BMS Digital Microwave Solutions for National Security & Defense
I. Introduction

People have become accustomed to viewing video from the most remote corners of the globe on their TV’s and computers. Although this capability may be taken for granted, it still requires a feat of technology, engineering, and integration to record and deliver quality video in real time from anywhere. Broadcast Microwave Systems, Inc. (BMS) has taken the lead in developing an extensive digital product line for the mobile encoding and microwave transmission of video and audio. BMS also provides the system integration services necessary to deliver a complete solution according to the requirements of the customer.

Versatility and quality are the hallmarks of BMS system solutions. BMS products have been networked into comprehensive government surveillance systems that span large geographical areas on land and sea. BMS systems are also designed for law enforcement, public safety, military, electronic news gathering, and entertainment applications. Examples include the encoding and transmission of video from fixed wing and helicopter aircraft, ships, mobile vans, stationary cameras, and even from the backpacks of reporters and military personnel.

The purpose of this document is to describe in more detail the benefits of BMS solutions tailored for government applications of security and defense systems.
II. COFDM Technology Overview

Digital microwave is the most efficient and secure transport medium for the increasing number of applications and volume of users for wireless video transmission. Digital microwave transmission offers many advantages over analog systems, including enhanced security, capacity, and the quality of reception on stationary or mobile receivers.

BMS has selected Coded Orthogonal Frequency Division Multiplexing (COFDM) as the most effective digital modulation technology for its terrestrial microwave products. COFDM involves modulating the data onto a large number of carriers and is well suited for advanced communications networks that require resistance to multipath propagation (see Figure 1). This is essential for advanced video communications systems that require a guaranteed quality of service. As a result, COFDM operates effectively through walls, around corners, and does not require a direct line of sight. The advantage of a robust signal in the most difficult of RF environments makes COFDM an obvious choice for the defense industry. For a more detailed explanation of COFDM refer to the Bibliography at the end of this document.

For the BMS digital microwave product suite, BMS has coupled its COFDM technology with the DVB-T standard for terrestrial digital video broadcasting. DVB-T has been well established as a standard by ETSI in Europe and has now been field tested and implemented throughout the world. By choosing to adhere to the DVB-T standard, BMS products are compatible and interoperable with digital products from other manufacturers that are compliant with DVB-T. Interoperability and vendor independence is an important requirement of many BMS customers. The adherence to standards also reduces development costs as well as the price to the customer.

Another well established video compression standard in the broadcast industry is MPEG-2. In fact, MPEG-2 is the specified video compression standard within the DVB-T standard. Therefore, all digital video encoding and decoding in the BMS product line adhere to MPEG-2, which provides consistent video and audio performance. This makes BMS products interoperable and available at a lower cost for the same reasons explained for DVB-T. In the future, BMS intends to support other digital encoding standards such as MPEG-4, H.263, and H.264 as they become more widely adopted for applications in industry and government.

Because of obstacles and reflectors the transmitted signal arrives at the receiver from various directions over multiple paths. Multipath causes fluctuations in amplitude and phase as well as time delays in the received signals. COFDM can accommodate Non-line-of-sight transmission with high levels of multipath propagation and still deliver a quality signal.

*Figure 1: Multipath*
III. Video Communications Systems for Security & Defense

In addition to the deployment of BMS digital microwave systems for mobile television broadcasting, BMS systems are also used by local, state, federal, and international agencies to secure the safety and defense of communities, regions, and entire nations. This section describes some solution scenarios and architecture considerations for the implementation of BMS systems to provide secure and mobile video surveillance over small or large areas of sea and land.

Following is a sampling of security and defense applications for which an integrated BMS system provides video, audio, and strategic information.

- Search & Rescue
- Surveillance
  - Borders
  - Coastlines
  - Military installations
  - Strategic sites
- Reconnaissance
- Battle Assessment
- Unmanned Aerial Vehicle (UAV) remote imaging
- Field training

Although other technologies are available, such as traditional satellite systems, BMS digital microwave systems provide distinct advantages for security and defense applications:

- Improved clarity
- Accuracy
- Redundancy
- Reduced latency
- Lower cost
- Increased flexibility
- Reduced weight
- Smaller size

The precision required for most security and defense applications will dictate the need for a robust, secure digital microwave technology. BMS systems mounted on air, sea, and ground vehicles are deployed to attain critical information from a safe distance. Video, audio, and accurate map coordinates can be transmitted in real time to a central command center in order to analyze and react quickly to suspicious, volatile, or perilous situations.

