PATROLL Winning Submission

U.S. Patent 7,983,140

U.S. Patent 7,983,140 ("*Redwood Technologies LLC*" or the "patent-at-issue") was filed on December 3, 2004, and claims an earliest priority date of December 8, 2000. Claim 1 of the patent-at-issue is generally directed to a transmitting apparatus comprising: 1) a front-end transmission processing unit for converting transmission signal into a transmission time slot, 2) a frame generator for generating a frame, and 3) a back-end transmission processing unit for transmitting the generated frame as a radio signal. The frame includes a series of n (where n is an integer equal to or greater than 1) time slots and a frame guard period added to the series of n time slots to suppress a frame loss due to interference.

The primary reference, U.S. Patent 7,095,708 ("*AT&T*"), was filed on June 14, 2000, and claims an earliest priority date of June 23, 1999. The publication is directed to a wireless communication system that is spectrally efficient and responsive to communications involving voice and/or high speed data, such as Internet data. The system preferably utilizes Orthogonal Frequency Division Multiplexing (OFDM) or OFDM-like communication techniques, and defines each one of a plurality of traffic channels by a unique combination of frequency and time slots. Each wireless data traffic channel is used for carrying high speed data in addressed data packets to and from the plurality of fixed wireless remote units. On the other hand, each wireless voice traffic channel can be assigned and dedicated to a particular voice communication call involving one of the plurality of fixed wireless remote units for carrying voice data of the call..

The primary reference, JPH07273741 ("*Toshiba*"), was published on October 20, 1995. The Japanese patent is directed to an OFDM transmission method that can suppress the negative effects of the degradation of the demodulation symbols after equalization and the reference symbols if they are disturbed. The patents relates to transmitting two or more consecutive reference symbols during the transmission frame of OFDM.

The secondary reference, U.S. Patent 6,714,511 ("*Panasonic*"), was filed on December 16, 1999, and claims an earliest priority date of December 22, 1998. The publication is directed to an OFDM transmission/reception apparatus capable of improving the transmission efficiency while maintaining the function of adding a guard interval to eliminate a delayed signal. The OFDM transmission/reception apparatus changes the length of a guard interval added at the start of a valid symbol suitably to maintain the minimum necessary length of the guard interval (that is, the guard interval of an appropriate length) to eliminate a delayed signal at a given moment and in a given environment.

A sample claim chart comparing claim 1 of *Redwood Technologies LLC* to *AT&T, Toshiba*, and *Panasonic* is provided below.

US7983140 ("*Redwood Technologies LLC*")	**A. US7095708** (*"AT&T"*) **B. JPH07273741** (*"Toshiba"*) **C. US6714511** (*"Panasonic"*)
1.*pre* A **transmitting apparatus**, in an **orthogonal frequency division multiplexing wireless communication system**, comprising:	**A. US7095708** "FIG. 1 is an illustrative representation of a **wireless communication system** 100 **that utilizes OFDM communication techniques**. Wireless communication system 100 includes at least one wireless base unit 102 and a plurality of wireless remote units 104. Although any suitable number of remote units may exist, the plurality of wireless remote units 104 in FIG. 1 includes wireless remote units 106, 108, 110, 112, 114, and 116. Wireless base unit 102 and the plurality of wireless remote units 104 include, among other things described later, **wireless OFDM transceivers to communicate data over an airlink**." *AT&T* at col. 6:14-24 "Referring now to FIG. 2, a **wireless transmitter** 200 and a wireless receiver 202 which may be utilized by a wireless base unit and a wireless remote unit (e.g., in FIG. 1), respectively, are illustrated." *AT&T* at col. 7:5-8 **B. JPH07273741** "Examples of the invention will be described below with reference to the drawings. Fig.1 is a diagram illustrating one example of a **transmission method OFDM** in accordance with the present invention. Note that Fig.1 illustrates each time slot of 1 to M and each OFDM symbol." *Toshiba* at par. 0029 **C. US6714511** "The **OFDM transmission**/reception **apparatus** according to Embodiment 1 of the present invention is explained using FIG. 5. FIG. 5 is a block diagram showing an outlined configuration of the OFDM transmission/reception apparatus according to Embodiment 1 of the present invention." *Panasonic* at col. 6:1-6
1.a a **front-end transmission processing unit for converting a transmission signal into a transmission time slot**;	**A. US7095708** "**Wireless transmitter** 200 **includes** a sampler 206, a compressor 208, a block encoder 210, a modulator 212, **an Inverse Fast Fourier Transform (IFFT) processor** 214, a **digital-to-analog converter (DAC)** 215, a radio frequency (RF) upconverter 216, a transmitter front end 218, an antenna220, and a **processor** 224." *AT&T* at col. 7:13-18

