This license is being sought in pursuit of a research project being carried out by Cornell University and The Georgia Institute of Technology with support from the Defense Advanced Research Projects Agency (DARPA). The work uses a new network of small HF beacon stations to probe the ionosphere in an attempt to augment space situational awareness for DoD-related U.S. agencies. Two HF beacon transmitters will be deployed under this project – one near Poker Flat, Alaska, and the other near Gakona, Alaska, at research sites operated by the University of Alaska, Fairbanks. The beacon transmitters operate alternately at two frequencies (2.9 and 3.4 MHz), transmit 5W of power, employ low-gain dipole antennas deployed less than 20' above ground, and utilize BPSK coding. The transmitters will operate for a few hours a day, a few days a month. The beacon transmitters are essential for this project. No comparable instrumentation exists at present. An FCC experimental class license for the transmitters is being sought by Hysell at Cornell.

HR001118S0055 Space Environment Exploitation (SEE)
Prime Proposer: Georgia Institute of Technology
PI: Morris Cohen
Proposal Title: HEARTBEAT: Heliosphere to Earth Atmosphere Rendering Through Building Excellent Artificial-intelligence Training
Subawardee: Cornell University
Subawardee PI: David Hysell

The Cornell team will have two primary tasks under this project — the deployment and operation of an HF beacon network for ionospheric specification at high latitudes, and the refinement and application of a high-definition model of ionospheric plasma irregularities in the *E* and *F* region.

Task 3.3

Cornell will build the hardware and develop the software for a regional network of HF beacons. The beacons will employ pseudo-random codes and operate at multiple frequencies, providing group delay and Doppler shift information for observables. A model based on statistical inverse methods will be used for ionospheric reconstructions. We tentatively plan on stations in Eagle, Kacktovic, Fairbanks, and Gakona. Milestones for task 3.3 include

- Year 1 : Development of hardware and data acquisition software and deployment of HF beacons to Alaska.
- Year 2: Acquisition of beacon data during campaigns followed by analysis, yielding regional electron density specification.
- Year 3: Integration of ionospheric specifications into physics- and machine learning-based forecast algorithms.

Task 4.3

A physics-based model of plasma dynamics and plasma instabilities producing density irregularities in the *E* and *F* region will be refined and applied to the forecast problem. The model will include a three-dimensional potential solver and an algorithm for updating the number densities of the most important ionospheric species. The model will be similar to an existing one currently applied to the low- and mid-latitude ionosphere only updated for high-latitude applications. It will be able to reproduce gradient drift, ExB, current convective, drift wave, and Kelvin Helmholtz-type instabilities given a specification of the initial plasma composition and the forcing due to electric fields and winds. Milestones for task 4.3 include:

- Year 1: Adaptation of the physics-based intermediate-scale model to high-latitude applications.
- Year 2: Testing and validation of the model code based on campaign studies using dataset arising from the data-fusion effort.
- Year 3: Integration of the model code in the ML-forecasting framework and application to actual space-weather forecast studies.