BMS security and defense systems can be implemented as standalone surveillance systems or integrated into large-scale, multipurpose systems. For example, small systems may be configured for simple video capture, encoding, and transmission to short range receive sites. Larger systems may involve both stationary and mobile relay receive sites over large geographical regions, with data being consolidated, analyzed, and distributed from a central command station.

The systems are architected according to the scope, complexity, and objectives of the applications. The following three scenarios describe some considerations and architectures for security and defense systems. (See the appendix of this document for the basic equipment requirements for the following scenarios).
Scenario 1: Sample BMS Ground, Sea, and Aerial Surveillance System

Figure 2 illustrates a BMS national defense system that captures video across large areas from aircraft, ships, and individuals or vehicles on the ground. The video is relayed over secure links to a central command center and remote viewing sites. The capabilities and functionality of this system will be described in more detail.

The overall objective of this surveillance system is to provide secure, real time video, audio, and data intelligence from multiple sources to a central command center. The command center uses the data received for analysis, consolidation, distribution and storage. The video and data transmitted to the command center provides a comprehensive view of what is occurring at the scenes being recorded in order to make well-informed decisions.

*Figure 2: Surveillance System for National Security & Defense*

**System Functionality**

1. Video/Audio/Data Capture & Transmission
   - Video is captured and transmitted from unmanned aerial vehicles (UAV), helicopters, ships, ground transport vehicles, and ground reconnaissance troops.
   - Wireless transmission accommodated without data degradation up to distances of 200 miles (320 kilometers) to receive sites.
   - Ground reconnaissance personnel are able to capture and transmit video from portable, hand-carried cameras.
• The moving map geographical data of the video captured from the UAVs and helicopters is computed and transmitted.
• The GPS coordinates of the UAVs, helicopters, ships, and hand-carried cameras are captured and transmitted.
• On helicopter installations, the cockpit audio is transmitted along with the video and geographic data.
• On ship installations, the designated onboard personnel’s audio is transmitted along with the video and geographical data.

2. Receive Sites
• Receive sites are unmanned and fully automated for maximum performance.
• Steerable antennas automatically adjust to changes in transmitter location based on GPS coordinates.
• Multiplexing of all data for transport over fiber links to command center.
• Command center remotely monitors and receives diagnostics from receive sites.

3. Command Center
• Receive and decrypt secured data from all receive sites.
• Ethernet conversion of ASI video and audio.
• Optional RAID storage of all or selected video and audio.
• Determine how and which video is viewed real time.
• Display video on wall monitors in selected sizes and configurations.
• Display video transmission source locations on moving map.
• Distribute selected video, audio, and map data to authorized remote fixed-video viewing stations over secure fiber links.
• Distribute selected video, audio, and map data to authorized remote mobile-video stations over secure wireless links.
• Convert digital video to analog as additional backup.

4. System Quality
• All video is captured and delivered to a command center in real time (i.e., minimal latency tolerance).
• Adequate network redundancy is provided to ensure failover from receive sites that are congested or damaged.
• Transmitters mounted on helicopters and ships are electronically adjustable for frequencies and antenna positioning.
• Helicopters and ships are equipped with handheld control units to do the following:
  - Select and point transmitter to receive sites
  - Select the frequency of the transmitter
  - Control the pin code of the transmitter
• All transmitter and receiver equipment is built to handle rugged motion and severe weather conditions.
• System is scalable to handle:
  - a substantial increase in video encoding sources
  - Remote controlled pan/tilt/zoom capabilities of cameras mounted on UAVs and other unmanned camera sites.
  - Increased ranges of wireless video transmission to receive sites.

5. System Security
• All video, audio, and geographic data is encrypted throughout transmission.
• Live video access and viewing has multiple security levels determined at the command center.
• Access to stored RAID files are password protected by the command center and has multiple viewing security levels.
Remote viewing sites require password authorization.

Scenario 2: Advanced Mobile Relay System Capabilities

In a more complex system, some of the transmission aircraft, ships and vehicles can be equipped to provide a dual function as relay stations for video transmitted from other sites. Each mobile relay station will multiplex its own on-board video with the video received from other remote transmitters and direct all the data to a fixed receive site. This dual function as a source transmission site and a relay station affords the following advantages:

- Transmission over wider ranges without requiring additional receive sites.
- Enhanced flexibility and mobility of the system ranges and locations
- Greater reliability when a mobile relay aircraft, ship, or vehicle needs to reroute video to an alternate receive site.

