Raytheon Company (Missiles & Defense – M)
Application to Renew License
Call Sign: WF2XUK
File No:

Explanation of Experiments and Need to for a STA
Adding C-band TM

Overview:

Raytheon Company (Missiles & Defense – M) (Raytheon) builds and sells missiles to the US military. As a part of the engineering development and production process, Raytheon tests communications systems in its products to make sure they meet customer specifications. Currently, Raytheon holds WF2XUK which allows missile check out near the end of the production cycle at its manufacturing facility in Huntsville, Alabama. The testing of all the flight terminate systems in the lab and factory requires the use of radio transmissions requested here to make sure all the antennas, receivers and transmitters work properly. The testing proposed here is to be conducted on production lines to ensure that all of the installed radio systems are operating properly. The facility has seven production areas where these radio operations are required. The three radio systems are used in the field by the customers for Range Safety. The three radio systems used for testing are the Flight Terminate Receiver, S-Band Telemetry transmitter and the C-Band transponder. These systems must be tested and retested as part of the production process for the Range Flight Safety System. Raytheon is seeking to renew its authorization to use the systems installed on missiles that will be tested at government ranges. Prior to delivery of the product to the customer, the product must be tested as part of engineering development and production testing.

Actual missile flight testing is conducted at government test and training ranges using federal frequency assignments. Since the lab and production testing is taking place at Raytheon's facilities, and because some of the work being done is actually internal to Raytheon as part of independent research and development, it is necessary to request an experimental authorization to allow for the proper, licensed operation of the missile during development and production testing.

Description of spectrum use for production line preparation for missile test:

UHF (420-430 MHz), C (4400-4940 MHz and 5400-5900 MHz) and S (2200-2390 MHz) band transmitters are installed on the missile to allow for control and monitoring of the missile while it is in flight. Most missile flight tests are very short in nature, about 5 minutes. Raytheon conducts approximately 40 lab or production line tests each day on various programs, for a total time in which there might be spectrum use of about 200 minutes, or just over three hours. Because the UHF, C band, and S band frequencies are used throughout the flight tests, the experimental testing proposed in the lab or production facilities in this application mimics the flight test use of the radio systems to ensure proper operation

when the products are actually engaged in flight testing. The Spectrum Managers at Raytheon coordinate the use of these transmitters to mitigate any interference problems.

To minimize any potential interference, most of the testing is done using hooded transmitters in the lab and on the production line. Those hoods are placed over the antennas on the missiles, and the hoods are shielded and filled with anechoic material. This minimizes the potential for any radio signals to get out of the building in which the radio testing is being conducted. There are some instances in which hoods cannot be used, and the application requests authorization for the parameters of the unhooded use.

The UHF (420-430 MHz) Flight Terminate Receiver on the missile receives information on a very specific frequency that can be used to steer the missile and/or destroy it in the unlikely event that the range deems the missile a safety hazard. For development engineering and or production testing, a test transmitter is used to test all of the functions of the Flight Terminate Receiver and its antenna. No flight testing is performed at Raytheon Missile Systems' facility. Only testing of the system to ensure it functions properly. Most of the test sets have the following characteristics:

- Carrier Frequency 406 to 450 MHz in 100 kHz Steps (in this case 420-430 MHz only)
- Carrier Frequency Stability +/- .005%
- Power Output 0 to -127 dBm
- Modulation WBFM, +/- 30 kHz Per Tone
- Tone Frequencies Any combination of up to 20 tones per IRIG 313-01 (6 simultaneous, max)
- Spurious Outputs -50 dBc

The S-band telemetry transmitter operates on a very narrow frequency in one of three frequency bands; 2200-2290 MHz, 2310-2360, 2360-2390 MHz. The C-Band telemeter transmits at 4400-4940 MHz. Power output is 2 to 40 watts of power. All testing is conducted indoors, and the transmitters are hooded to provide shielding to prevent signal propagation outside of the facility.

For purposes of the application filed here, Raytheon has requested authorization to use the full 40 W of power which may rarely be required. Most of the testing will be done at a power level of approximately 5 watts. When this system is used in actual flight test, missile telemetry data is sent to the test center to provide information such as temperature, altitude, speed, voltages, and vibration levels as the missile is in flight.

The information is normally transmitted using Pulse code modulation (PCM)/frequency modulation (FM). The newer systems, which require less bandwidth, are the Feher patented quadrature phase shift keying (FQPSK-B and FQPSK-JR), the shaped offset quadrature phase shift keying (SOQPSK-TG), and the Advanced Range Telemetry (ARTM) continuous phase modulation (CPM). We have entered emission designators also reflecting the maximum bandwidth usage, based on the PCM/FM transmissions, but most of the transmissions will use narrower bandwidth than that proposed. Each of these methods offer constant, or nearly constant, envelope characteristics and are compatible

with non-linear amplifiers with minimal spectral regrowth and minimal degradation of detection efficiency. All these systems operate in accordance with the IRIG-106 standard. For the development engineering and/or production testing proposed here, a test receiver will be used to receive the telemetry data. The telemetry data received over these frequencies helps the controllers determine the health and status of the missile in flight. If the missile flight is not correct, the S-band information is then used to correct flight errors or, in extreme circumstances, the information is used to trigger the flight terminate sequence. This S-band system, like the UHF and C-band systems, must be tested to ensure that the missile control frequencies are operating properly and that the m issile can be effectively controlled. No flight testing is performed at Raytheon Company.

