At NTC realism is the key

by D. E. Getz and Maj. Charles Giasson

The Department of the Army has developed a National Training Center (NTC) at Fort Irwin, California, to train maneuver battalions in a realistic tactical environment, including electronic countermeasures and close air support. Battalions from CONUS posts are normally deployed to the NTC for two weeks of intensive field training. During this period, the battalions are issued NTC instrumented equipment and sent to the force-on-force engagement area where a numerically superior opposing force awaits. Also, during the NTC rotation, the battalions are placed on the live-fire exercise area where their ability to shoot-move-communicate against electronically controlled targets is thoroughly tested.

The NTC has installed extensive instrumentation in and around the exercise area which makes it possible to monitor and record the training activity. The "engagement" is monitored by the Multiple Integrated Laser Engagement System (MILES), which is installed on the players and their equipment. Position data of each instrumented player plus MILES engagement data are telemetered to the Operations Center for purposes of evaluation, recording, editing and exercise after-action-reviews. The rotational unit's maneuver actions are recorded by television cameras whose output is relayed to the Operations Center for inclusion into the after-action-reviews. There are approximately 600 tactical emitters in use during each rotational training period encompassing the whole of the military use of the frequency spectrum. This extensive use of the radio frequency spectrum to support tactical operations in addition to NTC instrumentation, normal post, camp, or station purposes, has resulted in unique opportunities to develop and utilize innovative spectrum management techniques. This is especially important due to other users of the electromagnetic spectrum on and around Fort Irwin.

The choice of Fort Irwin as the site for the NTC created special and unique spectrum management problems. Not only did the NTC have to be set into the Mojave Desert Area (MDA) with Edwards AFB, George AFB, China Lake Naval Weapons Center, and other DoD activities (see Figure 1), but compatibility with one of the most sensitive receiver systems in the world had to be established, the National Aeronautical and Space Administration's (NASA) Goldstone Deep Space Network (DSN). This network was also an established inhabitant of the MDA during the pre-NTC era. The receiving systems that NASA utilizes are as much as 13.2 billion times more sensitive than the AN/VRC-12 series radio receivers. This is an astounding number, but it helps to explain NASA's initial concern regarding the establishment of the NTC at Fort Irwin. Admittedly, the difference in sensitivity refers to the main antenna beam, on-frequency situation, but it raised the question regarding just how much energy the Army emitters might produce in the NASA Goldstone receive frequency band. In the past, spurious signals many Kilohertz or even Megahertz removed from the transmitted frequency really created little concern or worry. However, due to the close proximity of NTC emitters and the sensitivity of the NASA Goldstone receivers, the possible problems that can be caused by spurious emissions must be faced by the NTC and its Spectrum Manager. The initial NASA requirement for siting the NTC at Fort Irwin was a "guarantee of NO interference" from the NTC.

A Spectrum Management Engineering and Control System was designed by the DoD Electromagnetic Compati-