Figure 3 depicts a relay ship receiving video from another transmitter ship as well as a downlink from a UAV. The relay ship multiplexes the two videos, which may show completely different areas or different perspectives of the same area. The multiplexed videos are retransmitted to a fixed receive site where it is transported to the command center for demultiplexing, viewing, and analysis. How the information is viewed will be determined at the command center which receives the GPS coordinates of the transmitting sites as well as the map data of the video sites.

Figure 3: Sea and Air Video Surveillance Relay System
Another example, Figure 4, shows ground reconnaissance troops that are equipped with a light weight, low powered camera system that transmits over a short distance to a nearby military vehicle relay station. The relay vehicle uses a higher powered transmitter to uplink the signal to a military helicopter. Personnel in the relay vehicle can also view the video real time while it is transmitted to the helicopter. The helicopter multiplexes the video feed with its own on-board video and transmits the combined feed to a fixed received site.

Figure 4: Multiplexed Ground & Air Video Surveillance Relay System
Scenario 3: Standalone Surveillance System

Surveillance systems that exclude the use of a central command station can also be configured in a local fashion. For example, enemy military tanks advancing in low visibility weather conditions or through mountainous terrain may not be visible by ground troops, placing them in a perilous situation. Aerial video of the advancing tanks is captured by a UAV or helicopter deployed with a standalone surveillance system. The video, along with location coordinates, is transmitted via non-line-of-sight COFDM technology to the ground troops, providing immediate intelligence for ground troops to respond appropriately. Figure 5 depicts this scenario.

![Figure 5: Video Reconnaissance of Advancing Enemy Tanks](image)

IV. Conclusion

COFDM digital microwave provides clear advantages over alternative radio technologies in the delivery of video, audio, and data. These advantages are easily demonstrated over long distances and in unforgiving environments where significant multipath interference occurs.

The security and defense system scenarios shown in this document are only a sampling of the possible configurations of BMS video security and defense systems. Obvious advantages to these configurations are the mobility, flexibility and reliability that can be attained with the BMS digital microwave technology.

For over twenty years BMS has been in the business of developing high quality products for microwave applications. However, BMS is not just in the business of making microwave products; BMS is in the business of creating digital microwave solutions that are optimized to meet unique and vital security and defense requirements on land, sea, and air.

To learn more about BMS solutions and experience in providing wireless security and defense systems to vital local, state, and national programs, please inquire via email at sales@bms-inc.com or call 1-800-669-9667.
APPENDIX

Basic Equipment Requirements for BMS Security and Defense Systems

Helicopter Installations

- Solid state directional tracking antenna
- GPS receiver and antenna
- Video/audio encryption module
- Hand held controller
- Gyro-stabilization assembly
- Power amplifier
- Cockpit audio module
- BMS Newscoder (encoder and transmitter modules)
- Camera system with controller and map data

Ground Vehicle and Ship Installations

- Solid state directional tracking antenna
- GPS receiver and antenna
- Video/audio encryption module
- Power amplifier mounted on pneumatic mast (can be operated with mast up or down)
- Intercom audio module
- BMS Newscoder (encoder and transmitter modules)
- Camera system with controller and map data

UAV Installations

- Remote controlled directional antenna
- GPS receiver and antenna
- Video/audio encryption module
- Gyro-stabilization assembly
- Power amplifier
- BMS Newscoder (encoder and transmitter modules)
- Camera system with controller and map data

Ground reconnaissance personnel equipment

- Compact and lightweight BMS Carry-Coder (encoder/transmitter module)
- Camera mount or backpack
- GPS receiver
- Video encryption module
- Camera

Additional equipment for relays on helicopters, ships, and ground vehicles

- BMS Carry-Newscoder multiplex module to multiplex received video with on-board video for simultaneous transmission
- Omni-directional antenna
- BMS decoder module
- RF Filter
- GPS multiplexer

**Receive Site Installations**
- Antennas
  - High gain steerable antenna
  - Medium Gain omni-directional antenna
- Multiple receivers (expandable)
- BMS Decoders
- Tracking controller
- Modems

**Command Center**
- Decryption modules
- BMS Decoders
- Wall monitors
- SAN RAID storage system
- ASI/Ethernet converters
- Operator consoles
- IP switch
- Interactive white board
- Graphics controller
Bibliography

