DECLARATION UNDER 37 CFR 1.131(a)

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Patent Number: 10,389,568

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Inventor: Steve Shattil

Attorney Docket Number:

I, Steve Shattil, declare as follows:

1. I am the inventor of Patent No. 10,389,568 (’568).

2. This Declaration establishes constructive reduction to practice (and thus, invention) of the subject matter of each rejected claim prior to the effective date (under 35 U.S.C. 102(e)) of references on which the rejection is based.

3. I completed my invention as described and claimed in the subject patent (’568) as evidenced by the following:

4. The subject matter of each of the rejected claims is disclosed in U.S. Patent appl. no. **60/163,141 (’141), filed Nov. 2, 1999**.

<u>Re: Claim 1</u>

5. With respect to claim 1, the figures and written description throughout ’141 support the claimed invention of the instant patent. For the sake of brevity, FIG. 6A of ’141 is shown below.

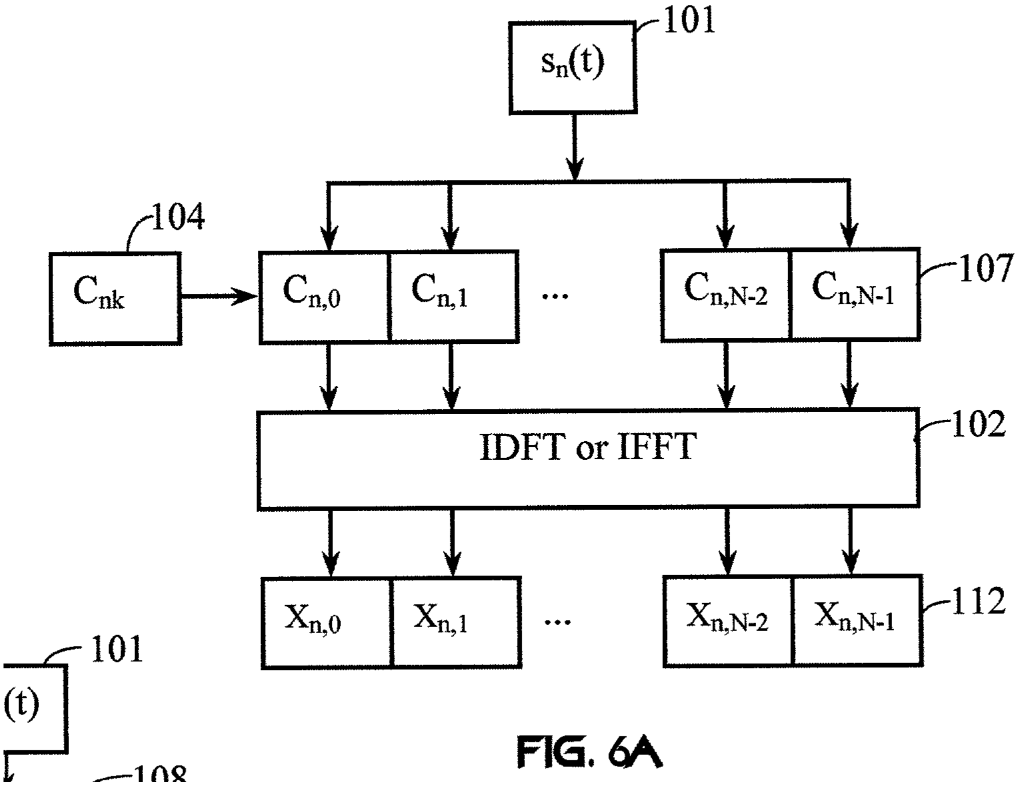

FIG. 6A

6. The features of claim 1 (with emphasis) and corresponding support in '141, by way of example, but without limitation, are shown as follows:

- **dividing a block of complex-valued symbols into a plurality of sets of complex-valued symbols; transform precoding each of the plurality of sets of complex-valued symbols into a block of transform-precoded complex-valued symbols;**

7. Written support in '141 includes the following:

Page 24, third Par. – Page 25, first Par. (emphasis added)

"FIG. 6A shows a multicarrier transmitter and transmission method of the present invention. **An n^{th} information signal $s_n(t)$, such as for an n^{th} user, is applied to an n^{th} code c_n having N chips c_{kn} (k = 0 to N-1). The information signal $s_n(t)$ may modulate the**

code or it may be modulated by the code c_n.

A code generator 114 provides the N chips c_{kn} to a serial-to-parallel converter 107 that arranges the chips c_{kn} to parallel modulate each of a plurality of carrier signals generated by a carrier-signal generator 102. If the carriers are multi-frequency carriers, the carrier-signal generator 102 may be represented by the operation or implementation of a digital method for generating multi-frequency carriers, such as an inverse Discreet Fourier Transform or an inverse Fast Fourier Transform. Each chip c_{kn} may be applied to a frequency bin of a transform process. **The chips c_{kn} may have** binary, real, or **complex values**. The modulated carriers are optionally coupled to an output processor 112, which processes the carriers prior to coupling them into a communication channel (not shown).

The code generator 114 can be used as an information-signal encoder or a carrier encoder. **An information signal may be used to modulate at least one code sequence.** The code generator 114 may be a multi-stage code generator. **Code generators may include one or more N-point transforms. N-point transforms include Discrete Fourier Transforms (DFT),** Fast Fourier Transforms (FFT), Walsh Transforms (WT), Hilbert Transforms (HT), Randomizer Transforms (RT), Permutator Transforms (PT), Inverse DFTs, Inverse FFTs, Inverse WTs, Inverse HTs, Inverse RTs, Inverse PTs, and any other reversible transform."

