused government agencies or from reputable organizations that specifically deal with the area of military communications. The journal sources were obtained from peer-reviewed, scholarly military communication journals. The two book sources dealt with the area of military communications and are authored by experts within said field. Each of the twelve sources focused on the area of military communications and current problems and advances within that industry. These sources were also annotated as this allows for a brief summary of the relevance of each of the sources. The annotated bibliography for these twelve sources was submitted to David M. Merchant on January 12, 2011.

2. *Internal Proposal*

This task was completed in order to bring to the attention of the Umbrella Corporation the necessity of further research and development in the field of military communications. The internal proposal addressed the issue of human error and loss of human life on the battlefield due to faulty military communications. The proposal detailed the current situation within the field of military communications as well as offered three possible solutions to the problems with that field. The scope of the proposed project was also offered so that the necessary limitations of this project would be presented as this field of research is a wide-ranging enterprise. A project plan for the proposed research was presented in order to give an understanding of the amount of time necessary to complete this phase of research. My qualifications for this project were also offered and a section detailing the possible costs and benefits to the Umbrella Organization was also presented.

3. *Extended Definition*

This task gave an in-depth look into an innovative solution to faulty military communications. The specific term that was defined in this task was "envelope tracking." As this is a field-specific term, I also explained the concepts associated with this innovative solution. Then, I presented the model of a traditional communication device that does not use envelope tracking in order to explain what envelope tracking was not. Afterwards, I explicated how a communication device that uses envelope tracking would function. I also used metaphors to help those unfamiliar with this field to understand the problem that is being examined.

Future Activities

The final tasks to be completed for this research are the development and submittal of a technical report. This report will be a feasibility report on the possible innovative solutions to the problems currently plaguing the military communications industry. I will use the data that I have gathered from my research task as well as my extended definition to offer a more sound report. The solutions will allow me to analyze three possible solutions to the faulty military communications issue and also allow me to create criteria with which to judge the possible solutions. After analyzing these solutions, the most feasible and beneficial will emerge, and I will recommend that the Umbrella Corporation proceed with research and development of the newfound solution. The technical report will be submitted to David M. Merchant on February 17th, 2011.

In order to provide the reader with an appropriate background of the subject, I will include a summary of the current situation in reference to faulty military communication devices, the scope of my research, and an analysis of possible benefits to this kind of research. I will also include the Extended Definition and the Internal Proposal tasks within the appendices should the reader desire more information concerning my research.

Conclusion

As the four complete activities have laid a foundation for further development, my next task is the Technical Report. I am currently on schedule to complete the report within the pre-assigned time frame. Upon completing the Technical Report, I will submit the report to David M. Merchant of the Umbrella Corporation. The Technical Report will enable the Umbrella Corporation to move forward with its focus on military communications. To continue this very important research, I am requesting authorization to progress with my research unto completion. Once my findings are submitted, soldiers and their families will be able to rest easier knowing that a solution to their communication device problems has been found.

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