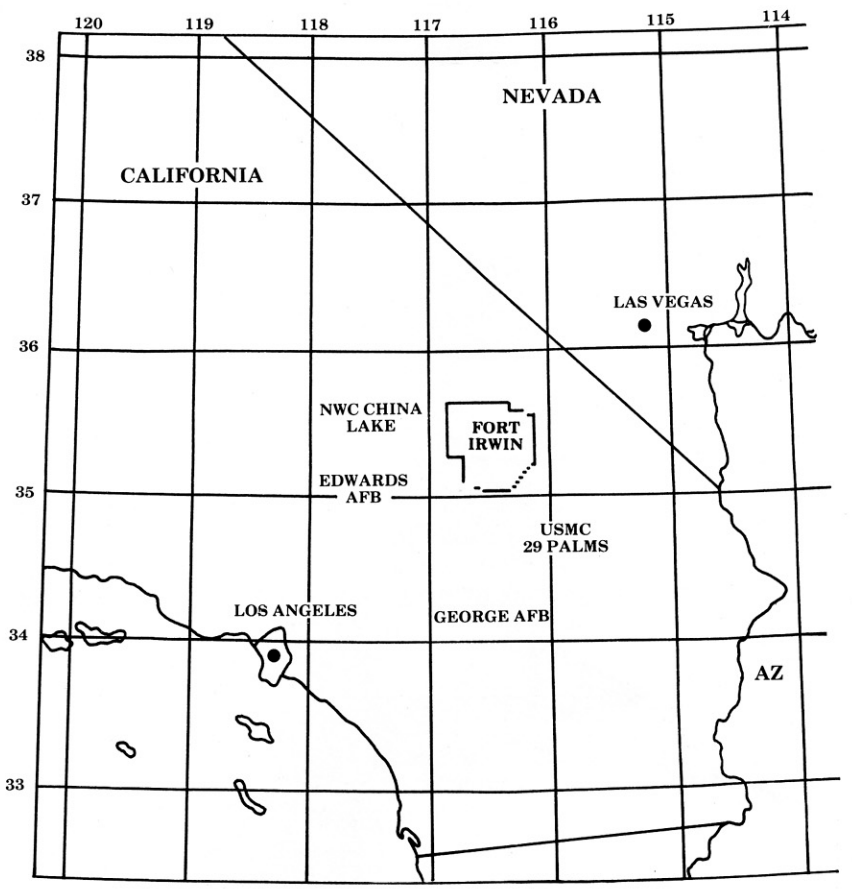

Figure 1.

bility Analysis Center for the US Army in order to comply with NASA's requirements. The system was designed in two phases with phase 1 being implemented as early as possible. Phase 1 of SMECS implementation consists of the components shown in Figure 2. This system provides the NTC Spectrum Management Office (SMO) with the capability to perform pre-exercise analysis and planning; real-time monitoring, analysis, and control; and post-exercise evaluation of spectrum usage throughout the duration of each rotational training period.

The Spectrum Analyzer System I on Tiefort Mountain is currently the heart of the spectrum management system. It allows the operators in the Operations Center to automatically or manually control the scanning of any part of the frequency spectrum between 200 kHz and 18 GHz. The operator is located 11 miles from the fixed monitoring site and has the option to make a hard paper copy of a list of frequencies and associated signal amplitudes observed from Tiefort Mountain. Additionally, the operator may rapidly generate a frequency/amplitude trace of the observed spectrum (much like the display of the spectrum analyzer) or make a larger, more detailed plot of the observed frequencies and their amplitudes. The operator also has the capability to store a trace in the computer for later plotting and further analysis. Figure 3 illustrates how the signal actually appears on the spectrum analyzer and also on the system's computer screen in the Operations Center. The particular frequencies shown in this figure are assigned to the NTC non-tactical radio system. The spike shown in the center of the screen is a received signal on 142.975 MHz at a level of -72 dBm at 1501 hrs. and represents a potential problem.

If an unauthorized use of a frequency is observed, the SMECS operator takes action through appropriate channels to identify the user and reestablish spectrum discipline and good order. The system also provides the terminal operator with the capability to remotely control directional antennas for determining the azimuth, from the monitoring site, to an emitter of interest. This mode of operation provides the communications analysts with additional details on bandwidth, signal strength, and frequency to use when called upon to resolve an interference case. The information used to monitor and control the NTC spectrum usage is also achieved and thus available to resolve interference event disputes and operational scheduling conflicts. In this way, the system assists in accomplishing the

