Delivering Broadband IP Connectivity to the Tactical Edge
ONE OF THE BIGGEST CHALLENGES FACING MODERN TACTICAL NETWORKS IS HOW TO PROVIDE VEHICLE-BASED OR DISMOUNTED UNITS WITH ACCESS TO THE SAME VOICE, VIDEO AND DATA SERVICES THAT ARE AVAILABLE ON THE FIXED NETWORK. THIS REQUIRES AN ON THE MOVE (OTM) COMMUNICATIONS SYSTEM THAT CAN PROVIDE THE HIGH LEVELS OF THROUGHPUT NECESSARY TO SATISFY THE OPERATIONAL SCENARIOS. TRADITIONAL COMBAT NET RADIOS CANNOT DO THE JOB AS THEIR DATA THROUGHPUT IS LIMITED TO A FEW 10’S OF KB/S. THE NEW AD HOC NETWORK RADIOS CLAIM TO HAVE 100’S KB/S OF THROUGHPUT, BUT HAVE BEEN SHOWN TO HAVE DISAPPOINTING PERFORMANCE. THE LIMITATIONS OF THESE SYSTEMS ARE IN THE NUMBER OF NODES SUPPORTED AND THE HIGH MANAGEMENT OVERHEAD WHICH LIMITS THE AVAILABLE THROUGHPUT.

CURRENT OTM CONNECTIVITY IS TYPICALLY DELIVERED VIA SATELLITE COMMUNICATIONS SYSTEMS. THESE SYSTEMS ARE VERY EXPENSIVE TO USE, AND ARE OFTEN LIMITED TO A 500KB/S OR 1MB/S ON-THE-MOVE THROUGHPUT. UBIQUITOUS OTM CONNECTIVITY IS THEREFORE UNAFFORDABLE AND EXTREMELY LIMITED IN BANDWIDTH FOR MOST COMMAND AND CONTROL APPLICATIONS.

THE PROBLEM INDUSTRY HAS TO SOLVE IS THE EFFECTIVE DELIVERY OF SUFFICIENT BANDWIDTH DOWN TO THE LOWEST MOBILE ECHELONS TO ENABLE COMMAND AND CONTROL AT THE TACTICAL EDGE. THIS IS ACCOMPLISHED BY LEVERAGING THE BEST TECHNOLOGIES TO PROVIDE ROBUST BROADBAND OTM CONNECTIVITY OVER WIDE AREAS.

THE WAY FORWARD

REAPING THE BENEFITS OF THE BILLIONS OF DOLLARS ALREADY INVESTED IN R&D AND STANDARDIZATION EFFORTS BY THE COMMERCIAL SECTOR, AND ADAPTING THESE OFF-THE-SHELF TECHNOLOGIES TO MEET THE RANGE, THROUGHPUT, SECURITY AND FREQUENCY REQUIREMENTS OF THE MILITARY, TIME-TO-MARKET CAN BE REDUCED AND PERFORMANCE IN THE FIELD CAN BE DRAMATICALLY IMPROVED. IN ORDER TO ENSURE SOLDIER SURVIVABILITY AND A CONSTANT LINE OF COMMUNICATIONS FROM THE EDGE OF BATTLE BACK TO THE BATTALION HEADQUARTERS, MILITARY PERSONNEL ARE LOOKING FOR EASY METHODS TO ACCESS AND SHARE REAL-TIME INFORMATION. USERS DEPLOYED IN THE FIELD INCREASINGLY EXPECT TO HAVE ACCESS TO THE SAME RICH AND INCREASINGLY POWERFUL SERVICE MIX THEY HAVE GROWN ACCustomed TO IN CIVILIAN LIFE, AND COMMANDERS HAVE SEEN THE DEMONSTRATED VALUE OF SYSTEMS LIKE TIGR, VIDEO CONFERENCING, SHARED REAL-TIME DATA, ACCESS TO HIGHLY-ACCURATE GIS DATABASES, AND FEEDS FROM DRONE AND OTHER REMOTE SENSOR SYSTEMS. ALL OF THESE FACTORS COMBINE TO DRIVE THE NEED FOR BANDWIDTH AND NETWORK CAPACITY TO EVER-INCREASING LEVELS.

