UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

GENGHISCOMM HOLDINGS, LLC Plaintiff, v. TOYOTA MOTOR NORTH AMERICA, INC., TOYOTA MOTOR SALES, U.S.A., INC., and TOYOTA MOTOR ENGINEERING & MANUFACTURING NORTH AMERICA, INC., Defendants	Case No. 2:23-cv-228 COMPLAINT FOR PATENT INFRINGEMENT AND JURY TRIAL DEMANDED

COMPLAINT

This is an action for patent infringement arising under the patent laws of the United States, Title 35 of the United States Code, against Defendants Toyota Motor North America, Inc., Toyota Motor Sales, U.S.A., Inc., and Toyota Motor Engineering & Manufacturing North America, Inc., (collectively "Toyota") that relates to four U.S. patents owned by GenghisComm: U.S. Patent Nos. 9,768,842 (the "'842 Patent"), 10,200,227 (the "'227 Patent"), 10,389,568 (the "'568 Patent"), and 11,075,786 (the "'786 Patent") (collectively, the "Patents-in-Suit").

THE PARTIES

1. Plaintiff GenghisComm Holdings, LLC ("GenghisComm") is a Colorado limited liability company with an address at 942 Broadway Street, Suite 314c, Boulder, CO 80302.

2. Steve Shattil, Director of GenghisComm, is the named inventor on the patents and holds advanced degrees in physics and electrical engineering. He invented technologies which are essential parts of cellular and wireless standards.

3. Defendant Toyota Motor North America, Inc. is a corporation with its principal place of business at 6565 Headquarters Drive, Plano, Texas 75024. Toyota Motor North America can be served with process through its registered agent, C T Corporation System, at 1999 Bryan Street, Suite 900 Dallas, Texas 75201.

4. Toyota Motor Sales, U.S.A., Inc. is a corporation with a place of business located at 6565 Headquarters Drive, Plano, Texas 75024. Toyota Motor Sales, U.S.A., Inc., can be served with process through its registered agent, C T Corporation System, at 1999 Bryan Street, Suite 900 Dallas, Texas 75201.

5. Toyota Motor Engineering & Manufacturing North America, Inc. is a corporation with a place of business located at 6565 Headquarters Drive, Plano, Texas 75024. Toyota Motor Engineering & Manufacturing North America, Inc. can be served with process through its registered agent, C T Corporation System, at 1999 Bryan Street, Suite 900 Dallas, Texas 75201.

6. Toyota makes, uses, imports, sells and offers for sale vehicles that come equipped with cellular connectivity for providing internet access to other devices, also known as Wi-Fi Hotspots. A telematics/LTE module installed in each vehicle provides LTE cellular network connectivity. The LTE module communicates with the LTE network in accordance with the 3GPP LTE standards.

7. Toyota is one of the top selling automobile manufacturers in the U.S., selling over 2.3 million cars in the U.S. in 2021, for example.

8. Toyota's top selling models include the RAV4, Camry, and Corolla.

JURISDICTION AND VENUE

9. This Complaint states causes of action for patent infringement arising under the patent laws of the United States, 35 U.S.C. § 1 *et seq.,* and, more particularly 35 U.S.C. § 271.

10. This Court has subject matter jurisdiction of this action under 28 U.S.C. §§ 1331 and 1338(a) in which the district courts have original and exclusive jurisdiction of any civil action for patent infringement.

11. Each Toyota Defendant is subject to this Court's general personal jurisdiction pursuant to due process and/or the Texas Long Arm Statute, Tex. Civ. Prac. & Rem. Code § 17.042, due at least to its substantial business conducted in this District, including: (i) having conducted business in this District and the State of Texas through its multiple offices; (ii) having solicited business in the State of Texas, transacted business within the State of Texas and derived financial benefit from residents of the State of Texas in this District, including benefits directly related to the instant patent infringement causes of action set forth herein by selling Toyota automobiles in Texas and this District; (iii) having placed its products and services into the stream of commerce throughout the United States and having been actively engaged in transacting business in Texas and in this District, and (iv) having committed the complained of tortious acts in Texas and in this District.