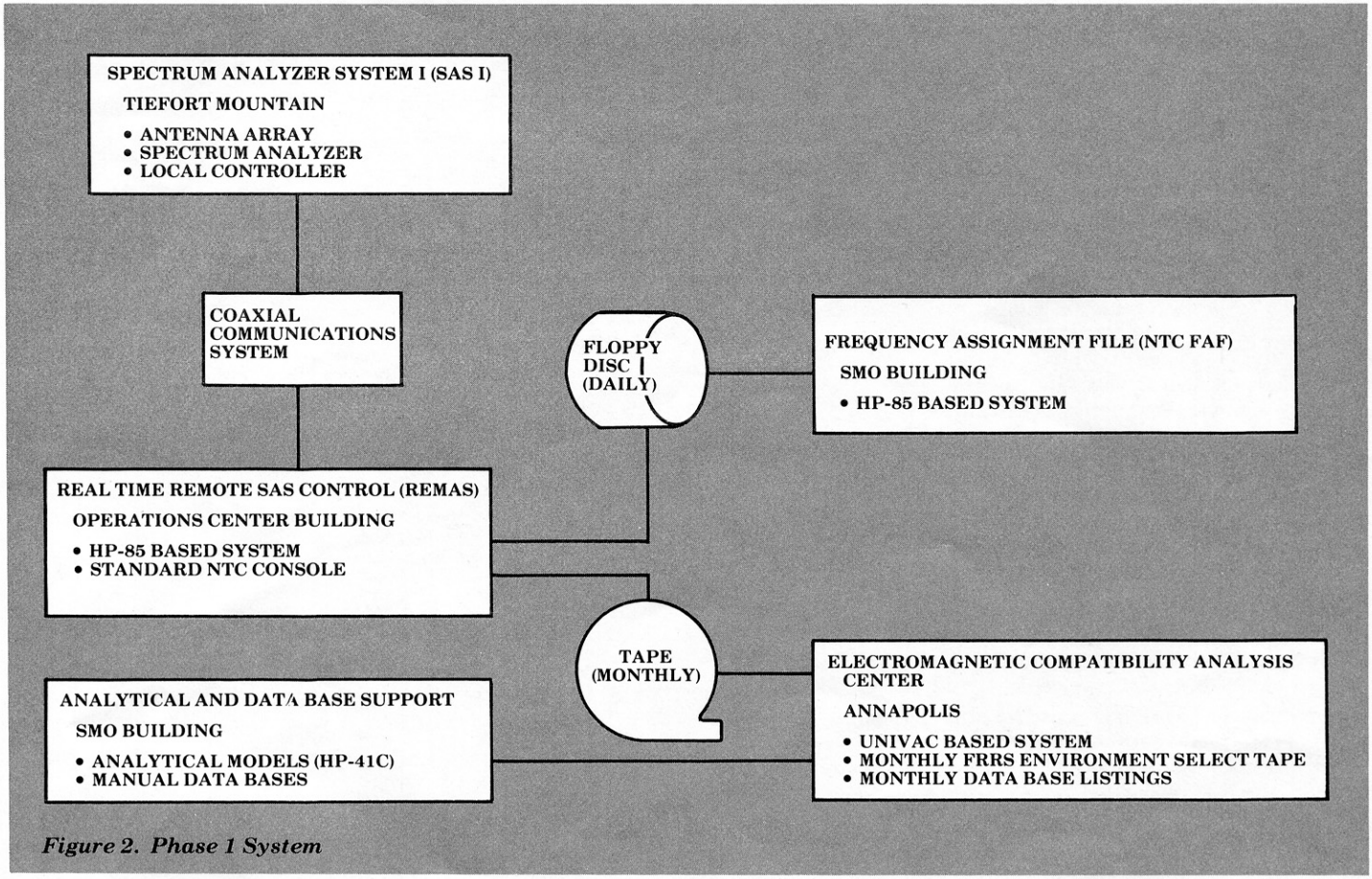

Figure 2. Phase 1 System

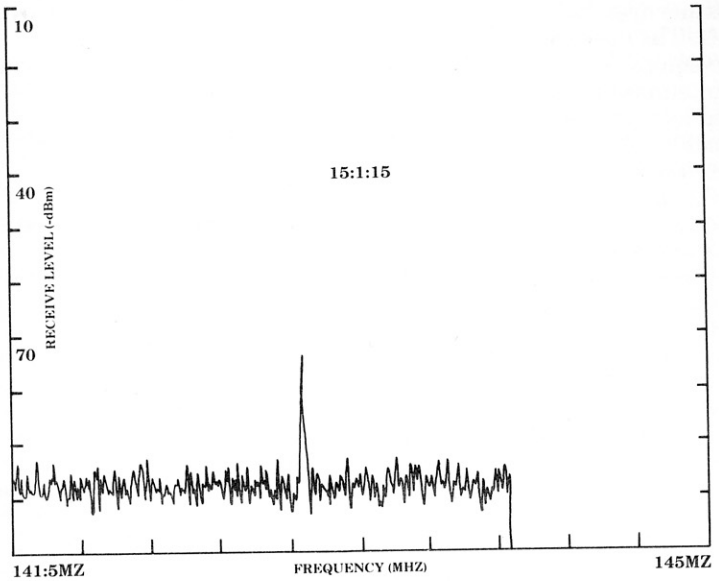

Figure 3. Sample frequency-amplitude plot

NTC training mission by allowing the necessary communications-electronics activities to continue without unwarranted and unnecessary interruptions.

The phase 2 system is currently undergoing development and is shown in Figure 4. Software to support the system is being integrated to verify intra-system compatibility. Expected delivery of the initial operational capability is 3rd quarter FY83.

The phase 2 system will provide a greatly improved capability to manage the frequency spectrum for the NTC. The system is conveniently divided in three parts in order to better execute the NTC Spectrum Management functions: (1) the Real-Time Monitoring Facility; (2) the Stand-Alone Spectrum Management Facility; and (3) the Mobile Signature Acquisition System.