8. s_n(t) is a single element of the set of complex-valued symbols. The POSITA would know that creating a block of such elements and "**dividing a block of complex-valued symbols into a plurality of sets of complex-valued symbols**" is a necessary step of implementing the code generator with an N-point transform.

9. The POSITA would know that the "**Code generators may include one or more N-point transforms**" performs **transform precoding each of the plurality of sets of complex-valued symbols into a block of transform-precoded complex-valued symbols**.

- **generating an Orthogonal Frequency Division Multiplex (OFDM) signal comprising a plurality of OFDM subcarriers modulated by the transform-precoded complex-valued symbols,;**

10. Written support in ’141 includes the following:

Page 24, third Par. – Page 25, first Par.: (emphasis added)

“FIG. 6A shows a multicarrier transmitter and transmission method of the present invention. An n^{th} information signal $s_n(t)$, such as for an n^{th} user, is applied to an n^{th} code c_n having N chips c_{kn} (k = 0 to N-1). The information signal $s_n(t)$ may modulate the code or it may be modulated by the code c_n.

A code generator 114 provides the N chips c_{kn} to a serial-to-parallel converter 107 that arranges the chips c_{kn} to **parallel modulate each of a plurality of carrier signals generated by a carrier-signal generator 102. If the carriers are multi-frequency carriers, the carrier-signal generator 102 may be represented by the operation or implementation of a digital method for generating multi-frequency carriers, such as an inverse Discreet Fourier Transform or an inverse Fast Fourier Transform.** Each chip c_{kn} may be applied to a **frequency bin of a transform process**. The chips c_{kn} may have binary, real, or complex values. **The modulated carriers** are optionally coupled to an output processor 112, which processes the carriers prior to coupling them into a communication channel (not shown).

The code generator 114 can be used as an information-signal encoder or a carrier encoder. An information signal may be used to modulate at least one code sequence. The code generator 114 may be a multi-stage code generator. Code generators may include one or more N-point transforms. N-point transforms include Discrete Fourier Transforms (DFT), Fast Fourier Transforms (FFT), Walsh Transforms (WT), Hilbert Transforms (HT), Randomizer Transforms (RT), Permutator Transforms (PT), Inverse DFTs, Inverse FFTs, Inverse WTs, Inverse HTs, Inverse RTs, Inverse PTs, and any other reversible transform.”

11. The POSITA would understand that the disclosed IDFT or IFFT produces an OFDM signal (e.g., “a digital method for generating multi-frequency carriers, such as an inverse Discreet Fourier Transform” in Page 24, third Par.), and OFDM is explicitly disclosed, such as:

Page 43, third Par.: (emphasis added)

"Redundantly modulated **multicarrier signals** may be used as a multiple-access communication protocol such as CIMA, MC-CDMA, or an **OFDM** protocol that transmits data over multiple carriers."

Page 18, fourth Par. – Page 19, first Par.: (emphasis added)

"The signal generator 102 produces a **multicarrier signal. A multicarrier signal is defined as a plurality of carrier signals having different orthogonalizing properties (also referred to as orthogonality parameters or diversity parameters), such as** time, differential power, location, mode, **frequency**, polarization, phase space, directivity, spread-spectrum code, or any combination of orthogonalizing properties. An orthogonalizing property (such as polarization) may not be completely orthogonal. For example, polarized signals having less than 90-degrees separation between them have cross-polarization (interference) terms. A multicarrier signal may be defined by any signal property that affects propagation characteristics, such as velocity, reflections, and refraction. Each multicarrier signal may be defined by a different propagation mode.

- **wherein the transform precoding generates a plurality of orthogonal spreading codes to provide a superposition of the plurality of OFDM subcarriers with a reduced peak-to-average-power ratio.**

12. Written support in '141 includes the following:

Page 13, thirteenth and fourteenth Pars.: (emphasis added)

"FIG. 5A is a plot of relative amplitudes of a set of multi-frequency carriers that produce a composite signal 130 (shown in FIG. 5B) having time-domain characteristics of a direct-sequence CDMA signal.

FIG. 5B is a time-domain plot of a **superposition of the carrier signals** shown in FIG. 5A."

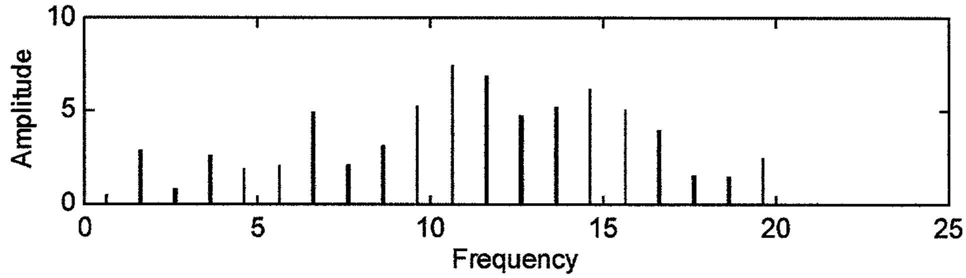

FIG. 5A

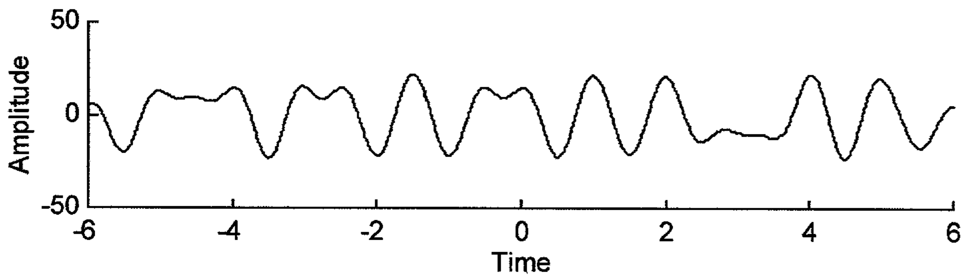

FIG. 5B

13. It was well-known in the art that a direct-sequence signal is a single-carrier signal that has lower peak-to-average power ratio than a prior-art multicarrier signal (see Richard D.J . van Nee; "OFDM Codes For Peak-to-Average Power Reduction And Error Correction", Proceedings of GLOBECOM'96. 1996 IEEE Global Telecommunications Conference). FIG. 5B illustrates how the amplitude of the multicarrier signal produced by the invention has a reduced peak-to-average power ratio.