12. Toyota, directly and/or through subsidiaries and agents (including distributors, retailers, and others), makes, imports, ships, distributes, offers for sale, sells, uses, and advertises (including vehicles, products and services through its website https://www.toyota.com as well as other retailers) its products and/or services in the United States, the State of Texas, and the Eastern District of Texas.

13. Toyota, directly and/or through its subsidiaries and agents (including distributors, retailers, and others), has purposefully and voluntarily placed one or more of its infringing products and/or services, as described below, into the stream of commerce with the expectation that they will be purchased and used by consumers in the Eastern District of Texas. These

infringing products and/or services have been and continue to be purchased and used by consumers in the Eastern District of Texas. Toyota has committed acts of patent infringement within the State of Texas and, more particularly, within the Eastern District of Texas.

14. In addition, Defendant Toyota Motor North America, Inc. is registered to do business in the State of Texas and headquartered in this District in Plano, Texas. Defendants Toyota Motor Sales, U.S.A., Inc. and Toyota Motor Engineering & Manufacturing North American, Inc. are headquartered in Plano, Texas as well.

15. Venue is proper in this District under 28 U.S.C. §§ 1391(b) and (c) and 1400(b). Defendant is subject to personal jurisdiction in this District, has transacted business in this District, and has committed acts of patent infringement in this District.

16. This Court's exercise of personal jurisdiction over Toyota is consistent with the Texas long-arm statute, Tex. Civ. Prac. & Rem. Code § 17.042, and traditional notions of fair play and substantial justice.

17. Toyota is also subject to this Court's specific personal jurisdiction, because the present dispute arises from, and is related to, Toyota's activities in Texas and in this District, as described above. These activities include Toyota soliciting business from, and transacting business with customers in the State of Texas and deriving financial benefit from transactions with customers in the State of Texas in this District, including sales of Toyota automobiles. Toyota, directly and/or through subsidiaries and agents (including distributors, retailers, and others), makes, imports, distributes, offers for sale, sells, uses, and advertises (including offering products and services through its website https://www.toyota.com as well as other retailers) its products and/or services in the United States, the State of Texas and the Eastern District of Texas.

18. For Toyota defendants Toyota Motor North America, Inc., Toyota Motor Sales, U.S.A., Inc., and Toyota Motor Engineering & Manufacturing North America, Inc., venue is proper in this District under §1400(b), which provides that "Any civil action for patent infringement may be brought in the judicial district where the defendant resides, or where the defendant has committed acts of infringement and has a regular and established place of business." Venue is proper as to Toyota Motor North America, Inc. because it has a regular and established place of business in this District at 6565 Headquarters Drive, Plano, Texas 75024 and has committed acts of infringement here, including making, using, selling, and offering for sale the accused products. Venue is proper as to Toyota Motor Sales, U.S.A., Inc. because it has a regular and established place of business in this District at 6565 Headquarters Drive, Plano, Texas 75024 and has committed acts of infringement here, including making, using, selling, and offering for sale the accused products. Venue is proper as to Toyota Motor Engineering & Manufacturing North America, Inc. because it has a regular and established place of business in this District at 6565 Headquarters Drive, Plano, Texas 75024 and has committed acts of infringement here, including making, using, selling, and offering for sale the accused products.

BACKGROUND FACTS REGARDING THE GENGHISCOMM PATENTS

19. GenghisComm is the owner of record an assignee of each of the Patents-in-Suit.

20. GenghisComm has the exclusive right to sue and the exclusive right to recover damages for infringement of the Patents-in-Suit during all relevant time periods.

21. On September 19, 2017, the '842 Patent entitled "Pre-coding in multi-user MIMO" was duly and legally issued by the USPTO.

22. On February 5, 2019, the '227 Patent entitled "Pre-coding in multi-user MIMO" was duly and legally issued by the USPTO.

23. On August 20, 2019, the ’568 Patent entitled “Single carrier frequency division multiple access baseband signal generation” was duly and legally issued by the USPTO.

24. On July 27, 2021, the ’786 Patent entitled “Multicarrier sub-layer for direct sequence channel and multiple-access coding” was duly and legally issued by the USPTO.

