

**File Number: 0254-EX-PL-2016**

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### **Question 7 Experimental Description**

The following narrative statement describes in detail the following items:

- a. The complete program of research and experimentation proposed including description of equipment and theory of operation.
- b. The specific objectives sought to be accomplished.
- c. How the program of experimentation has a reasonable promise of contribution to the development, extension, expansion or utilization of the radio art, or is along line not already investigated.

#### **Program of research**

- Investigate the potential for an HF based system that provides regional coverage for a portable/mobile data/image/media transmission system where no cellular or internet coverage is available. This system will take advantage of Near Vertical Incidence Scattering (NVIS) propagation.
- Test robust digital vs. conventional analog image techniques against multipath, fading, static and interference.
- Data transfer tested using H.264, DRM AAC/AAC+ and additional codecs.
- Why these frequencies - NVIS provides coverage of several hundred km, optimum frequency will vary with diurnal, seasonal and solar cycles. The 4.7 to 10 MHz band was chosen for reliability. Simulations were run using the Voice of America Coverage Analysis Program for HF Propagation Prediction and Ionospheric Communications Analysis (VOACAP) program provided by NTIA to evaluate the potential of various frequencies. VOACAP simulations were run over paths from 100 to 550km for varying season and sunspot numbers (see attached model output).
- Frequencies also chosen to minimize interference, avoid channel proximity to high priority services such as Aviation and Marine.
- Channel actively monitored prior to transmission.
- Project Timeline submitted as an attachment.

#### **Description of equipment**

Equipment used will employ both linear analog and digital modulation techniques. Purpose built as well as COTS equipment will be used.

**Theory of Operation** NVIS propagation modes will be employed. Modulation schemes to be employed include phase shift keying, quadrature amplitude modulation, analog single sideband with and without a carrier and phase shift methods. The information carried will be streams carrying image and speech information. Static images will be encoded using JPEG compression, video will be encoded using H.264 (MPEG-4 Part 10) Advanced Video Coding a block-oriented motion-compensation-based video compression standard. Digital modulation will be tested and compared with the same media as transmitted by analog modulation techniques.

#### **Objectives**

Development and testing of system capable of regional data/voice transmission not relying on cellular infrastructure.

- Voice circuit for test, alignment and backup control channel.
- Four HF Frequency bands for day/night summer/winter propagation conditions

#### **Request for a five year grant**

The project is scheduled to commence at a sunspot minima, propagation at a solar maximum is expected to be quite different, therefore a five year grant is requested as this will give a range of propagation conditions up to the next solar maximum in 2021. VOACAP simulations (attached) support this request.