Page 23, third Par.: (emphasis added)

"The modulator 104 may provide weights to each of the carriers according to a predetermined code. **The coded weights may be applied to the carriers in order to generate a predetermined time-domain profile, such as a direct-sequence signal.** A preferred embodiment of the invention includes a process of **applying complex weights to a multicarrier signal in order to create a predetermined time-domain signal. A**

predetermined time-domain signal (or profile) is defined herein as a specific shape of at least one signal parameter, such as amplitude, frequency, polarization, and phase in the time domain."

Page 13, thirteenth and fourteenth Pars. (emphasis added); and FIG. 5B depicts a single-carrier signal, i.e., a direct-sequence CDMA signal, with low PAPR.

"FIG. 5A is a plot of relative amplitudes of a set of multi-frequency carriers that produce a composite signal 130 (shown in FIG. 5B) **having time-domain characteristics of a direct-sequence CDMA signal**.

FIG. 5B is a time-domain plot of a superposition of the carrier signals shown in FIG. 5A."

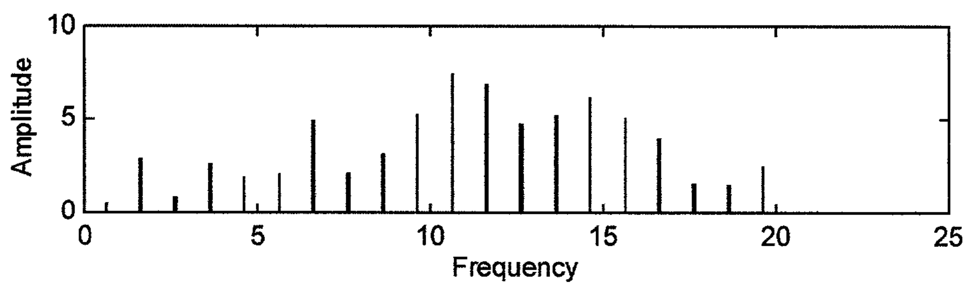

FIG. 5A

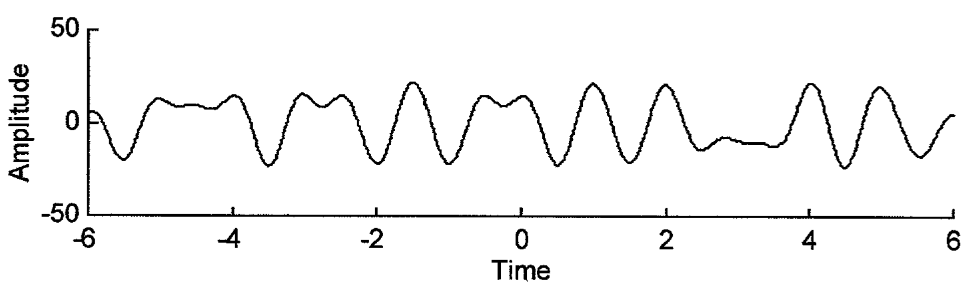

FIG. 5B

Page 70, first Par.: (emphasis added)

"Furthermore, **constant-modulus signals may be transmitted** in the communication system. Constant-modulus transmissions can simplify the demultiplexing of received signals."

14. The POSITA would understand that constant-modulus signals have a low peak-to-average-power ratio, which reduces transmission power requirements.

Page 6, second Par.: (emphasis added):

"The frequency-diversity of CIMA signals greatly **reduces transmission power requirements**…"

15. The POSITA would understand that the phase shifts "$n\Delta\phi_k$ to each n^{th} carrier" are codes that provide "orthogonal coding", such as described in:

Page 21, first Par. (emphasis added):

"The CIMA envelopes are periodic with a period of $1/f_s$. The mainlobe of the envelope has a width of $2/Nf_s$, and the N-1 sidelobe widths are $2/Nf_s$. Applying a phase shift of $n\Delta\phi_k$ to each n^{th} carrier shifts the CIMA envelope in time by $\Delta t = \Delta\phi_k/2\pi f_s$. Therefore **N signals can be positioned orthogonally in time**."

Page 28, fourth Par. (emphasis added):

"CIMA provides superior bandwidth efficiency compared to any other protocol, and it allows a seamless conversion from **orthogonal coding** to quasi-orthogonal coding."

Claim 2: The method of claim 1, wherein the transform precoding spreads the block of complex-valued symbols with a plurality of orthogonal spreading codes comprising complex-valued coefficients of a discrete Fourier transform (DFT) to produce the block of

transform-precoded complex-valued symbols.

16. Written support in ’141 includes the following:

Page 24, fifth Par. – Page 25, first Par.: (emphasis added)

“Code generators may include one or more N-point transforms. N-point transforms include **Discrete Fourier Transforms (DFT)**, Fast Fourier Transforms (FFT), Walsh Transforms (WT), Hilbert Transforms (HT), Randomizer Transforms (RT), Permutator Transforms (PT), Inverse DFTs, Inverse FFTs, Inverse WTs, Inverse HTs, Inverse RTs, Inverse PTs, and any other reversible transform.”