COMMERCIAL OFF-THE-SHELF TECHNOLOGIES SUCH AS WIMAX AND WI-FI, WITH THEIR HIGH RELIANCE ON FIXED INFRASTRUCTURE, CANNOT DELIVER THE DYNAMIC ON-THE-MOVE SOLUTION REQUIRED BY THE TACTICAL NETWORK. HOWEVER, WITH ADAPTATION, WIMAX AND WI-FI PRODUCTS CAN BE COMBINED AND ENHANCED TO PROVIDE A SYSTEM THAT MAINTAINS CONNECTIVITY TO VEHICLES AND BATTLEFIELD PERSONNEL, PERMITTING THE COMMANDER TO OBTAIN REAL-TIME INFORMATION AND RETAIN HIS MOST VALUED COMMAND AND CONTROL TOOLS WHILE ON THE MOVE.

THE SOLUTION ADOPTED BY ULTRA TCS INCORPORATES AND ADAPTS NEW COMMERCIAL BROADBAND TECHNOLOGIES SUCH AS WI-FI, WIMAX AND LTE TO PROVIDE AN EFFECTIVE WAY TO DELIVER COMMUNICATIONS TO THE TACTICAL EDGE WITH BI-DIRECTIONAL CAPABILITIES. IN THE PAST, SUCH A NETWORK REQUIRED THE DEPLOYMENT OF A NUMBER OF DIFFERENT TECHNOLOGIES. THE KEY IS INTEGRATING THESE PRODUCTS INTO A SYSTEM WHICH BENEFITS FROM THE SYNERGISTIC COMBINATION OF THE BEST ELEMENTS OF MULTIPLE PRODUCTS. BY PACKAGING THESE TECHNOLOGIES IN A
way suitable for military deployment, Ultra TCS is able to offer a mobile deployable system to support voice, video and data on the move at an affordable cost.

**OPERATIONAL NEEDS**

Military communications have come a long way over the last 10 to 20 years. Prior to being able to leverage commercial technology on the battlefield, the development of proprietary and custom communications systems for military missions had an extremely long cycle time. Compared to today’s commercial communication technologies, which are developed and released at an unprecedented rate, traditional military communication solutions are often obsolete by the time they reach the field.

Considered in broad context, military communications are at a tipping point. The military acknowledges they need to be more responsive when it comes to technology and are open to integrating new and/or commercial technologies to remain effective and relevant. To this end, the military is increasingly willing to deploy commercial communications technology when appropriate in order to benefit from innovations such as:

- Mobile operations with lightweight & small devices
- Availability of video and communication services and an ever increasing amount of “Apps”
- Enhanced Situational Awareness and improved Command & Control at the edge

Handheld devices and portable computers play a growing role in modern tactical communications networks due to their affordability, small footprint, and capability to receive and upload mission-critical data. Providing military and disaster relief personnel with wireless access for use in remote areas remains a challenge, as these users require technology that can be easily integrated into current platforms and can easily be deployed, retrieved, reset and re-deployed. These technologies must be ruggedized and the network they form must be resilient to provide robust capabilities down to every soldier on the battlefield.

The Battalion to Soldier communications system needs to operate in a number of different scenarios:

**Battalion to Company Command Post**

In this scenario the requirement is to provide seamless high-capacity communication between the Battalion command post and the mobile Company Command Posts. Communications range is important and in some cases aerial relay and or terrestrial meshing is required to extend the range.

**Forced Entry Operations**

With Forced Entry operations, the communications is supporting an air assault or amphibious landing. A forward operating base is established and communications is required to mobile patrols. One of the key attributes is that the system has to be self-sustaining as there is no supporting infrastructure.
Mounted Patrols

The communications requirements for mounted patrols and convoy support require reliable and reasonably high capacity communications between the highly mobile moving vehicles. Video from the front of the convoy needs to be sent to the command vehicle. One of the challenges in this type of scenario is the effects of terrain shielding and distance between the vehicles.

Civil Defense Mission

Operation in an urban environment is a challenge for most communications systems. In some cases the commercial infrastructure can be used but in others the system needs to operate completely stand alone. Cooperation and interoperability with NGO’s is required requiring gateway technology.

Extraction or Raid

In the case of extractions or raids there are few communications assets available. The operation requires communication between small groups of vehicles and the area covered is restricted to a small area of operations.

There is not one radio system that can support all of these different requirements. The Ultra TCS solution is to integrate different COTS+ solutions into a single system to effectively operate in a diverse range of operational scenarios.

TACTICAL OPERATING ENVIRONMENT CONSIDERATIONS

The tactical operating environment is harsh compared to the commercial infrastructure one. Equipment is subjected to repeated moving, setup and teardown. Environmental conditions are often harsh and may vary widely. Space in military vehicles is very restricted, as is the available power. Antenna space on the outside of the vehicles is also very limited due to the other systems competing for scarce mounting space. This means any solution must consider size, weight and power as key parameters.