(cont.) 1.a a **front-end transmission processing unit for converting a transmission signal into a transmission time slot**;	"An **IFFT is performed on the plurality of modulated tones by IFFT processor** 214 **to produce OFDM signal samples** (step 314). The **OFDM signal samples are converted into analog OFDM signals** by DAC 215 (step 315). The OFDM signals are upconverted by RF upconverter 216 and fed into transmitter front end 218 for RF transmission out from antenna 220 (step 316). **RF OFDM signals** 226 which carry the voice signals are carried over one of the voice traffic channels dedicated to the voice communication call. For transmission of the voice data, **processor** 224 **operates to select the unique frequency and time slots associated with the assigned voice traffic channel**. The process is repeated for the duration of the voice communication call." *AT&T* at col. 7:46-58 **B. JPH07273741** "The **IFFT circuit** 9 **uses the input data for IFFT processing to create and output the OFDM modulated wave (OFDM symbol)** to the addition circuit 10." *Toshiba* at par. 0050 "The multiplex circuit 4 selects ROM 5 to output the null symbol from IFFT circuit 9. Also, the multiplex circuits 4 and ROM and 6,7 are selected so that the reference symbols A , B and IFFT are respectively output from the circuits 9. Similarly, informational symbols are obtained by selecting the output of multiplex circuit 4 symbol mapping circuit 3. **The transmission frame shown in Fig.1 is output from the IFFT circuit** 9 **by the multiplex circuit** 4 **corresponding to the time slot selection of the transmission frame of Fig.1**." *Toshiba* at par. 0059 **C. US6714511** "IDFT circuit 12 performs **inverse discrete Fourier transform (hereinafter referred to as "IDFT")** on the input signals." *Panasonic* at col. 1:22-24 "S/P converter 101 converts a serial input signal to a plurality of parallel signals. Switches 102 and 103 switch between two input signals and outputs either of the two. **IDFT circuit** 104 **performs IDFT processing on the input signals**. Guard interval inserter 105 inserts a guard interval into the input signal for every valid symbol. D/A converter 106 performs D/A conversion on the signal with a guard interval inserted. In this way, a transmission signal is obtained." *Panasonic* at col. 6:15

(cont.) 1.a a **front-end transmission processing unit for converting a transmission signal into a transmission time slot**;	"The signal with a guard interval added is converted to an analog signal by D/A converter 106 and becomes a **transmission signal**." *Panasonic* at col. 7:26-28 "11. The OFDM transmission/reception apparatus according to claim 4, wherein said generator comprises: a **counter that converts the output of said symbol extractor to a data signal per a predetermined time**; and" *Panasonic* at claim 11
1.b.i a **frame generator for generating a frame that includes a series of n (greater than 1) time slots** and a **frame guard period** added to the series of n time slots,	**A. US7095708** "A **physical voice channel using 16 QAM modulation consists of a single FTR per TDMA frame (equivalent to eight TDMA time slots)** for the duration of the call. FIG. 21 presents the time multiplexing structure for multiple RUs in a graph 2100 having a frequency axis 2102 and a time axis 2104. Note, as for RU2 in FIG. 21, that there is no implication that uplink and downlink channels be paired." *AT&T* at col. 13:37-43 **B. JPH07273741** "As shown in FIG. 1, **the time slot at the head of a transmission frame is a null symbol for reception synchronization**, and symbol data with an amplitude of 0 is assigned to all subcarriers." *Toshiba* at par. 0031 "1 'OFDM' symbol 'N' subcarriers Each subcarrier is modulated by, for example, 0 symbol data, predetermined reference data or informational symbol data. M OFDM symbols constitute a transmission frame. **Modulated with 0 symbol data OFDM symbols (null symbols) are transmitted in the first time slot of the transmission frame. Each time slot consists of a guard period** and a valid symbol period, the waveform of the guard period being a duplicate of the valid symbol period." *Toshiba* at par. 0041 "The multiplex circuit 4 selects ROM 5 to output the null symbol from IFFT circuit 9. Also, the multiplex circuits 4 and ROM and 6,7 are selected so that the reference symbols A , B and IFFT are respectively output from the circuits 9. Similarly, informational symbols are obtained by selecting the output of multiplex circuit 4 symbol mapping circuit 3. **The transmission frame shown in Fig.1 is output from the IFFT circuit** 9 by the multiplex circuit 4 corresponding to the time slot selection of the transmission frame of Fig.1." *Toshiba* at par. 0059