Claim 3: The method of claim 2, wherein the DFT is a fast Fourier transform (FFT).

17. Written support in ’141 includes the following:

Page 24, fifth Par. – Page 25, first Par.: (emphasis added)

“Code generators may include one or more N-point transforms. N-point transforms include Discrete Fourier Transforms (DFT), **Fast Fourier Transforms (FFT),** Walsh Transforms (WT), Hilbert Transforms (HT), Randomizer Transforms (RT), Permutator Transforms (PT), Inverse DFTs, Inverse FFTs, Inverse WTs, Inverse HTs, Inverse RTs, Inverse PTs, and any other reversible transform.”

Claim 4: The method of claim 2, wherein:
$M_{sc}^{PUSCH} = M_{RB}^{PUSCH} * N_{sc}^{RB}$;
M_{RB}^{PUSCH} **is a scheduled bandwidth for uplink transmission expressed as a number of resource blocks; and**
N_{sc}^{RB} **is a resource block size in the frequency domain expressed as a number of subcarriers.**

18. Written support in ’141 includes the following:

Page 24, second Par.: (emphasis added)

“The **bandwidth** of the time-domain sequence is related to the bandwidth of the carriers, which is related to the **number and spacing of the carriers**.”

Claim 5: The method of claim 4, wherein:
$M_{RB}^{PUSCH} \leq N_{RB}^{UL}$; and
N_{RB}^{UL} is an uplink bandwidth configuration expressed in multiples of N_{sc}^{RB}.

19. Written support in ’141 includes the following:

Page 24, second Par.: (emphasis added)

“The **bandwidth** of the time-domain sequence is related to the bandwidth of the carriers, which is related to the **number and spacing of the carriers**.”

Page 41 third Par.: (emphasis added)

“The received signals are preferably separable **through a multiple-access technique based on** at least one diversity parameter, such as spread-spectrum code, **frequency**, time, differential power, polarization, or phase space.”

Page 43, third Par.: (emphasis added)

“Redundantly modulated multicarrier signals may be used as a multiple-access communication protocol such as CIMA, MC-CDMA, or an **OFDM** protocol that transmits data over multiple carriers.”

Claim 6: The method of claim 1, comprising: mapping the block of transform-precoded

complex-valued symbols to physical resource blocks assigned for transmission of a physical uplink shared channel.

20. Written support in ’141 includes the following:

Page 24, fourth Par.: (emphasis added)

> “A code generator 114 provides the N chips c_{kn} to **a serial-to-parallel converter 107 that arranges the chips c_{kn} to parallel modulate each of a plurality of carrier signals** generated by a carrier-signal generator 102. If the carriers are multi-frequency carriers, the carrier-signal generator 102 may be represented by the operation or implementation of a digital method for generating multi-frequency carriers, such as an inverse Discreet Fourier Transform or an inverse Fast Fourier Transform. **Each chip c_{kn} may be applied to a frequency bin of a transform process**. The chips c_{kn} may have binary, real, or complex values. The modulated carriers are optionally coupled to an output processor 112, which processes the carriers prior to coupling them into a communication channel (not shown).”

21. The ”mapping” is performed by the **serial-to-parallel converter 107**, which **arranges** the chips (i.e., the spread data symbols resulting from “information signal $s_n(t)$… applied to an n^{th} code c_n having N chips”) **to parallel modulate each of a plurality of carrier signals generated by a carrier-signal generator 102**. Mapping is performed when each chip is **applied to a frequency bin of a transform process**. In an Inverse DFT or an Inverse FFT, each frequency bin corresponds to one of a plurality of OFDM subcarriers.”

Claim 7: The method of claim 6, wherein the mapping is responsive to an assignment of spectrum resources for selecting a plurality of OFDM subcarriers corresponding to at least one OFDM symbol interval.

22. Written support in ’141 includes the above and the following:

Page 23, sixth Par. – Page 24, first Par.: (emphasis added)

"Although carriers may be modulated with respect to codes, or information signals may be modulated onto the carriers within **multiple time intervals** or having different time offsets, the carriers are redundantly modulated with at least one information signal. In this specification, redundantly modulated multicarrier signals describe any of a set of signals wherein at least one information signal is modulated onto a plurality of carrier signals having different values of at least one diversity parameter. A modulator may simultaneously modulate the carriers with the information signal, or it may modulate each carrier independently. The carrier signals may be modulated at **different time intervals**."

Claim 8: The method of claim 6, wherein at least one of the transform precoding and the mapping is configured to weight each of the plurality of OFDM subcarriers with an amplitude scaling factor to adjust gain of the superposition.

23. Written support in '141 includes the above and the following:

Page 20, fourth Par.: (emphasis added)

"In an optional third modulation step 104C additional **weights a_{nk} are applied to the carriers**. The weights a_{nk} may include windowing weights, channel-compensation values, and/or weight values that facilitate signal separation by cancellation or constellation methods at a receiver (not shown)."

Page 54, last Par.: (emphasis added)

"Each of the information signals $s_n(t)$ has a series of **scaling factors** α_{mk}, β_{mk},..., ζ_{mk} that depends on the amplitude-versus-frequency profile $C_n(x)$ applied to the carrier signals."

Claim 9: The method of claim 6, wherein the mapping is configured to select the plurality of OFDM subcarriers according to at least one of a frequency division multiple access

scheme, a time division multiple access scheme, a space division multiple access scheme, a code division multiple access scheme, and a frequency-hopping scheme.

