Particulars of Operation and Narrative Statement

Necessary Bandwidth, Modulating Signal and Program of Research

The purpose of this research is to determine the performance of the Universal Mobile Telecommunications System Terrestrial Radio Access ("UTRA") Frequency Division Duplex ("FDD") communications equipment being developed by InterDigital Communications Corporation ("InterDigital").[1]

Description of Equipment

The suite of equipment consists of UTRA/FDD user equipment ("UE") subscriber units which transmit/receive a set of Wideband Code Division Multiple Access ("WCDMA") signals to and from a simulated base station (Node-B). The WCDMA signal transmitted by the base station is referred to as the downlink channel ("DL") and the signal transmitted by the subscriber units is referred to as the uplink channel ("UL"). Each set of subscriber WCDMA signals includes one or more dedicated and common channels. The subscriber units will also transmit to all base stations a set of global UL signals that include:

- Dedicated Physical Data Channel
- Dedicated Physical Control Channel
- Physical Random Access Channel
- Physical Common Packet Channel

The base station will transmit to all subscriber units a set of global DL signals that includes the following:

- Downlink Physical Channel
- Primary and Secondary Common Control Physical Channel
- Physical Downlink Shared Channel
- Primary and Secondary Pilot Channels
- Primary and Secondary Synchronization Channels
- Paging Indicator Channel
- Acquisition Indicator Channel

Theory of Operation

The InterDigital UE product design is based on the goals and requirements as specified in the 3rd Generation Partnership Project ("3GPP"). The 3GPP was originally

[1] On December 10, 2003, the Commission granted InterDigital an experimental authorization to test the performance of UTRA Time Division Duplex ("TDD") communications equipment. *See* File No. 0254-EX-PL-2003, Call Sign WD2XGR. The instant request is substantially similar to InterDigital's previous request, except the instant request seeks to test the performance of FDD, not TDD, equipment.

established to produce globally applicable technical specifications and reports for a 3rd generation mobile system based on evolved Global System for Mobile Communication ("GSM") core networks and the radio access technologies that they support. *See* http://www.3gpp.org. InterDigital's development program for 3GPP was originally established to gain a working knowledge and authority in the technology development of GSM core networks and the radio access technologies that they support. InterDigital subsequently expanded its program to include the maintenance and development of evolved radio access technologies such as High Speed Data Packet Access ("HSDPA") and Transmit Diversity.

The radio interface access scheme is Direct-Sequence Code Division Multiple Access ("DS-CDMA") with information spread over approximately 5 MHz bandwidth, thus also often denoted as WCDMA due to that nature. The radio interface, which is the air interface point between UE and network/Node-B, will use FDD technology for operating with paired bands. This system shall utilize a duplex method whereby uplink and downlink transmissions use two separated radio frequencies. Additionally, each uplink and downlink shall use different frequency bands that have specified separation.

A physical channel is therefore defined as a code (or number of codes) and completes the definition of a physical channel. The information rate of the channel varies with the symbol rate being derived from the chip rate and the spreading factor.

Particulars of Operation

The InterDigital UE product development program is designed to operate in certain segments (as shown in the accompanying Form 442) of the following paired spectrum bands:

1920 – 1980 MHz: Uplink (UE transmit, Node-B receive)
2110 – 2170 MHz: Downlink (Node-B transmit, UE receive)

The UE product shall be designed to operate with a transmit-to-receive frequency separation of 190 MHz and a nominal channel spacing of 5 MHz.

The nominal maximum output power for either the UE product or the base station will be 2 Watts (+33.0 dBm). The nominal power defined is the transmit power of the device, *i.e.* the power in a bandwidth of at least (1+α) times the chip rate of the radio access mode; the period of measurement shall be at least one timeslot. All testing will be conducted indoors at InterDigital's laboratory. Accordingly, there is little if any chance of detectable emissions leakage beyond the confines of the building.

WCDMA is a spread-spectrum technique in which all signals in a link share the same spectrum. A WCDMA signal is created by multiplying a baseband signal by a unique pseudo-random code consisting of a certain number (Q) of chips (a measurement of information) and then converting it to the common RF carrier of the link. A WCDMA

receiver recovers a particular WCDMA signal from the shared spectrum by knowing the unique pseudo-noise ("PN") code, and multiplying the received baseband signal by that code, and summing the product over Q chips. The bandwidth of the shared spectrum is inversely proportional to the width of the chips used. The maximum necessary bandwidth will be 5 MHz (as specified by the 3GPP standards).

For InterDigital's UE product, the WCDMA signal has a chip rate (repetition period) of 3.84 Mchips per second and is QPSK modulated. The data is spread orthogonally with Q chips per symbol where $Q = 2^p$, $0 <= p <= 15$ (maximum as per 3GPP Release 5 HSDPA). The symbol rate duration T_s depends on the spreading factor Q and the chip duration T_c: $T_s = Q \times T_c$, where $T_c = 1/\text{chiprate}$. The modulated signal is passed through a root raised cosine pulse-shaping filter with a roll-off factor of 0.22.

Objectives

The following objectives will guide the UE product development:

- Demonstrate that all transmitters reliably transmit intended signals.
- Demonstrate that radiated emissions from the equipment will remain within acceptable levels.
- Demonstrate that the UE product subscriber unit will successfully establish a link with the base station.
- Demonstrate that a base station will successfully establish a link with single or multiple UE product subscriber units.
- Determine that a UE product subscriber unit with an established link to a base station will successfully transfer from one base station to another while maintaining a link with the core network.
- Determine the quality of the links established between the base station and the UE product subscriber units.
- Determine the maximum number of UE product subscriber units with which a base station can simultaneously establish a link.
- Determine the impact on performance of UE product subscriber unit movement, stationary and moving reflectors, age, and intercell interference.
- Determine the length of time over which a two-way link can be maintained.
- Determine the impact of high speed downlink packet access on performance.
- Determine the improvements achieved implementing antennae diversity on mobile products.

Contribution of Experiment to the Art of Radio

Little is known about the performance of UTRA-FDD WCDMA systems operating in the 1920-1980 and 2110-2170 MHz frequency range. This experiment will prove the reliability and performance of such systems and thereby establish the viability of the technology.