The C-band transponder system, operating at 5400-5900 MHz, is used for tracking the missile in flight. This system includes an interrogator radio fixed on the ground and a transponder on the missile. In actual use, the power output can be up to 100 watts. In an actual flight test, the government range radar (AN/FPS-16) interrogates the missile transponder with a single or dual pulse. The transponder receives coded or single pulse interrogation from ground stations and transmits a single-pulse reply in the same frequency band. The radar ground stations determine the position of the vehicle C-band transponder by measuring range, azimuth angle, and elevation angle. Range is derived from pulse travel time, and angle tracking is accomplished by amplitude-comparison monopulse techniques. As many as four radar stations may track the beacon simultaneously. The proposed experimental use in the lab and at the production facility will replicate the radar interrogations – but at a power level of only 1 watt, because that is all the power needed for the indoor interrogation transmissions and responses at the normal power level of 100 watts to ensure the proper functioning of the C Band system on the missile.

For our use at Raytheon a Lab test of the interrogator set with the following characteristics is used to test the missile transponder:

- **RF POWER OUTPUT:** -5 DBM TO -65 DBM ± 1.5 DB INTO A 50 OHM LOAD, N-TYPE CONNECTOR
- **RF FREQUENCY:** 5.4 TO 5.9 GHZ, SYNTHESIZED IN 1 MHZ STEPS
- **PULSE WIDTH:** 0.25 TO 1.0 MICROSECONDS
- **PULSE SPACING:** 3 TO 12 MICROSECONDS
- **PRF:** 100 TO 2600 HZ
- **OPERATING MODES:** CW, AUTOMATIC TEST, REPEATING PULSE, MANUAL, CAL
- **ANALYSIS RESULTS:** GO/NO GO, RETURNED PULSE COUNT, TRANSPONDER POWER RETURNED

The transponder on the missile operates as it would in test flight, with 100 W of power with a -6dB gain antenna for an ERP of 25 Watts.

For development engineering and or production testing a transmitter is used to test the operation of the C-Band Transponder and its antenna. No flight testing is performed at Raytheon Missile Systems.

Spectrum Use Coordination

Raytheon will submit a frequency coordination request to AFTRCC for the use of the S band telemetry frequencies. Raytheon will request that AFTRCC send its response to both Raytheon and the FCC after it has completed consideration of the formal request. Informal consultation with AFTRCC has shown that they are likely to approve this request. A copy of the AFTRCC response will be submitted to the FCC as soon as it is available.

Expected Effect of Spectrum Use

Over the past 50 years, Raytheon has tested its products during engineering, development and production. The federal frequency assignment authorized the use of UHF, S-Band, and C-Band spectrum to control the missile, monitor its flight and as necessary terminate the test flight, exactly as is proposed here. There were no incidents of harmful radio interference during the previous engineering development and or production testing that is licensed and operational in Tucson. As a result, no harmful interference is expected from the testing proposed here.

Review of the FCC's regulations shows that in the UHF band, the operations should not involve spread spectrum radio location systems. As explained above, this application proposes to use the 420-430 MHz spectrum for a very discrete purpose and does not employ spread spectrum technology, nor is the frequency used for radio location.

Additionally, in reviewing the FCC's regulations, we noted that the S band frequencies are not to be used for flight test of manned aircraft. The testing being conducted is simply for product testing in the lab and on the production line.