In the commercial world, spectrum is purchased at a high cost and is fixed for a particular system. In the tactical environment the military allocated spectrum is shared with other systems and other coalition forces. In most countries of the world the military is being slowly forced out of the lower frequency bands by the pressure to free up spectrum for the commercial operators. This means the radios selected for tactical applications must be able to operate over a wide frequency spectrum or have a choice in the band of operation. Propagation from the vehicle is very limited due to the low antenna height and the effects of terrain shielding.

The amount of training and skill level of the military operators is very different from the maintenance staff in commercial deployments, and provisioning operations are often being performed in a hurry and under pressure. This means that military radios must be simple to operate and to maintain, particularly at the lower echelons.
Tactical radios are required to carry the IP network that supports all of the command and control, intelligence and surveillance requirements for the Command Post and patrol / reconnaissance vehicles. In the past, voice communications made up most of the command and control traffic. Today, with the increasing availability of and reliance upon situational awareness information, sensor video and collaboration tools, the bandwidth demand has increased exponentially.

**END-USER APPLICATIONS**

The increasing number of end user applications is driving the requirement for more bandwidth. Even low-level command posts require full situation awareness and a way to collaborate with the higher levels of command. The ability to view UAV video and metadata is becoming an increasing requirement as commanders demand to have full awareness of a situation before making decisions. With the advent of everything-over-IP and the common seamless network supporting the communications requirements, it becomes more important to have enough bandwidth. The move to a service oriented architecture for many command and control elements means that data services can be requested across the network. Access to detailed GIS databases for mapping and terrain data also increases the amount of data sent over the network. This service-oriented approach only works well if the network can support the transfer of large amounts of data with low latency.

**PRACTICAL SOLUTIONS USING ENHANCED COTS TECHNOLOGY**

Ultra TCS has introduced the UltraMove system to satisfy this Battalion to the Edge communications requirement. The Battalion to Brigade Communications requirements include the high-capacity reach back to the Brigade HQ, the long range high-capacity link to the Company command elements and the inter-vehicle communications for convoy and patrol operations. Ready to go at a moment’s notice and simple to operate, the system supports the voice, video data and sensor integration needs of the lower echelons.

UltraMove is a transit case based solution which packages a number of communications technologies in an efficient manner to meet the system requirements. The high-capacity backhaul link is provided by the HCR or EHCLOS radio. This platform is software defined and can support aggregate traffic rates of up to 200Mb/s over links of up to 50km.
The long range on-the-move communications capability of the UltraMove system is based on rugged 4th generation COTS equipment using the newer 802.16e WiMAX standard. The Ultra TCS HCLOS PMP-E product supports the mobile long range communications requirements of mobility with automatic affiliation and handover. One of the key features is the distributed ASN gateway for automatic handover. This allows the military vehicles to roam seamlessly between base stations in the deployed area. The long range waveform can be in the military band 3 frequency range or in the commercial WiMAX bands depending upon the frequency allocation for the system.

In the past, the military has often had disappointing results when deploying commercial WiMAX for these military applications. Early systems were based on the 802.16d standard and did not support mobility. The new 802.16e standard addresses this issue and offers advantages in uplink performance over the earlier standard. The UltraMove solution uses ruggedized equipment that is well suited to the military environment. The choice in frequency band allows the user flexibility to choose the optimum band for the system. The UltraMove system offers a choice of both military and commercial frequency bands that allows the user to place the system in the applicable frequency band. For the long range waveform, the frequency band can be selected from the following table:

<table>
<thead>
<tr>
<th>Frequency Band</th>
<th>Low Power Base Station</th>
<th>High Power Base Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>1350 – 1400 MHz</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>1400 – 1520 MHz</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>1800 – 1830 MHz</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2300 – 2400 MHz</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2496 – 2690 MHz</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3400 – 3600 MHz</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3600 – 3720 MHz</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Shorter range vehicle-to-vehicle and dismounted communications is handled using Wi-Fi technology augmented by a mesh capability to allow relaying between the vehicles to extend the range. Dismounted soldiers can use standard Wi-Fi accessories such as Android telephones and laptop computers.
The UltraMove system includes the base station elements and the vehicle equipment to ensure reliable communication in a multitude of different scenarios. The system also includes the infrastructure to interconnect the base stations in a tactical environment. Using transit case packaging, the nodes are easily transported to the operational site. High-capacity military IP radios are used to ensure the full capacity of the system is supported in the backhaul system.

