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U.S. Patent 8,139,652

U.S. Patent 8,139,652 ("*Ariscale*" or the "patent-at-issue") was filed on December 29, 2006, and claims an earliest priority date on December 29, 2005. Claim 1 of the patent-at-issue is directed to a method of decoding a transmission signal. The method includes receiving the transmission signal including repeated symbols, deinterleaving the received signal, mutually combining the repeated symbols in the deinterleaved signal, and decoding the combined symbols. According to the method, reception performance is improved as compared to a conventional decoding method, and system performance is improved by reducing the loss of frame information included in an FCH.

The primary reference, U.S. Patent 7,630,691 ("*Qualcomm 1*"), was filed on January 23, 2002, and claims priority on the same date. The patent is directed to a method of selectively combining multiple non-synchronous transmissions to recover a message comprised of multiple frames in a wireless communication system. Initially, each transmission is separately processed to recover the message. If the message cannot be recovered error-free from any single transmission, then portions of multiple transmissions are selectively combined to recover the message. Erased frames in a message recovered from a primary transmission and good frames from other transmissions are determined. One or more combined messages are then formed, each including a different set of good frames substituting for the erased frames. If a good frame cannot be derived from any single transmission for a given erased frame, then symbols from multiple transmissions may be combined to derive the good frame. Each combined message is checked to determine whether it is good or erased.

The secondary reference, U.S. Patent 7,002,900 ("*Qualcomm 2*"), was filed on September 29, 2003, and claims priority on the same date. The patent is directed to a method of transmit diversity processing for a multi-antenna OFDM communication system. The method includes a transmitter that encodes, interleaves, and symbol maps traffic data to obtain data symbols. The transmitter processes each pair of data symbols to obtain two pairs of transmit symbols for transmission from a pair of antennas either (1) in two OFDM symbol periods for space-time transmit diversity or (2) on two subbands for space-frequency transmit diversity. $N_T(N_T - 1)/2$ different antenna pairs are used for data transmission, with different antenna pairs being used for adjacent subbands, where N_T is the number of antennas. The system may support multiple OFDM symbol sizes. The same coding, interleaving, and modulation schemes are used for different OFDM symbol sizes to simplify the transmitter and receiver processing. The transmitter performs OFDM modulation on the transmit symbol stream for each antenna in accordance with the selected OFDM symbol size. The receiver performs the complementary processing.

A sample claim chart comparing claim 1 of *Ariscale* to *Qualcomm 1* and *Qualcomm 2* is provided below.

US-8139652-B2 (“*Ariscale*”)	**A. US-7630691-B2** (“*Qualcomm 1*”) **B. US-7002900-B2** (“*Qualcomm 2*”)
[1.pre] A **computer-implemented method** for **decoding a transmission signal**, the method comprising:	**A. US-7630691-B2** “1. **A method** for **selectively combining a plurality of received transmissions from a plurality of respective signal sources to recover a message comprised of a plurality of frames**, comprising…” *Qualcomm 1* at claim 1 “9. **The method of claim 1**, further comprising… …**decoding the combined symbols to derive a good frame for the erased frame**.” *Qualcomm 1* at claim 9 “Each stream is processed by **deinterleaving and decoding the symbols for each frame of the message**, checking the CRC value for each decoded frame, assembling the decoded frames to form the message, and checking the CRC value for the message, at step 512. Other quality metrics may also be derived and monitored for the current stream being processed. Such quality metrics may include, for example, the re-encoded symbol error rate (SER), the re-encoded power metric, the "modified" Yamamoto metric, and so on.” *Qualcomm 1* at col. 9:63-10:10 “The combined frame formed by the accumulation of symbols from **multiple transmissions is then decoded and checked at the frame level**, at step 854. If the CRC for this combined frame checks, as determined at step 856, then the combined frame is provided as the good frame for the erased frame, at step 858, and the process terminates.” *Qualcomm 1* at col. 14:7-12 **B. US-7002900-B2** “For a **hardware implementation, the processing units used to perform transmit diversity processing at each of the access point and the user terminal may be implemented** within one or more application specific integrated circuits (ASICs), **digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, micro-controllers, microprocessors**, other electronic units designed to perform the functions

