

White Paper

Examining the Advantages of Networking Radios for Dismounted Combat

September 2016



Since the advent of warfare, the ability to communicate clearly on the battlefield has been of paramount importance. From the trumpets and cornets of ancient Rome, to the carrier pigeons and runners of World War I, to modern software-defined radios, the ability for commanders to transmit orders to soldiers in response to a changing tactical environment is a key element of military endeavour.

It is only within the past few decades, however, that the dismounted soldier has been issued with an individual radio for communications between comrades within a squad, or section. Previously, use of hand signals and shouting was deemed adequate for the type of operations carried out within the relatively limited geographical scope of a dismounted infantry squad. The advantages of soldier radios soon became evident – primarily in enabling the close co-ordination of movements when screened or behind cover.

Soldier radios also allow combatants to discuss and evaluate complex and dynamic situations in a way that would not have been possible previously. Take, for example, two fire teams approaching an objective in rolling terrain in arrowhead formation who receive effective enemy fire and manoeuvre to dead ground as a result. If the terrain obscures line-of-sight contact between the two teams, a soldier radio can ensure the two teams can jointly evaluate the situation and take more effective action.

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Examining the constraints of traditional communication technology

Traditional soldier radios have provided point-to-point communications over a limited range – perhaps up to 800m in open terrain. While a squad would reasonably be expected to operate within these confines – not straying beyond the effective range of their primary weapons – the operational environment can have a significant impact on the useful range of a soldier radio, reducing it considerably from the notional 800m figure.

The low power output of legacy soldier radios means that they are easily screened by natural or artificial features. This reduction in range can mean that soldiers within a squad are not able to communicate directly with each other – so messages need to be relayed manually, potentially leading to distortion of commands and certain members of the unit not receiving orders. Some newer soldier radios operate at a higher 2W output power, but tend to be wideband radios using the higher power to achieve modest ranges as the power density is low. The low power density means range for these radios is also very sensitive to the physical environment.

Networked communications

Various solutions have been proposed in order to alleviate the limitations of point-to-point radios. Some soldier radios provide an automatic rebroadcast function, enabling one radio to re-transmit a transmission that it has received from another radio. More complex devices provide mobile ad hoc network (MANET) functionality, in which each radio acts as a node and is aware of the relative locations and potential paths to other radios in order to ensure that a message is transmitted to all users on the network.

MANET solutions, while providing a more intelligent approach to a simple rebroadcast, impose a significant burden on the network as each radio must issue and receive handshakes from neighbouring radios in order to determine the path that messages should take.



Figure 1: Point-to-point communication obstructed

They can be spectrum and power hungry as a result, leading to the need for more batteries (and more weight) to cover a mission. In addition, MANET radios are expensive – something that may deter even developed nations from equipping each and every soldier with this level of capability.

Other radios exist that provide a middle way between rebroadcast and true MANET solutions. For example, intelligent networking waveforms maintain a frequently updated picture of who is where in the network. The best route for re-transmission is always known. This maintains communication as team members move in and out of any shielding resulting from terrain features that prevent direct communication between them. Combining this approach with a limited number of hops reduces broadcast traffic and network management overhead to provide the best communication coverage within the bandwidth available. For the kind of short-range communications needed within a dismounted infantry squad, simulation and real trials have shown that three hops is the optimal networking complexity needed to ensure coverage between soldiers within the usual confines of a squad-level operation, even in the most demanding environments.

Networking benefits for the dismounted soldier

The benefits of networking radios for dismounted soldier communications are two-fold. Firstly, they can extend the operational range of the radio in question. If the point-to-point range of a soldier radio is up to 1 km in open terrain, then three hops enable this to be extended to a theoretical 3km. Clearly this goes beyond the usual operational range of a section, and it is unlikely that one would deploy one's soldiers in such a strung-out formation, but the advantages that this can bring in environments where the range is attenuated by buildings, trees and the suchlike are significant.

An example of the utility of this can be illustrated in Figure 2, which depicts an assault on a key objective:

In the picture, a squad of twelve soldiers splits into three fire teams. Each of the fire teams occupies positions within dead ground (i.e. an area of ground that is outside the line of sight of the objective) with Fire Team 1 and Fire Team 3 not able to maintain line of sight with each other due to obstruction by urban buildings and trees. With a point-to-point radio, given the undulating terrain and distances involved, Fire Team 1 would have to ask for transmissions to Fire Team 3 to be rebroadcast manually by Fire Team 2.