## Appendix VOACAP Simulations

## Signal Strength at Receiver (dBW)

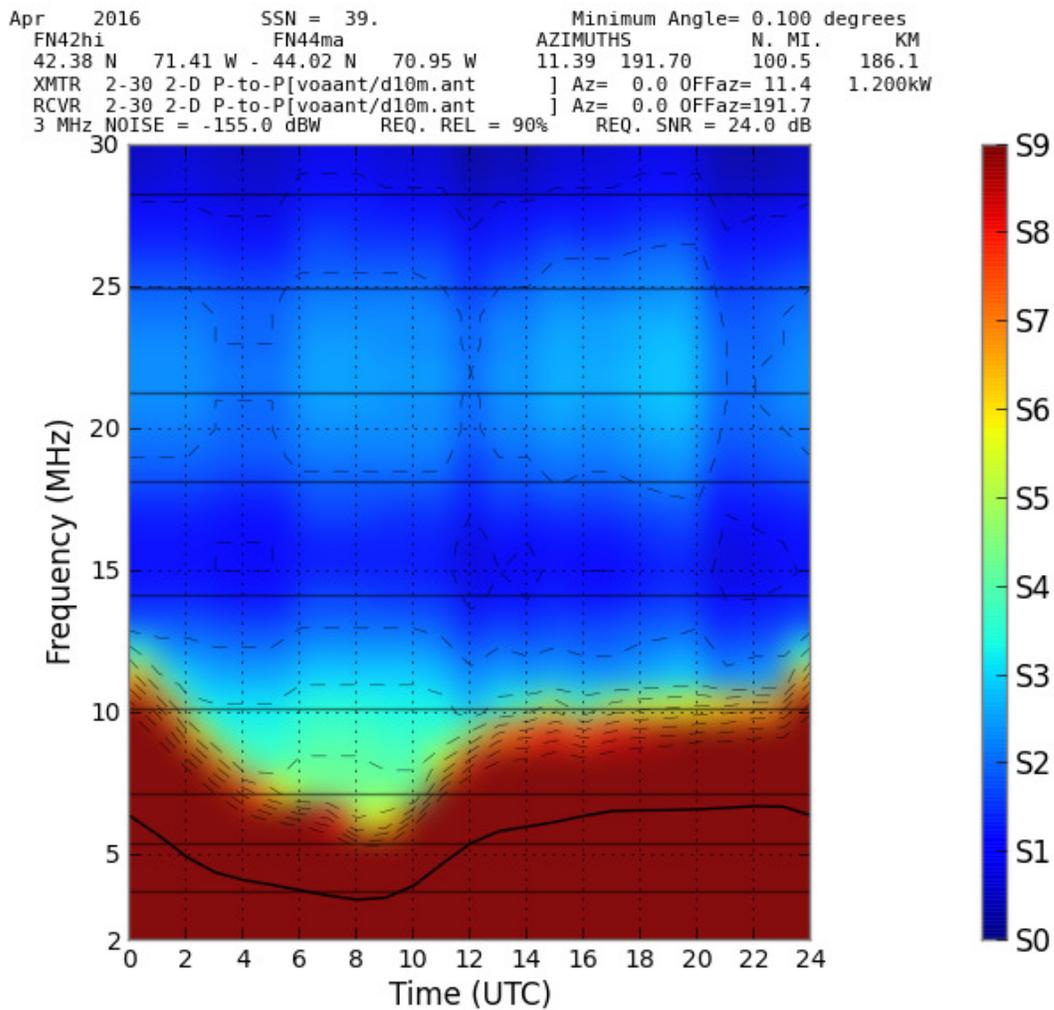


Figure 1. VOACAP simulation Spring conditions, 190km North-South path, low sunspot number conditions. This simulation supports the request for frequencies in the 2 to 7 MHz band.