(cont.) [1.pre] A **computer-implemented method** for **decoding a transmission signal**, the method comprising:	described herein, or a combination thereof." *Qualcomm 2* at 19:65-20:8 "**The recovered data symbols for each transport channel are then processed** (e.g., demapped, deinterleaved, decoded, and descrambled) **to obtain decoded data for that transport channel**." *Qualcomm 2* at col. 3:51-54 "32. **A method** of **processing data for transmission in a wireless multi-antenna orthogonal frequency division multiplexing (OFDM) communication system**, the method comprising…" *Qualcomm 2* at claim 32 "34. **The method of claim 32**, further comprising… …**decoding the deinterleaved data in accordance with a decoding scheme to obtain decoded data**." *Qualcomm 2* at claim 24
[1.a] **receiving, using a computer processor, the transmission signal**, which is formed by **repeating symbols including downlink frame prefix information**, **encoding repeated symbols to form encoding blocks**, and **interleaving the encoding blocks**;	**A. US-7630691-B2** "As shown in FIG. 1, various terminals 106 are dispersed throughout the system. In an embodiment, **each terminal 106 may communicate with one or more base stations 104 on the forward link and/or reverse link at any given moment**, depending on whether or not the terminal is active and whether or not it is in an area with adequate forward link signal quality from more than one base stations 104. **The forward link (i.e., downlink) refers to transmission from the base station to the terminal**, and the reverse link (i.e., uplink) refers to transmission from the terminal to the base station." *Qualcomm 1* at col. 3:47-56 "**Encoder 218 codes each CRC-coded frame in accordance with a particular coding scheme to provided coded data. The coding scheme may include convolutional coding, Turbo coding, block coding, other coding, or any combinations thereof, or no coding at all. Typically, traffic data and messages may be coded using different schemes, and different types of message may also be coded differently**. **The coded data for each frame is typically interleaved to provide time diversity against deleterious path effects**." *Qualcomm 1* at col. 5:6-14 "The **coded** and **interleaved** data is provided to a modulator 220 and further processed to generate modulated data. The processing by modulator 220 may include (1) **mapping the coded bits to symbols based on a particular modulation**

(cont.) [1.a] **receiving, using a computer processor, the transmission signal**, which is formed by **repeating symbols including downlink frame prefix information**, **encoding repeated symbols to form encoding blocks**, and **interleaving the encoding blocks**;	**scheme (e.g., BPSK, QPSK, M-PSK, or M-QAM),** (2) **repeating or puncturing (i.e., deleting) zero or more symbols to obtain the desired data rate**, (3) **covering the symbols with orthogonal or pseudo-orthogonal codes (e.g., Walsh codes, orthogonal variable spreading factor (OVSF) codes, or quasi-orthogonal functions (QOF)) to channelize the messages into the assigned code channels (e.g., the paging channel),** and (4) **spreading the covered data with a complex PN sequence assigned to the base station**." *Qualcomm 1* at col. 5:15-27 "25. **A digital signal processor**, comprising: **means for processing a plurality of signal instances from a plurality of respective signal sources in a received signal** to provide a **plurality of signal streams, wherein each symbol stream corresponds to a respective received transmission from one of a plurality of respective signal sources included in the received signal**…" *Qualcomm 1* at claim 25 **B. US-7002900-B2** "At each user terminal 150, **one or multiple antennas 152 receive the transmitted downlink signals**, and each antenna provides a received signal to a respective demodulator (DEMOD)." *Qualcomm 2* at col. 3:39-42 "**An encoder 216 encodes the scrambled data in accordance with a coding scheme and provides code bits. The encoding increases the reliability of the data transmission. A repeat/puncture unit 218 then repeats or punctures (i.e., deletes) some of the code bits to obtain the desired code rate for each packet**… **An interleaver 220 interleaves (i.e., reorders) the code bits from repeat/puncture unit 218 based on an interleaving scheme. The interleaving provides time, frequency, and/or spatial diversity for the code bits**." *Qualcomm 2* at col. 4:50-62 "**FIG. 10 shows a flow diagram of a process 1000 for performing transmit diversity processing at a transmitter** in a multi-antenna OFDM system. The transmitter encodes traffic data in accordance with a coding scheme to obtain coded data (block 1012). **The coding scheme may comprise a fixed rate base code and a set of repetition and/or puncturing patterns for a set of code rates supported by the system**." *Qualcomm 2* at col. 19:8-15