24. Written support in ’141 includes the above and the following:

Page 41, third Par.: (emphasis added)

“The received signals are preferably separable through a **multiple-access** technique based on at least one diversity parameter, such as **spread-spectrum code**, **frequency**, **time**, differential power, polarization, or phase space.”

Page 43, third Par.: (emphasis added)

“Redundantly modulated **multicarrier signals** may be used as a multiple-access communication protocol such as CIMA, MC-CDMA, or an **OFDM** protocol that transmits data over multiple carriers… CIMA signals can be used to construct many different wireless protocols including GSM, other **TDMA** protocols, and **CDMA**.”

Page 15, eleventh Par.: (emphasis added)

“FIG. 26 is a schematic diagram of a communication system that uses redundantly modulated carriers to enhance diversity and uses **spatial interferometry multiplexing** to increase capacity.”

Claim 10: The method of claim 1, comprising: scrambling a block of bits of one subframe of a physical uplink shared channel resulting in a block of scrambled bits; and modulating the block of scrambled bits resulting in the block of complex-valued symbols.

25. Written support in ’141 includes the above and the following:

Page 8, fourth Par.:

"CIMA can also be used to create other protocols, such as CDMA."

A person of ordinary skill in the art would know that CDMA employs a pseudo-noise scrambling code. For example, in F. Vanhaverbeke, et al.; "DS/CDMA with two sets of orthogonal spreading sequences and iterative detection"; IEEE Communications Letters (Volume: 4, Issue: 9, September 2000):

> "In this letter we introduce a direct-sequence code-division multiple access (DS/CDMA) concept which accommodates a higher number of users than the spreading factor N. Each of the available orthogonal spreading sequences of length N is assigned to one of the first N users which employ a common pseudonoise (PN) **scrambling** sequence." (emphasis added)

Page 24, last Par. – Page 25, first Par.: (emphasis added)

> "The code generator 114 can be used as an information-signal encoder or a carrier encoder. An information signal may be used to modulate at least one code sequence. The code generator 114 may be a multi-stage code generator. Code generators may include one or more N-point transforms. N-point transforms include Discrete Fourier Transforms (DFT), Fast Fourier Transforms (FFT), Walsh Transforms (WT), Hilbert Transforms (HT), Randomizer Transforms (RT), **Permutator Transforms (PT)**, Inverse DFTs, Inverse FFTs, Inverse WTs, Inverse HTs, Inverse RTs, Inverse PTs, and any other reversible transform."

The POSITA understands that permutation is a scrambling operation.

Claim 11: The method of claim 10, wherein the scrambling is configured to scramble the block of bits into a block of scrambled bits with at least one pseudo-noise code.

26. Written support in '141 includes the above and the following:

Page 8, fourth Par.:

"CIMA can also be used to create other protocols, such as CDMA."

A person of ordinary skill in the art would know that CDMA employs a pseudo-noise scrambling code. For example, in F. Vanhaverbeke, et al.; "DS/CDMA with two sets of orthogonal spreading sequences and iterative detection"; IEEE Communications Letters (Volume: 4, Issue: 9, September 2000):

> "In this letter we introduce a direct-sequence code-division multiple access (DS/CDMA) concept which accommodates a higher number of users than the spreading factor N. Each of the available orthogonal spreading sequences of length N is assigned to one of the first N users which employ a common **pseudonoise** (PN) scrambling sequence." (emphasis added)

Claim 12: The method of claim 1, wherein the transform precoding is applied according to

$$z(l \cdot M_{sc}^{PUSCH} + k) = \frac{1}{\sqrt{M_{sc}^{PUSCH}}} \sum_{i=0}^{M_{sc}^{PUSCH}-1} d(l \cdot M_{sc}^{PUSCH} + i) e^{-j\frac{2\pi ik}{M_{sc}^{PUSCH}}}$$

wherein:

the block of complex-valued symbols and the block of transform-precoded complex-valued symbol comprises a plurality of resource elements;

l **represents a time-domain index of each of the plurality of resource elements;**

k **represents a frequency-domain index of each of the plurality of resource elements;**

M_{sc}^{PUSCH} is a scheduled bandwidth for uplink transmission expressed as a number of subcarriers;

$d(l \cdot M_{sc}^{PUSCH}+i)$ represents resource elements of the block of complex-valued symbols; and $z(l \cdot M_{sc}^{PUSCH}+k)$ represents resource elements of the block of transform precoded complex-valued symbols.

27. Written support in '141 includes the following:

Page 21, first Par.:

"A CIMA signal corresponding to the superposition on N carriers uniformly spaced in frequency by f_s has a waveform envelope according the equation:

$$E(t) = \left| \frac{\sin(N\pi f_s t)}{\sin(\pi f_s t)} \right|$$

The CIMA envelopes are periodic with a period of $1/f_s$. The mainlobe of the envelope has a width of $2/Nf_s$, and the N-1 sidelobe widths are $2/Nf_s$. Applying a phase shift of $n\Delta\phi_k$ to each n^{th} carrier shifts the CIMA envelope in time by $\Delta t = \Delta\phi_k/2\pi f_s$. Therefore N signals can be positioned orthogonally in time."