The Real-Time Monitoring Facility will use a Digital Equipment Corpora-

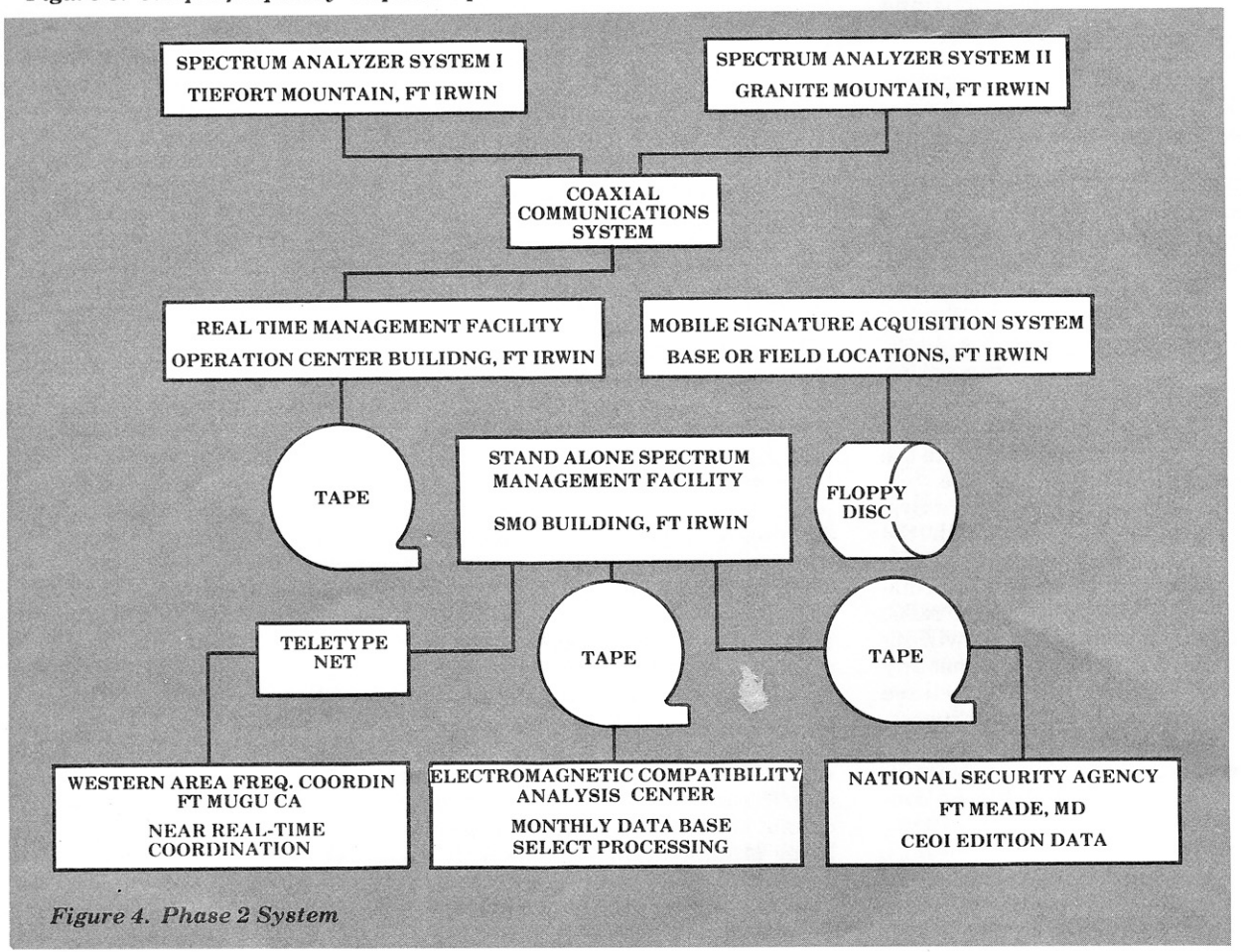

Figure 4. Phase 2 System

tion PDP-11/44 and will provide the following real-time spectrum management capability:

the ability to scan the entire spectrum in 1500 separate frequency bands.

real-time correlation of the assigned versus the observed spectrum usage.

provide for either computer or manual control of the bands observed.

provide for automatic storage of spectrum management data.

allow spectrum observation and recording from two fixed sites.

The Stand Alone Spectrum Management Facility will provide off-line support for the Real-Time and Mobile Facilities, and computer analysis support to the Spectrum Management staff. The facility will have the ECAC Frequency Resource Record System file, modified ECAC analysis models, and the NTC Frequency Assignment File to assist in spectrum management functions and analyses. The facility will provide the capability to:

provide expected spectrum data to the real-time facility.

generate daily lists of frequencies coordinated for electromagnetic compatibility activities.

generate daily lists of TABOO frequencies.

consolidate and review the real-time archived data.

perform large scale interference and compatibility analyses and predictions.

support data exchange with the real-time facility.

support, maintain, and update the NTC Frequency Assignment File.

The Mobile Spectrum Analysis System will provide the NTC with the capability to gather and store transmitter signature characteristic information on equipment used at the NTC. The spectrum signature data will include necessary information about any spurious emissions in any of the three Goldstone Bands for control purposes. The mobile system, housed in an S-141 shelter and mounted on a suitable military vehicle, will be capable of conducting either open- or closed-loop measurements. The open-loop method connects the equipment under test to the van via antennas through the