## Circuit Reliability (%)

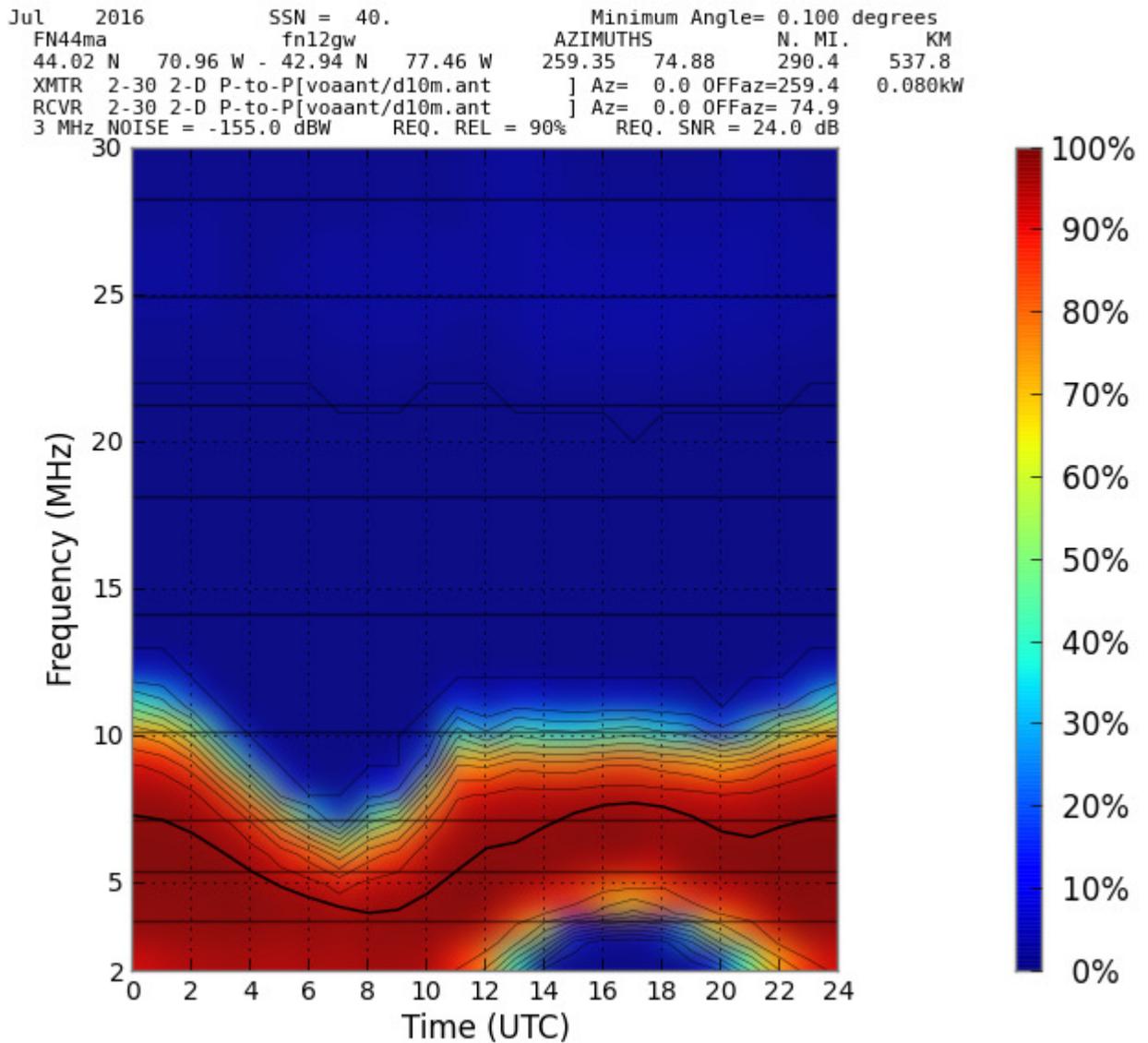


Figure 2. VOACAP simulation Summer conditions, 540km East-West path, low sunspot number conditions.