28. The POSITA would understand that the phase shifts "$n\Delta\phi_k$ to each n^{th} carrier" is precoding that provides the term $e^{-j\frac{2\pi ik}{M_{sc}^{PUSCH}}}$ and the sum over $\mathbf{M_{sc}^{PUSCH}}$ carriers in the above equation. The POSITA would understand that the disclosed "N carriers" in the disclosed wireless communication system expresses the number of subcarriers represented by $\mathbf{M_{sc}^{PUSCH}}$. The POSITA understands that the disclosed "N carriers" is equivalent to the "resource elements" terminology. The POSITA understands that the disclosed coding is applied to blocks of data symbols using a digital transform, such as a DFT. For example, support in '141 includes:

Page 25, first Par. (emphasis added):

"**The code generator 114 can be used as an information-signal encoder** or a carrier encoder. **An information signal may be used to modulate at least one code sequence.** The code generator 114 may be a multi-stage code generator. **Code generators may include one or more N-point transforms. N-point transforms include Discrete Fourier Transforms (DFT)**…"

29. Thus, the POSITA understands that the DFT operates on blocks of data symbols (i.e., information signal), the equation in claim 12 being representative of the disclosed DFT, which denotes the scaling term, $\frac{1}{\sqrt{M_{sc}^{PUSCH}}}$, and the blocks of data symbols $d(l \cdot M_{sc}^{PUSCH}+i)$ and transform-precoded (i.e., coded) symbols $z(l \cdot M_{sc}^{PUSCH}+k)$. Specifically, the POSITA recognizes the equation in the above claim as the k^{th} DFT output, as the disclosure instructs

the POSITA to employ DFT coding.

Claim 13: The method of claim 12, wherein: the transform precoding spreads the block of complex-valued symbols with a plurality of orthogonal spreading codes comprising complex-valued coefficients of a discrete Fourier transform (DFT) to produce the block of transform precoded complex-valued symbols; and M_{sc}^{PUSCH} is a length of the DFT corresponding to the plurality of orthogonal spreading codes.

30. Written support in '141 includes the following:

Page 21, first Par.:

"A CIMA signal corresponding to the superposition on N carriers uniformly spaced in frequency by f_s has a waveform envelope according the equation:

$$E(t) = \left| \frac{\sin(N\pi f_s t)}{\sin(\pi f_s t)} \right|$$

The CIMA envelopes are periodic with a period of $1/f_s$. The mainlobe of the envelope has a width of $2/Nf_s$, and the N-1 sidelobe widths are $2/Nf_s$. Applying a phase shift of $n\Delta\phi_k$ to each n^{th} carrier shifts the CIMA envelope in time by $\Delta t = \Delta\phi_k/2\pi f_s$. Therefore N signals can be positioned orthogonally in time."

31. The POSITA understands that the disclosed phase shift codes applied to $\mathbf{M_{sc}^{PUSCH}}$ = N subcarriers comprises $\mathbf{M_{sc}^{PUSCH}}$ = N orthogonal codes, and the POSITA recognizes that the disclosed phase shift codes are the coefficients of a DFT. Written support in '141 explicitly instructs the POSITA to employ a DFT, such as in:

Page 25, first Par. (emphasis added):

"**The code generator 114 can be used as an information-signal encoder** or a carrier encoder. **An information signal may be used to modulate at least one code sequence.** The code generator 114 may be a multi-stage code generator. **Code generators may**

include one or more N-point transforms. N-point transforms include Discrete Fourier Transforms (DFT)…"

32. The POSITA understands that $\mathbf{M_{sc}}^{\mathbf{PUSCH}}$ = N is the length of the DFT that enables "N signals can be positioned orthogonally in time."

Claim 14: The method of claim 13, wherein: each transform-precoded set of complex-valued symbols of the block of transform-precoded complex-valued symbols is a single-carrier frequency division multiple access symbol; and said each transform precoded set of complex-valued symbols is processed by the DFT.

33. It was well-known in the art that a direct-sequence signal is a single-carrier signal. Written support in '141 includes the following:

Page 23, third Par.: (emphasis added)

"The modulator 104 may provide weights to each of the carriers according to a predetermined code. **The coded weights may be applied to the carriers in order to generate a predetermined time-domain profile, such as a direct-sequence signal.** A preferred embodiment of the invention includes a process of **applying complex weights to a multicarrier signal in order to create a predetermined time-domain signal. A predetermined time-domain signal (or profile) is defined herein as a specific shape of at least one signal parameter, such as amplitude**, frequency, polarization, and phase in the time domain."

Page 13, thirteenth and fourteenth Pars. (emphasis added); and FIG. 5B depicts a single-carrier signal, i.e., a direct-sequence CDMA signal.

"FIG. 5A is a plot of relative amplitudes of a set of multi-frequency carriers that produce a composite signal 130 (shown in FIG. 5B) **having time-domain characteristics of a direct-sequence CDMA signal**.

FIG. 5B is a time-domain plot of a superposition of the carrier signals shown in FIG. 5A."

34. Additionally, frequency-division multiplexing is disclosed throughout '141, such as OFDM mentioned on Page 43, third Par.: (emphasis added)

"Redundantly modulated multicarrier signals may be used as a multiple-access communication protocol such as CIMA, MC-CDMA, or an **OFDM** protocol that transmits data over multiple carriers."

And Page 41, third Par.: (emphasis added)

"The received signals are preferably separable through a **multiple-access** technique based on at least one diversity parameter, such as **spread-spectrum code**, **frequency**, time, differential power, polarization, or phase space."

Claim 15:. The method of claim 12, wherein: the block of transform-precoded complex-valued symbols comprises carrier interferometry symbol values (w_n); and the block of complex-valued symbols comprises data symbols (s_n).