	"43. **A receiver in a wireless multi-antenna orthogonal frequency division multiplexing (OFDM) communication system, comprising:** **a receive spatial processor operative to receive a stream of vectors of received symbols**…" *Qualcomm 2* at claim 43
[1.b] **deinterleaving, using a computer processor, the received transmission signal**;	**A. US-7630691-B2** "Decoder 318 receives each recovered symbol stream and **performs the signal processing complementary to that performed by encoder 218 at the transmitter unit**. The processing by decoder 318 for each recovered symbol stream may include (1) **deinterleaving the symbols for each frame in accordance with a deinterleaving scheme complementary to the interleaving scheme used at the transmitter unit**, and (2) decoding the deinterleaved symbols for each frame in accordance with a decoding scheme complementary to the coding scheme used at the transmitter unit." *Qualcomm 1* at col. 6:26-35 "Each stream is processed by **deinterleaving and decoding the symbols for each frame of the message**, checking the CRC value for each decoded frame, assembling the decoded frames to form the message, and checking the CRC value for the message, at step 512. Other quality metrics may also be derived and monitored for the current stream being processed. Such quality metrics may include, for example, the re-encoded symbol error rate (SER), the re-encoded power metric, the "modified" Yamamoto metric, and so on." *Qualcomm 1* at col. 9:63-10:10 **B. US-7002900-B2** "**A channel deinterleaver 974 then deinterleaves the demodulated data in a manner complementary to the interleaving performed at access point 110, as indicated by a deinterleaving control provided by controller 180y**. For the short OFDM symbol, the deinterleaving is performed across 48 data subbands for each short OFDM symbol, complementary to the interleaving described above. For the long OFDM symbol, the deinterleaving is performed across each of the four blocks of 48 data subbands, as also described above." *Qualcomm 2* at col. 18:21-30 "A receiver in a wireless multi-antenna orthogonal frequency division multiplexing (OFDM) communication system, comprising . . . **a deinterleaver operative to deinterleave the**

	demodulated data in accordance with a deinterleaving scheme to obtain deinterleaved data; and a decoder operative to decode the deinterleaved data in accordance with a decoding scheme to obtain decoded data." *Qualcomm 2* at claim 43
[1.c] **combining, using a computer processor, symbols** at the **same positions of deinterleaved encoding blocks among the repeated symbols in the deinterleaved transmission signal**; and	**A. US-7630691-B2** "FIG. 8 is a flow diagram of an embodiment of a process 838 for **combining symbols from multiple transmissions to attempt to recover a particular frame error-free. In this embodiment, the terminal is assumed to know the symbol-level timing for the received transmissions**. Process 838 may be used within steps 638 and 738 in FIGS. 6 and 7, respectively, to provide a good frame for an erased frame." *Qualcomm 1* at col. 13:48-54 "FIG. 8 shows an embodiment wherein **symbols from different streams are combined in a particular order based on the ranking of the recovered symbol streams corresponding to the received transmissions**. Due to multipath and other phenomena, it is possible that the quality of these transmissions may change over time. Thus, the ranking may be performed for each erased frame (e.g., based on the E_c/I_O estimate for the pilot received at **approximately the same time as the frame being combined or with as small a time difference as possible**)." *Qualcomm 1* at col. 14:23-32 "If a good frame cannot be derived from a single transmission for an erased frame, then symbols for two or more transmissions corresponding to the erased frame may be combined and decoded to derive the good frame for the erased frame. **The transmissions may be ranked** (e.g., based on the pilot E_c/I_O), **and the symbols from these transmissions and corresponding to the erased frame may be combined in a particular order determined based on the ranking of the transmissions. For example, the symbols from the two highest ranking transmissions may be combined first and decoded, then the symbol from the third highest ranking transmission may be combined next if a good frame cannot be derived from the first two transmissions, and so on**. The symbols from multiple transmissions may also be weighted (e.g., based on the pilot E_c/I_O) prior to being combined." *Qualcomm 1* at col. 2:55-3:2 "Decoder 318 receives each recovered symbol stream and performs the signal processing complementary to that