(cont.) 1.b.i a **frame generator for generating a frame that includes a series of n (greater than 1) time slots** and a **frame guard period** added to the series of n time slots,	"**Guard period**, **input circuit** 10 **adds guard period** to reduce the effects of multipath R, e and Im of the modulated wave, and D / A transducer 11,12 outputs. The reference data A , B is set based on the subcarrier frequency and length of guard period, followed by the waveform of the reference symbol A and valid symbol period, followed by the waveform of the reference symbol B and valid symbol period." *Toshiba* at par. 0060 "Thus, in this example, **when constructing the transmission frame**, **we will transmit the reference symbol** A **at the second time slot and then the reference symbol** B **at the third time slot**. Reference data A , B that modulates each subcarrier of reference symbol A , B is: Each subcarrier frequency and duration are set based on the length of the guard duration by the addition circuit 10, and the reference symbol A , B is consecutive for each subcarrier." *Toshiba* at par. 0063 **C. US6714511** "S/P converter 101 converts a serial input signal to a plurality of parallel signals. Switches 102 and 103 switch between two input signals and outputs either of the two. IDFT circuit 104 performs IDFT processing on the input signals. **Guard interval inserter** 105 **inserts a guard interval into the input signal for every valid symbol**. D/A converter 106 performs D/A conversion on the signal with a guard interval inserted. In this way, a transmission signal is obtained." *Panasonic* at col. 6:8-15
1.b.ii **each time slot including an effective symbol period** and **guard period added to the effective symbol period**, where the **length of the series of n time slots is less than the length of the frame**; and	**A. US7095708** "In every **TDMA slot**, **there is** a transmission burst **and a guard time**. Data is transmitted in each burst using multiple tones. The burst duration is Tburst. **A guard period of duration Tguard** is inserted after each burst." *AT&T* at col. 13:4-7 "The structure of a single RS block 2302 is shown in FIG. 23A. This process is repeated for another 132 bits of data to generate another 168 bits (shown by the ×2 multiplexer). The 336 bits are mapped to 84 **16 QAM symbols**; i.e., each 16 QAM symbol represents four bits. **Six pilot symbols are then added to generate 90 symbols**. **The 90 symbols are demultiplexed over five TDMA slots**. The 18 symbols in each TDMA slot are mapped onto 18 tones; i.e., placed in the appropriate frequency bins corresponding to the assigned FDMA slot." *AT&T* at col. 14:9-19

(cont.)

1.b.ii **each time slot including an effective symbol period** and **guard period added to the effective symbol period**, where the **length of the series of n time slots is less than the length of the frame**; and

"The resource management entity (RME) must maintain and account for the resource utilization under these adaptive modulation conditions. The HSD service represented in FIG. 21 is allocated the **last two time slots in each TDMA frame**." *AT&T* at col. 13:43-47

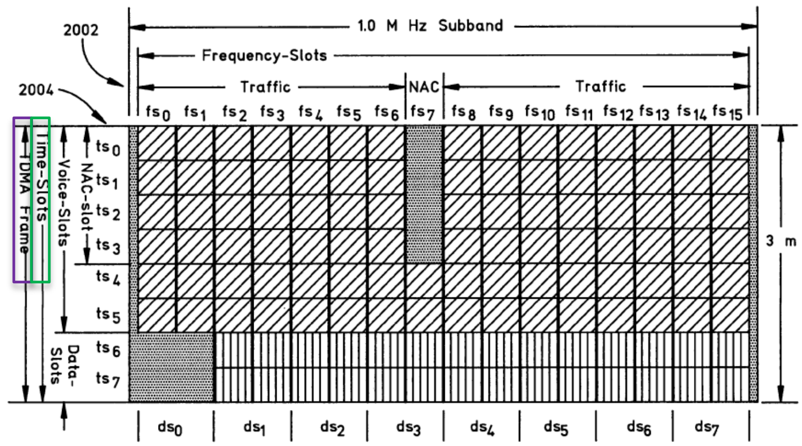
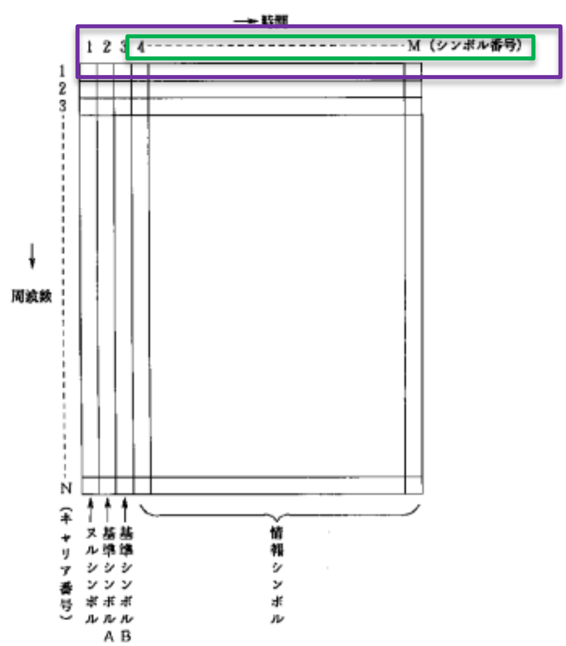