## Circuit Reliability (%)

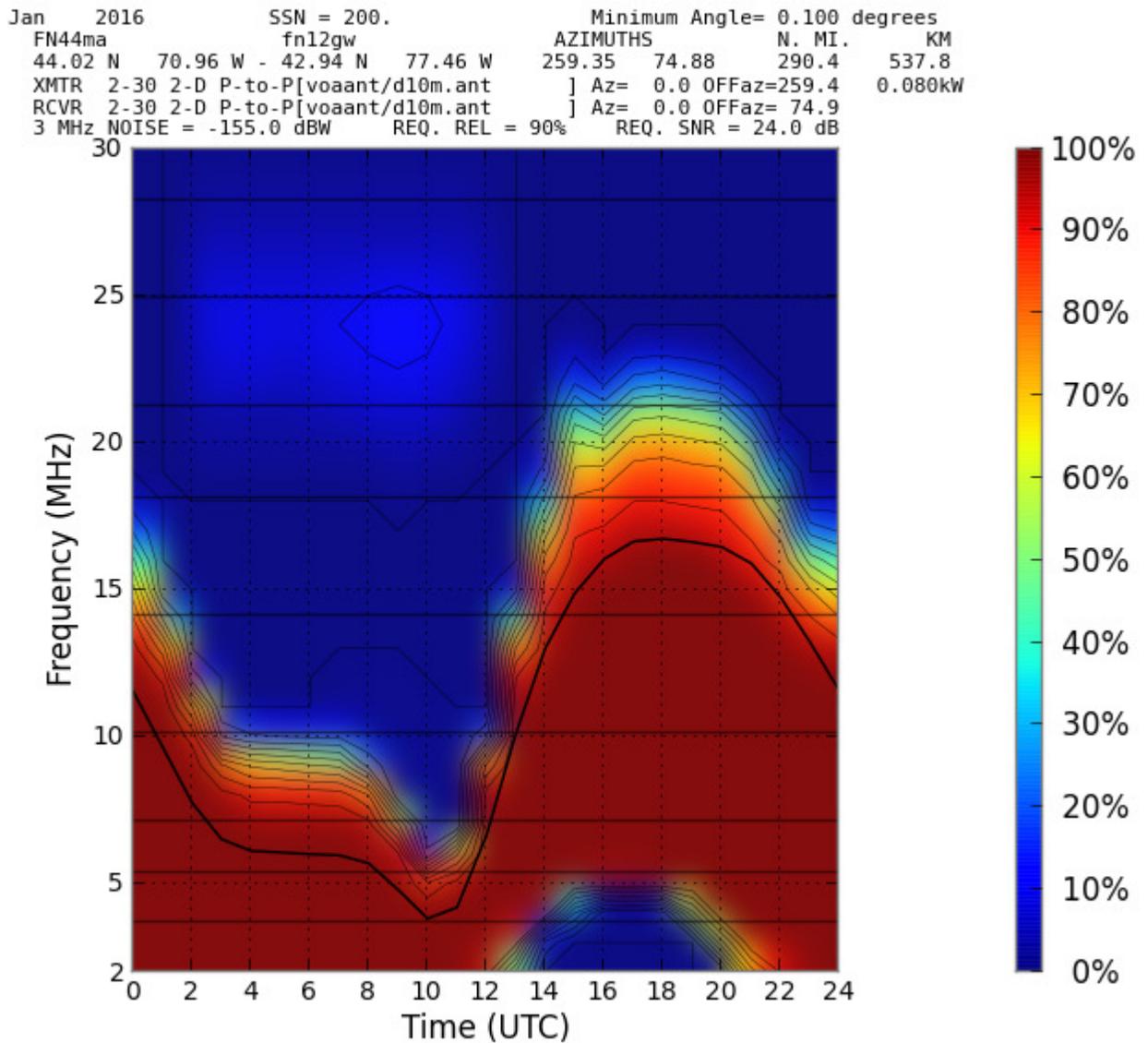
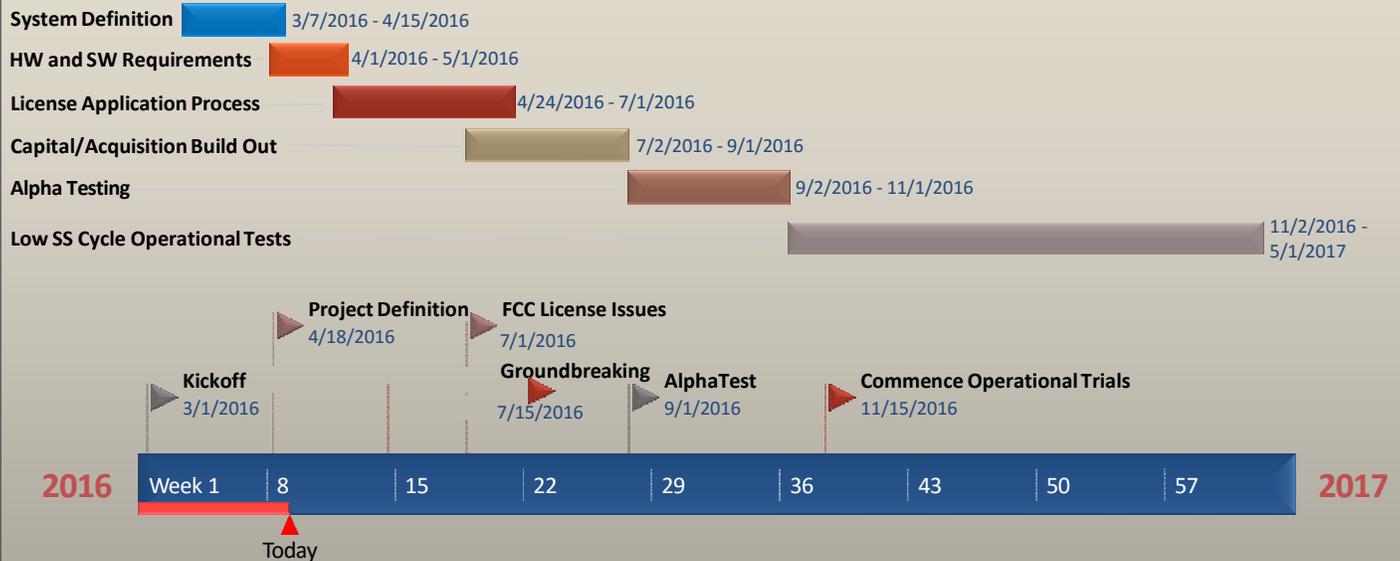


Figure 3. VOACAP simulation Winter conditions, 540km East-West path, high sunspot number conditions. Note that frequencies above 5MHz are required from approximately 13-20 UTC.

# HFMediaLink Project Timelines



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FCC File Number 0254-EX-PL-2016

Figure 4 Project Timeline