However, in this instance, a networking radio would extend the effective range of communication of Fire Team 1 and enable all soldiers to remain in contact with one another. Of greater relevance to dismounted infantry operations is the additional resilience that networking radios provide. In an urban operation, the ability for a message to hop several times from one radio to another means that communications are more likely to be maintained where buildings and other obstacles exist.

Another scenario can here be used to elaborate on the utility of networking:

The disposition of the soldiers in the image to the right is characteristic of an operation to seal off a street in an urban environment. The soldiers positioned at Point A are not able to directly communicate with those at Point C.

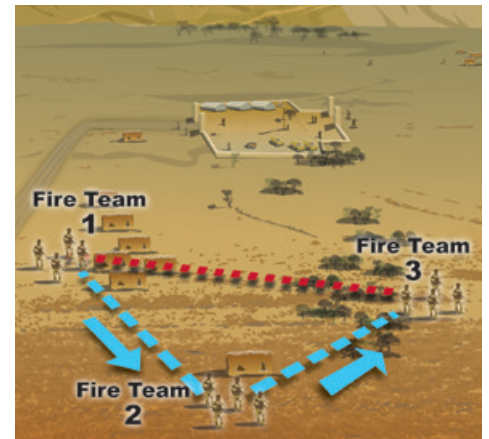


Figure 2: Fire teams utilising networking radios

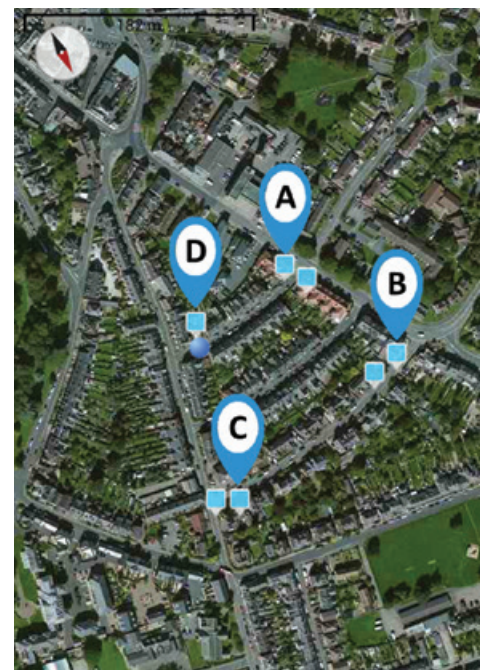


Figure 3: Networking radios maintaining communication despite urban obstructions

Although the range involved may be short, the density of the housing is such that the signal is sufficiently attenuated so as to render point-to-point communication impossible. With a networking radio, the message is able to hop between Point A to Point C via Points B or D.

In a more dynamic urban environment, where the relative positions of soldiers within the squad are constantly changing, the resilience that this networking offers can be invaluable in maintaining communications.

Even networking radios however need adequate point to point range to be effective. If communication points have fixed locations, networking can be used to reliably extend range. Soldiers however are continually manoeuvring and their movement cannot be constrained. If point to point radio range is poor then the burden on the network to maintain communications across the team is significant.

There is a higher likelihood that when the movement of a team member who is acting as a relay becomes shielded from communications, other team members, particularly on the edge of the network may lose communications, or the network may be split. Networking should not be seen as a substitute for point to point range performance but more as an insurance policy to provide confidence that radio communications can be maintained in the different environments in which soldiers operate – without excessive demands on either spectrum or power.

To conclude, the benefits of soldier radios have been well-proven since their introduction. That dismounted soldiers can communicate between one another has enlarged the scope for infantry to co-ordinate operations in a way that was not previously possible. However, this capability can be radically improved by providing soldiers with networking radios that extend range and provide more resilience to their communications. While a MANET solution provides this networking capability, it comes at a cost that is probably disproportionate compared to the relative benefit to dismounted infantry. Networking waveforms with a limited number of hops are therefore a more appropriate – and affordable – solution for dismounted soldier communications.

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