FIG. 20

B. JPH07273741

"As shown in Fig.1, the **time slot at the beginning of the transmission frame** is the null symbol for reception synchronization, and symbol data of amplitude 0 is assigned to all subcarriers. In the present embodiment, a **reference symbol** A **and a reference symbol** B **are allocated to the second and third time slots** as equalization reference signals for each subcarrier. The **fourth time slot** onward has an informational symbol assigned." *Toshiba* at par. 0031



(cont.) 1.b.ii **each time slot including an effective symbol period** and **guard period added to the effective symbol period**, where the **length of the series of n time slots is less than the length of the frame**; and	"**Reference symbol** A **has guard period** G 1 and **valid symbol period** R 1. **Guard period** G 1 is a copy of the waveform of the latter portion of **effective symbol period** R 1. It also has a **reference symbol** B **period** G 2 and an **effective symbol period** R 2. **Guard period** G 2 is a copy of the waveform of the latter portion of **effective symbol period** R 2. In this example, the amplitude and phase of the waveforms of the effective symbol periods R 1, R 2 are set such that the waveform of the termination of the reference symbol A is continuous as shown in Fig.2. This allows these two reference symbols A , B to be considered one reference symbol with a **longer equivalent guard period**." *Toshiba* at par. 0033 "1 'OFDM' symbol 'N' subcarriers Each subcarrier is modulated by, for example, 0 symbol data, predetermined reference data or informational symbol data. M OFDM symbols constitute a transmission frame. Modulated with 0 symbol data OFDM symbols (null symbols) are transmitted in the **first time slot of the transmission frame**. **Each time slot consists of a guard period and a valid symbol period**, the waveform of the guard period being a duplicate of the valid symbol period." *Toshiba* at par. 0041 **C. US6714511** "S/P converter 101 converts a serial input signal to a plurality of parallel signals. Switches 102 and 103 switch between two input signals and outputs either of the two. IDFT circuit 104 performs IDFT processing on the input signals. **Guard interval inserter** 105 **inserts a guard interval into the input signal for every valid symbol**. D/A converter 106 performs D/A conversion on the signal with a guard interval inserted. In this way, a transmission signal is obtained." *Panasonic* at col. 6:7-15
1.c a **back-end transmission processing unit** for **transmitting the generated frame as a radio signal**.	**A. US7095708** "The OFDM signals are upconverted by **RF upconverter** 216 **and fed into transmitter front end** 218 **for RF transmission out from antenna** 220 (step 316). RF OFDM signals 226 which carry the voice signals are carried over one of the voice traffic channels dedicated to the voice communication call." *AT&T* at col. 7:49-54 "FIG. 25 shows the functional block diagram of a base transmitter 2500 for the PWAN data channels in 16 QAM mode during steady state operation. The description in the

(cont.) 1.c a **back-end transmission processing unit** for **transmitting the generated frame as a radio signal**.	block diagram is for (1) **72 Kbps (two FDMA slots, two TDMA slots per frame) 216 bits of data**; (2) **carried within one RS block**; each RS block contains 216 bits of data and 36 RS parity bits; (3) 3 msec transmission time; i.e., four FTRs in one **TDMA frame**; and (4) nine pilot symbols (8+B/I−DS flag) within the 3 msec transmission time. **High speed data** 2502 **are fed into transmitter** 2500, **which includes an RS encoder** 2504, a 16 QAM mapper 2506, a pilot inserter 2508, a demultiplexer 2510, a tone mapper 2512, a channel multiplexer 2514 coupled to traffic from other channels 2526, an IFFT processor 2516, a cyclic prefix and filter 2518, a DAC 2520, an **RF stage** 2522, and an antenna 2524." *AT&T* at col. 15:58-67 through col. 16:24-29 **B. JPH07273741** "The quadrature modulation output of the quadrature modulation circuit 15 is given to the multiplier 24 after bandwidth limiting by BPF 22 of the frequency conversion circuit 21. The multiplier 24 is given a local oscillation output from the oscillator 25, and the multiplier 24 **is frequency-converted to a high frequency (RF) band signal**. Multiplier 24 outputs as band limited RF signals by BPF 26." *Toshiba* at par. 0062 "Input terminal 31 N OFDM modulated wave (OFDM symbol) is input in **transmission frame units**. The null symbol is transmitted at the beginning of the frame, the reference symbol A is transmitted at the second of the slots, and the reference symbol B is transmitted at the third of the slots. 4 to M. In addition, the reference symbol A , B is a continuous waveform. **These OFDM symbols are frequency-converted and input with a predetermined carrier frequency, followed by orthogonal modulation to RF band**." *Toshiba* at par. 0065 **C. US6714511** "The **signal with a guard interval added is converted to an analog signal by D/A converter 106 and becomes a transmission signal**." *Panasonic* at col. 7:26-28