35. The '141 disclosure refers to transform precoding as carrier interferometry. Written support includes the following:

Page 5, last Par.:

"VII. CARRIER INTERFEROMETRY

In U.S. Pat. No. 5,955,992, U.S. Pat. Appl. 09/393,431, and PCT Pat. Appl. No. WO99/41871, which are hereby incorporated by reference, applicant describes a multicarrier protocol that uses interference characteristics between the carriers to convey baseband information signals. This protocol is known as Carrier Interference Multiple Access (CIMA)."

Claim 16: The method of claim 15, wherein carrier interferometry code chip values are arranged with respect to a plurality of phase spaces.

36. Written support in ’141 includes the above and the following:

Page 28, second Par.:

> “FIG. 3A shows a plurality of phase spaces 123, 125, 127, and 129. Phase space (which is described in PCT Appl. No. WO99/41871) is the phase relationship between different carriers.”

37. The POSITA recognizes that each column of the DFT denotes a phase space described and shown in ’141.

Claim 17: The method of claim 16, wherein the plurality of phase spaces comprises orthogonal phase spaces.

38. Written support in ’141 includes the above and the following:

> Page 21, first Par.:
>
> “A CIMA signal corresponding to the superposition on N carriers uniformly spaced in frequency by f_s has a waveform envelope according the equation:
>
> $$E(t) = \left| \frac{\sin(N\pi f_s t)}{\sin(\pi f_s t)} \right|$$
>
> The CIMA envelopes are periodic with a period of $1/f_s$. The mainlobe of the envelope has a width of $2/Nf_s$, and the N-1 sidelobe widths are $2/Nf_s$. Applying a phase shift of $n\Delta\phi_k$ to each n^{th} carrier shifts the CIMA envelope in time by $\Delta t = \Delta\phi_k/2\pi f_s$. Therefore N signals can be positioned orthogonally in time.”

39. The POSITA understands that N sets of phase shifts of $n\Delta\phi_k$ to each n^{th} carrier, and the

resulting N shifts of the CIMA envelope which enable N signals to be positioned orthogonally, indicate orthogonal phase spaces. The POSITA understands that phase spaces corresponding to DFT basis vectors are orthogonal.

Claim 18: The method of claim 16, wherein each of the data symbol values is impressed upon one of the plurality of phase spaces.

40. Written support in ’141 includes the above and the following:

Page 25, first Par. (emphasis added):

> “**The code generator 114 can be used as an information-signal encoder** or a carrier encoder. **An information signal may be used to modulate at least one code sequence.** The code generator 114 may be a multi-stage code generator. **Code generators may include one or more N-point transforms. N-point transforms include Discrete Fourier Transforms (DFT)**…”

41. The POSITA understands that each phase space, represented as a set of phase shifts (e.g., “phase shift of $n\Delta\phi_k$ to each n^{th} carrier”) described in Page 21, first Par. is a column of the DFT disclosed in Page 25, first Par. Thus, the POSITA recognizes that the disclosed code generator impresses data symbols on phase spaces.

Claim 19: The method of claim 15, wherein the number of carrier interferometry symbol values is different than the number of data symbols.

42. Written support in ’141 includes the following:

Page 48, second Par.:

> “CIMA enables 2M-1 quasi-orthogonal signals $s_{n=2M-1}(t)$ in the time domain, whereas carrier processing yields only M equations.”

Claim 20: The method of claim 1, wherein each of the plurality of sets of complex-valued symbols is a single carrier frequency division multiple access (SC-FDMA) symbol.

43. It was well-known in the art that a direct-sequence signal is a single-carrier signal. Written support in ’141 includes the following:

Page 23, third Par.: (emphasis added)

“The modulator 104 may provide weights to each of the carriers according to a predetermined code. **The coded weights may be applied to the carriers in order to generate a predetermined time-domain profile, such as a direct-sequence signal.** A preferred embodiment of the invention includes a process of **applying complex weights to a multicarrier signal in order to create a predetermined time-domain signal. A predetermined time-domain signal (or profile) is defined herein as a specific shape of at least one signal parameter, such as amplitude**, frequency, polarization, and phase in the time domain.”

44. Additionally, frequency-division multiplexing is disclosed throughout ’141, such as OFDM mentioned on Page 43, third Par.: (Emphasis added)

“Redundantly modulated multicarrier signals may be used as a multiple-access communication protocol such as CIMA, MC-CDMA, or an **OFDM** protocol that transmits data over multiple carriers.”

Claim 21: The method of claim 1, comprising generating a time-continuous signal defined by:

$$s_l(t) = \sum_{k=-[N_{RB}^{UL} N_{sc}^{RB}/2]}^{[N_{RB}^{UL} N_{sc}^{RB}/2]-1} a_{k^{(-)},l} e^{j2\pi(k+1/2)\Delta f(t-N_{CP,l}T_s)}$$ **, wherein:**

N_{sc}^{RB} is a resource block size in a frequency domain express as a number of subcarriers;

N_{RB}^{UL} is an uplink bandwidth configuration express in multiples of N_{sc}^{RB};

$a_{k(-),l}$ is a value of a resource element;

Δf is subcarrier spacing;

$N_{CP,l}$ is a downlink cyclic prefix length for OFDM symbol *l* in a slot; and T_s is a basic time unit.

45. Written support in '141 includes the above and the following:

Page 24, fourth Par.: (emphasis added)

"A code generator 114 provides the N chips c_{kn} to a serial-to-parallel converter 107 that arranges the chips c_{kn} to parallel modulate each of a plurality of carrier signals generated by a carrier-signal generator 102. **If the carriers are multi-frequency carriers, the carrier-signal generator 102 may be represented by the operation or implementation of a digital method for generating multi-frequency carriers, such as an inverse Discreet Fourier Transform or an inverse Fast Fourier Transform.** Each chip c_{kn} may be applied to a frequency bin of a transform process. The chips c_{kn} may have binary, real, or complex values. The modulated carriers are optionally coupled to an output processor 112, which processes the carriers prior to coupling them into a communication channel (not shown)."