Stop Buzzer Point of Contact

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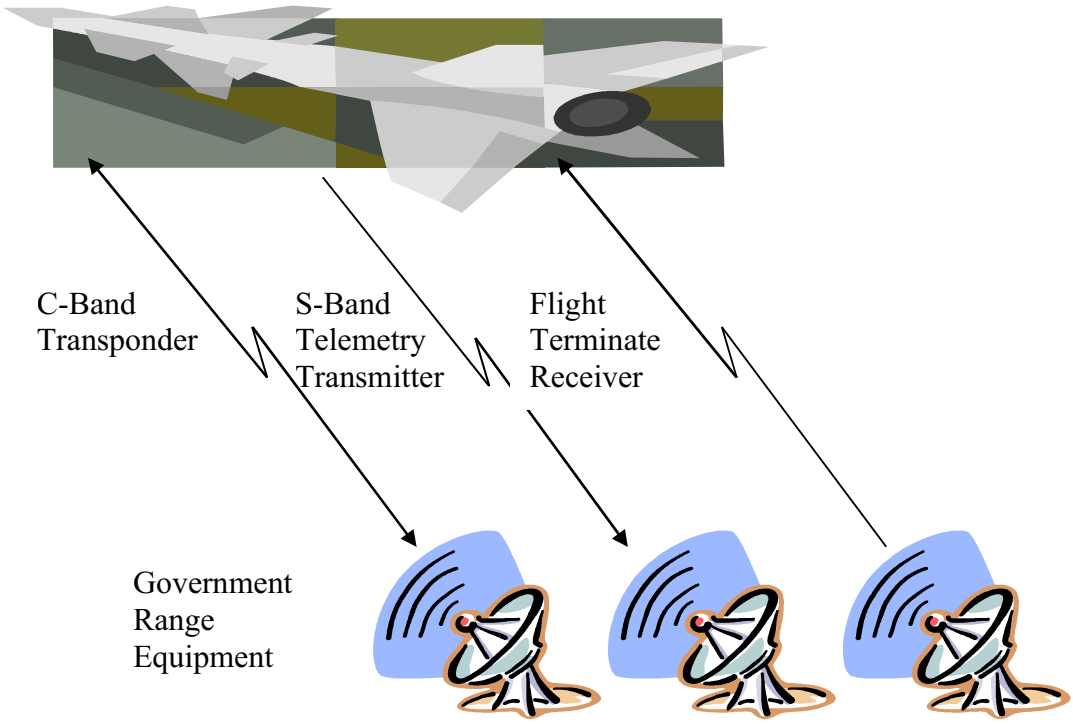
Conclusion

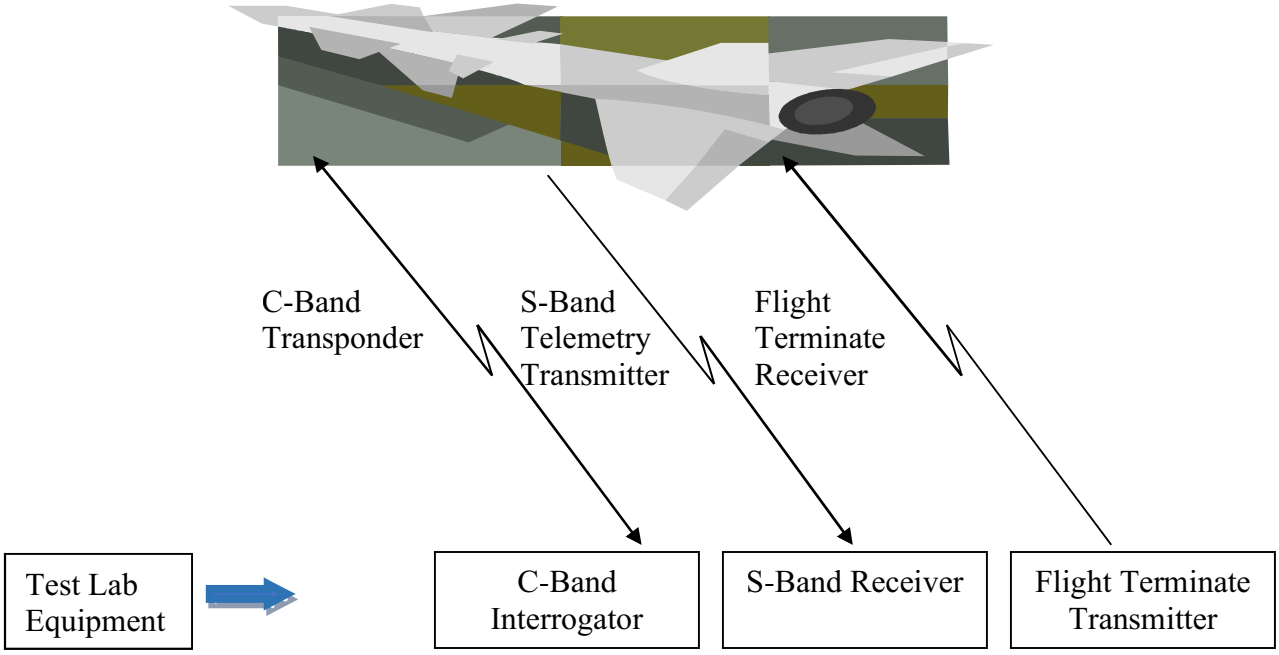
This STA application is being filed to add C-band telemetry for testing conducted by Raytheon for purposes of research and development. The locations are at Raytheon's production facility in Huntsville, Alabama. The frequencies proposed are those required by the customer, because the systems being tested are the

systems that will be used by the customer in actual flight testing that will take place at DOD facilities.

Should there be any questions about this application, they should be directed to Shaun Crum, Raytheon Spectrum Manager, 520-646-6421, shaun.crum@rtx.com



DOD Flight Test Configuration



Raytheon Engineering Development/Production Test Configuration