In a typical configuration, the transit case at the forward operating base or Battalion HQ contains the Wi-Fi equipment for local access, an Ultra TCS Universal Gateway to link single channel radios into the VoIP network and a server to hold the C2 software. An IP switch is used to link the various COTS products. The WiMAX base station and HCR or EHCLOS radio are mast mounted and connect to the system via the IP switch. All links are secured with encryption. Control of the equipment is provided via a laptop computer mounted in the transit case.

The system carries everything over a common IP network. Telephone voice is supported using VoIP telephones and a call manager located in the server. Additional telephones can be supported using additional routing equipment which can also provide the power over Ethernet for the telephones.
The Universal Gateway product interfaces to any single channel radio and converts the radio to VoIP. This means that the radio can be accessed from anywhere in the network. Different types of radios can be bridged to allow interoperability between different radio networks. The control of the Universal Gateway can be from a dedicated console, or from any laptop connected to the IP network.

The long range link in the UltraMove system provided by the HCLOS PMP-E product is based on the WiMAX 802.16e standard providing the ability to communicate to on the move vehicles with automatic handover between base stations. The system is optimized for mobile communications using MIMO signal processing.

The vehicle equipment is mounted in a single enclosure which contains the Wi-Fi equipment, WiMAX CPE, Universal Gateway and IP switch. A VoIP telephone and a tablet computer connect to the equipment case to complete the vehicle installation.

Space within the vehicle is always limited and UltraMove has integrated all of the required system elements for a small command post in a single military enclosure. This reduces the equipment footprint for the vehicle and simplifies the installation by reducing the wiring and requiring the mounting of only one equipment case in the vehicle.

**KEY OPERATIONAL DISCRIMINATORS**

Although commercial WiMAX and Wi-Fi equipment are fairly common, the integration and packaging of these products into a well-designed, ruggedized system is much less common. What Ultra TCS has achieved is the selection of best of breed equipment and the seamless integration of these different products into a tactical communications system.

Ultra TCS has developed a universal graphical interface to allow all of the different components to be monitored and controlled from a single computer screen. This removes the extra training required to operate several different human-machine interfaces.

The integration of different types of equipment into a compact enclosure is particularly effective when it comes to the vehicle installation. Space in military vehicles is particularly scarce and any saving of installation footprint is worthwhile. Ultra TCS has skillfully integrated the WiMAX subscriber equipment, Wi-Fi, combat net radio gateway, IP switch and power distribution into a single, simple to install enclosure.

UltraMove provides an effective OTM communications system for Battalion and below that supports the high-bandwidth demands of video and C2 data distribution.
ABOUT ULTRA ELECTRONICS, TCS

Ultra Electronics, TCS is a leading supplier of tactical Line of Sight (LOS) radio relay equipment and systems and is based in Montreal, Canada. Ultra Electronics, TCS traces its roots back to the Canadian Marconi Company (CMC) when it started supplying tactical radio relay equipment to the US Army in the 1960's. In 2002 the Military Communications Division of CMC was sold to Ultra Electronics and under the name of Tactical Communication Systems, it continued its focus on providing reliable and effective LOS communications to armed forces throughout the world.

The Ultra TCS head office is located in Montreal with facilities in the United States and Ottawa. The radio development and manufacturing capability is located in the Montreal facility, with IP switching expertise in the USA and Electronic Warfare specialization in Ottawa.

Ultra TCS has a team of systems engineers and designers who are very experienced in tactical communications systems. In radio design, Ultra TCS is an expert in the field of SCA and Software Defined Radio (SDR) products with a long legacy of RF technology development. Our products are known for their superior RF and system performance.

Ultra Electronics, TCS has delivered over 23,000 AN/GRC-103 radios, 7000 AN/GRC-226 radios, 5000 AN/GRC-512 ECCM radio kits and over 5000 AN/GRC-245 radios to more than 35 countries and has established a depot repair facility to support the US Army and other customers. Ultra Electronics, TCS has contractual commitments to several governments to support our radios for 20 years and we have more than satisfied this commitment with the previous generation AN/GRC-103 radio that was supported for more than 30 years.

Ultra TCS’ latest point-to-point products, the HCR and EHCLOS radios, are the ideal radios for modern area communications systems and can easily be reconfigured to operate in a multitude of different tactical environments. Using the Ultra TCS HCR and EHCLOS radios, various waveforms can be selected to support a large number of different missions. Effective ECCM is provided using frequency hopping at 2000 hops/second, diversity and error correction when required.

Ultra TCS has built a team of engineers with world-class experience in OFDM systems and solutions for on the move communications. Our systems engineers integrate these products with IP switches, encryption and gateway/access products to offer turnkey system solutions.

For more information on UltraMove, and other Ultra Electronics, TCS products, please visit: www.ultra-tcs.com