46. The POSITA recognizes that the equation in claim 21 has the form of an inverse Discrete Fourier Transform with a half-subcarrier offset and cyclic prefix, as was well-known in the art. For example, see the equivalent eqn (7) in **IEEE 802.11-98/072-r6, OFDM Physical Layer Specification for the 5 GHz Band (July 9, 1998):**

Starting at time $t=t_s$, an OFDM symbol $r_k(t)$ is defined as:

$$r_k(t) = \mathrm{Re}\left\{ w(t-t_s) \sum_{\substack{i=-\frac{N_s}{2} \\ i \neq 0}}^{\frac{N_s}{2}} d_{i+(N_s+1)(k+1/2)} \exp(j2\pi(f_c - \frac{i}{T})(t - t_s - T_{prefix})) \right\} \;,\; t_s \le t \le t_s + T + T_{prefix} + T_{postfix}$$

$$r_k(t) = 0 \;,\; t<t_s \wedge t>t_s + T + T_{prefix} + T_{postfix} \qquad (7)$$

Claim 22: The method of claim 21, wherein the time-continuous signal is generated in a single carrier frequency division multiple access (SC-FDMA) symbol.

47. It was well-known in the art that a direct-sequence signal is a single-carrier signal. Written support in ’141 includes the following:

Page 23, third Par.: (emphasis added)

“The modulator 104 may provide weights to each of the carriers according to a predetermined code. **The coded weights may be applied to the carriers in order to generate a predetermined time-domain profile, such as a direct-sequence signal.** A preferred embodiment of the invention includes a process of **applying complex weights to a multicarrier signal in order to create a predetermined time-domain signal. A predetermined time-domain signal (or profile) is defined herein as a specific shape of at least one signal parameter, such as amplitude**, frequency, polarization, and phase in the time domain.”

48. Additionally, frequency-division multiplexing is disclosed throughout ’141, such as OFDM mentioned on Page 43, third Par.: (Emphasis added)

“Redundantly modulated multicarrier signals may be used as a multiple-access communication protocol such as CIMA, MC-CDMA, or an **OFDM** protocol that transmits data over multiple carriers.”

Claim 23: The method of claim 1, wherein the transform precoding generates a plurality of quasi-orthogonal complex-valued spreading codes to provide a superposition of the plurality of OFDM subcarriers with a reduced peak-to-average-power ratio.

49. Written support in ’141 includes the following:

Page 28, fourth Par. (emphasis added):

"CIMA provides superior bandwidth efficiency compared to any other protocol, and it allows a seamless conversion from orthogonal coding to **quasi-orthogonal coding**."

Page 48, second Par.:

"CIMA enables 2M-1 **quasi-orthogonal** signals $s_{n=2M-1}(t)$ in the time domain, whereas carrier processing yields only M equations."

50. The POSITA understands that disclosed quasi-orthogonal coding provides low peak-to-average power according to similar mechanisms as employed by orthogonal coding.

Claim 24. An apparatus, comprising:

a processor; and

a non-transitory computer-readable memory communicatively coupled to the processor, the memory including a set of instructions stored thereon and executable by the processor:

51. Written support in '141 includes the following:

Page 24, fourth Par.:

"If the carriers are multi-frequency carriers, the carrier-signal generator 102 may be represented by the operation or **implementation of a digital method** for generating multi-frequency carriers, such as an inverse Discreet Fourier Transform or an inverse Fast Fourier Transform."

Page 26, first Par.:

"The modulated symbols may be processed in a carrier-signal generator 102, which may be a **digital signal processor**."

52. The POSITA understands that the disclosed digital methods and digital signal processors

include the claimed processor.

53. **Claims 24 and 47** recite similar features as those recited in claim 1.

54. **Claim 25** recites similar features as those recited in claim 2.

55. **Claim 26** recites similar features as those recited in claim 3.

56. **Claim 27** recites similar features as those recited in claim 4.

57. **Claim 28** recites similar features as those recited in claim 5.

58. **Claim 29** recites similar features as those recited in claim 6.

59. **Claim 30** recites similar features as those recited in claim 7.

60. **Claim 31** recites similar features as those recited in claim 8.

61. **Claim 32** recites similar features as those recited in claim 9.

62. **Claim 33** recites similar features as those recited in claim 10.

63. **Claim 34** recites similar features as those recited in claim 11.

64. **Claim 35** recites similar features as those recited in claim 12.

65. **Claim 36** recites similar features as those recited in claim 13.

66. **Claim 37** recites similar features as those recited in claim 14.

67. **Claim 38** recites similar features as those recited in claim 15.

68. **Claim 39** recites similar features as those recited in claim 16.

69. **Claim 40** recites similar features as those recited in claim 17.

70. **Claim 41** recites similar features as those recited in claim 18.

71. **Claim 42** recites similar features as those recited in claim 19.

72. **Claim 43** recites similar features as those recited in claim 20.

73. **Claim 44** recites similar features as those recited in claim 21.

74. **Claim 45** recites similar features as those recited in claim 22.

75. **Claim 46** recites similar features as those recited in claim 23.

DECLARATION

The declarant acknowledges that willful false statements and the like are punishable by fine or imprisonment, or both (18 U.S.C. 1001) and may jeopardize the validity of the application or any patent issuing thereon. The declarant attests that all statements made of the declarant's own knowledge are true and that all statements made on information and belief are believed to be true.

Date: May 9, 2025

Steve Shattil