(cont.) [1.c] **combining, using a computer processor, symbols** at the **same positions of deinterleaved encoding blocks among the repeated symbols in the deinterleaved transmission signal**; and	performed by encoder 218 at the transmitter unit. The processing by decoder 318 for each recovered symbol stream may include (1) **deinterleaving the symbols for each frame in accordance with a deinterleaving scheme complementary to the interleaving scheme used at the transmitter unit**, and (2) **decoding the deinterleaved symbols for each frame in accordance with a decoding scheme complementary to the coding scheme used at the transmitter unit**. For example, a Viterbi decoder or a Turbo decoder may be used if convolutional or Turbo coding, respectively, is performed at the transmitter unit. The deinterleaved symbols, which are estimates of the coded bits at the transmitter unit, for certain frames may also be provided to a symbol buffer 320 and stored for later use, as described below. Each decoded frame is provided to a CRC checker 322." *Qualcomm 1* at col. 6:26-42 "The **combined frame formed by the accumulation of symbols** from multiple transmissions is then decoded and checked at the frame level, at step 854. If the CRC for this combined frame checks, as determined at step 856, then the combined frame is provided as the good frame for the erased frame, at step 858, and the process terminates." *Qualcomm 1* at col. 14:7-12 **B. US-7002900-B2** "The OFDM demodulator includes a cyclic prefix removal unit 914 and a variable-size fast Fourier transform (FFT) unit 916. **Unit 914 removes the cyclic prefix in each OFDM symbol and provides a corresponding received transformed symbol that contains L samples**, where L is dependent on the OFDM symbol size. **Variable-size FFT unit 916 receives the stream of samples from unit 914, performs an L-point FFT on each sequence of L samples in the stream for a received transformed symbol, and provides a corresponding sequence of L received symbols for the transformed symbol**. **Demodulators 154a through 154r provide N_R streams of received symbols (for data) to RX spatial processor 160y and received pilot symbols to a channel estimator 960**." *Qualcomm 2* at col.17:63-18:9

[1.d] **decoding, using a computer processor, the combined symbols**.	**A. US-7630691-B2** "**Decoder 318 receives each recovered symbol stream and performs the signal processing complementary to that performed by encoder 218 at the transmitter unit**. The processing by decoder 318 for each recovered symbol stream may include (1) deinterleaving the symbols for each frame in accordance with a deinterleaving scheme complementary to the interleaving scheme used at the transmitter unit, and (2) **decoding the deinterleaved symbols for each frame in accordance with a decoding scheme complementary to the coding scheme used at the transmitter unit**." *Qualcomm 1* at col. 6:26-35 "A **digital signal processor**, comprising: **means for processing a plurality of signal instances** from a plurality of respective signal sources in a received signal to provide a **plurality of symbol streams**, wherein each symbol stream corresponds to a respective received transmission from one of a plurality of respective signal sources included in the received signal; **means for decoding each of the plurality of symbol streams separately to recover a respective message comprised of a plurality of frames**; means for detecting each frame in each recovered message as either a good frame or an erased frame; means for detecting each recovered message as either a good message or an erased message; and means for forming at least one combined message, if a message cannot be recovered error-free from a single symbol stream, wherein each combined message includes a particular combination of good frames substituting for erased frames in the message recovered from a first symbol stream, and wherein each combined message is detected to determine if it is a good message." *Qualcomm 1* at claim 25 **B. US-7002900-B2** "**A decoder 976 then decodes the deinterleaved data in a manner complementary to the encoding performed at access point 110, as indicated by a decoding control provided by controller 180y**." *Qualcomm 2* at col. 18:30-33 "A receiver in a wireless multi-antenna orthogonal frequency division multiplexing (OFDM) communication system, comprising . . . a **decoder operative to decode the deinterleaved data in accordance with a decoding scheme to obtain decoded data**." *Qualcomm 2* at claim 43