Exhibit 1

4. Particulars of Operation

There are two kinds of experiments that we want to perform that require transmission of UWB signals outside of a controlled laboratory environment. They are as follows:

Propagation experiments. We want to characterize the ability of low-power UWB radio to communicate well over short ranges in difficult environments, e.g., over small hills, in dense urban environments, etc. This work involves two kinds of measurements: (1) channel response measurements and (2) bit-error-rate (BER) measurements. The channel response measurements currently are accomplished by repeatedly transmitting a pulse and recording the received signal with a sampling oscilloscope (HP 54750). To develop a reliable time base that will allow array processing of measurements, the sampling scope trigger signal will be sent over a separate channel (a stationary UWB link or a coax or fiber trigger line). In either case, the structure of the test signal can be randomized to remove any line structure in the radiated power spectrum (i.e., to flatten the power spectral density) and minimize any possible interference to other systems. As indicated in Exhibit 3, we expect our average radiated power (output of the transmitting antenna) in these experiments to be under 10 microwatts per megahertz. The BER measurements over the same channel will then be used as a check on analytical performance estimates for that channel, based on the channel response measurements.

Interference experiments. We want to determine the effects of UWB transmissions on other radio systems. Some of these experiments are naturally outdoor experiments. As an example, we will test a Global Positioning System receiver's performance as a function of distance from a carefully characterized UWB transmitter. The L1 and L2 carriers of the GPS signal fall within the passband of our UWB transmitting antenna. To do this properly, we expect to team with a GPS receiver manufacturer and use a well-instrumented GPS receiver that will allow us to observe the effects of the UWB transmission on the receiver's tracking loop performance. Efforts will then be made to predict that performance from knowledge of the antenna systems and the UWB radiation. This kind of testing should either allay fears of UWB interference effects, or point out problems that UWB radio designers must understand and circumvent.

The particulars of our current radiating equipment are given in Exhibit 3. The antennas with which we are currently experimenting have a bandwidth spanning the frequency range from roughly .9 GHz to 1.7 GHz and for short-pulse UWB systems it is this bandwidth that the radiated signal occupies. The UWB modulation factor (bandwidth divided by center frequency) for this equipment is roughly 0.6. We envision future propagation experiments in which the radiation band is changed but the UWB modulation factor is kept at a level of at least 0.6. The center frequencies for these experiments may range from roughly 0.8 GHz to 3 GHz, with the corresponding frequency bands for these extremes being (.55 GHz to 1.05 GHz) and (2.1 GHz to 3.9 GHz) respectively. The objectives of these measurements are to determine if there is a real propagation advantage for any one of these bands over the other.

Exhibit 2

7. Government Research Contracts

This is a list of the government grants and research contracts that we have (or have had) to work on ultrawideband (UWB) radio.

1. R. A. Scholtz, K. Chugg, A. Otrega, A. Prata, "Fundamental Experimental and Analytical Studies in Ultra Wideband Radio with Application to Wireless Multimedia Communication," $700,660.00, **National Science Foundation**, September 1, 1998 -- August 31, 2001.
   This contract has as two of its tasks (1) the measurement and characterization of UWB propagation channels and (2) the study of the ability of UWB signals to coexist with other narrowband systems. We expect to cooperate with different companies and laboratories in the Los Angeles area to accomplish these objectives.

2. R. A. Scholtz and K. Chugg, "Request for Research Instrumentation for the UltRa Lab," $54,165, **U.S. Army Research Office**, April 1, 1998 -- March 31, 1999.
   This grant provided the funds for instrumentation.

3. R. A. Scholtz, "A Proposal to the Army Research Office for Support of a Workshop onUltra-Wideband Radio Techniques," $11,000.00, **U.S. Army Research Office**, May 15, 1998 -- May 14, 1999.
   This grant provided funds for a workshop held last May, attended by people from 25 companies, 7 government agencies (including Karen Rackley of the FCC), and several universities. Permission from the FCC to demonstrate early prototype equipment was obtained by the Time Domain Corporation, and USC test equipment was used in the demonstration.

4. R. A. Scholtz, "A Proposal to the AASERT Program for Research on Impulse Radio for Battlefield Communications," $186,500, **U.S. Army Research Office**, June 1, 1997 -- May 31, 2000.
   This grant supports US citizens who are working on UWB studies, and who are designing and testing new UWB equipment.

5. R. A. Scholtz, A. Willner, and J. Choma, "Acquisition of Instrumentation for Testing of Ultra-Wideband Wireless and Wired Communications and Design of Enabling Instrumentation," **National Science Foundation**, September 1, 1996 -- August 31, 1998, $403,952.
   This grant provided the infrastructure for our UWB radio laboratory.

6. C. Nikias, et al., "Engineering Research Center in Integrated Media Systems," cooperative agreement with the **National Science Foundation,** August 1, 1996 – July 31, 2001, $12,400,000.
   This is the basic grant for a major Engineering Research Center at the University of Southern California. The wireless effort at this center is in UWB communications. **Advanced Micro Devices** gave $150,000 through this center for support of the UWB radio laboratory's efforts.

Exhibit 3

13. Transmitting Equipment

The radio gear that we have and that we will construct are of a form known as ultrawideband (UWB) impulse radio. The radio functions by means of sequences of very narrow pulses (on the order of 1 ns in width) produced by a transmitter driving an appropriately designed antenna. The frequency spectrum of the transmitter output goes from dc to a few GHz. This signal, which drives the antenna, is not modulated on a carrier.

The transmitting antenna itself is a pulse shaping element, and is not tuned or resonant to a particular frequency. The inverse bow-tie antennas that we currently possess have a reasonable passband from roughly 0.9 GHz to 1.7 GHz, as measured by a network analyzer in an indoor (non-anechoic) environment.

Current Equipment:

experimental impulse radio prototype sets supplied by Time Domain Corporation

- Number: 2
- Average radiated power: 1.8 mW (2.6 dBm)
- Modulation format: Time-hopped spread-spectrum
- Data rate: 32 kbps PPM
- Average PRF: 10 Mpps
- Maximum radiated power density: < 4 μW/MHz (estimated)

Avtech Electro Systems pulsers (used in propagation experiments) in conjunction with inverse bow-tie antennas

- Number: 4 (only one in use during an experiment)
- Model: AVP-1-P-DSRCA1
- Average radiated power: < 2 mW (antenna dependent quantity)
- Maximum PRF: < 2 Mpps
- Maximum radiated power density: <4.5 μW/MHz (estimated, antenna dependent quantity)

We expect any further radiators that we design to have power density levels lower than these radiators.