air, while the closed-loop method utilizes a connecting cable. The closed-loop condition is preferred since this mode will provide the most system sensitivity. Higher-powered emissions will dictate use of the open-loop mode in order to protect the van's equipment. The mobile system could also be employed as a third monitoring site.

The spectrum signature information obtained through the use of the mobile system will be fully compatible with the real-time facility via the stand alone facility. The output will not only provide a clear "picture" of the output of tested equipment at the fundamental frequency band, but also a picture of any spurious or harmonic outputs occuring in NASA/Goldstone's bands of operation. This information will be useful when making compatibility or interference analyses and will be used in determining deployment and/or maneuvering limitations while at the NTC. The information could also be used for assessing the state of equipment performance IAW established standards, or to point out a possible trend concerning the C-E equipment maintenance program.

The Spectrum Management Engineering and Control System being developed for the National Training Center is a unique and innovative use of off-the-shelf computing and FR measurement equipment to provide a near real-time spectrum management capability to the NTC Commander. The NTC will benefit by being in a better position to improve the utilization of the available spectrum space allocated for this important training function. The system will enhance the realism of the training received at the NTC by allowing more Communications-Electronics activities in a fully coordinated, compatible environment while considering other Mojave Desert Area spectrum users. While the chance of unintended interference from an authorized user cannot be totally eliminated, the Spectrum Management System will increase the probability of electromagnetic compatibility in the Mojave Desert Area.

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