TOYOTA’S INFRINGING PRODUCTS

25. Defendant has been, and now is, directly infringing claims of the Patents-in-Suit under 35 U.S.C. § 271(a) by making, using, offering for sale, selling, and/or importing the below accused vehicles that include LTE cellular connectivity (e.g., in-car Wi-Fi hotspots) in this District and elsewhere in the United States that include the apparatuses claimed in the Patents-in-Suit.

26. Toyota’s infringing products include its vehicles that have LTE network connectivity and that adhere to the LTE standards; upon information and belief, all of Toyota’s (including Lexus brand) vehicles are installed with devices for LTE connectivity, including, but not limited to, its 4Runner, bZ4X, Camry, Corolla, Corolla Cross, Corolla Hatchback, Crown, GR Corolla, Highlander, Mirai, Prius, Prius Prime, RAV4, RAV4 Prime, Sienna, Sequoia, Tacoma, Tundra and Venza model cars, SUVs and trucks. Defendant’s infringing vehicles with LTE connectivity are collectively referred to as the “Accused Toyota LTE Devices.”

TOYOTA’S KNOWLEDGE OF THE PATENTS-IN-SUIT AND CONTINUED INFRINGEMENT DESPITE THAT KNOWLEDGE

27. On September 14, 2021, counsel for GenghisComm sent a letter by both UPS and email to Dwayne Norton, Managing Counsel for Toyota Motor North America explaining how Defendant infringed GenghisComm’s patents. The letter included detailed claim charts for the ’842, ’227 and ’568 Patents. Thus, Toyota has been aware of at least the ’842, ’227 and ’568 Patents since at least September 14, 2021. Including the claim charts, the letter was 107 pages.

28. Counsel received an email response from Takahasi Fujimoto of Toyota Motor Corporation in Japan on October 11, 2021, indicating that "[Toyota is] in receipt of your letter dated September 14, 2021 addressed to Mr. Dwayne Norton at Toyota Motor North America." Toyota's letter further requested that all future correspondence be directed to Mr. Fujimoto and Mr. Kuniaki Jinnai.

29. On January 5, 2022, GenghisComm's counsel received an additional email from Mr. Jinnai.

30. On March 15, 2022, GenghisComm responded to Toyota via email, confirming to Toyota that GenghisComm would contact Toyota's suppliers.

31. GenghisComm contacted Toyota's suppliers about resolving the issue. GenghisComm provided each of Toyota's suppliers with claim charts and other information.

32. Neither Toyota nor its suppliers have agreed to enter into any licensing agreement with GenghisComm.

33. This Complaint serves as notice to Toyota to at least the '786 Patent, and serves as additional notice for the '842, '227 and '568 Patents and the manner in which the Patents-in-Suit are infringed.

34. Despite knowledge of the Patents-in-Suit and knowledge of the manner in which the Patents-in-Suit are infringed as demonstrated in the provided claim charts, Toyota has continued to infringe, and/or induce the infringement of, the Patents-in-Suit.

COUNT I: INFRINGEMENT OF U.S. PATENT '842 CLAIM 1

35. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 of this Complaint as though set forth in full herein.

36. Claim 1 of the '842 Patent provides:

Claim 1 Preamble	An OFDM transmitter, comprising:

Element A	an OFDM spreader configured to spread a plurality of data symbols with Fourier coefficients to generate a discrete Fourier Transform (DFT)-spread data signal;
Element B	a mapper configured to map the DFT-spread data signal to a plurality of OFDM subcarriers; and
Element C	an OFDM modulator configured to modulate the DFT-spread data signal onto the plurality of OFDM subcarriers to produce an OFDM transmission signal comprising a superposition of the OFDM subcarriers, wherein the OFDM spreader is configured to provide the superposition with a reduced peak-to-average power ratio.

37. Toyota makes, uses, sells, offers for sale, and imports vehicles that include wireless devices that utilize 4G LTE networks and that comply with the 4G LTE wireless standards (e.g., 3GPP TS 36.211 version 8.7.0 Release 8; the "LTE Specification") and its requirements for uplink physical channel communications. These communications are sent from Accused Toyota LTE Devices to eNodeB receivers located at cell sites.

38. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 1 of the '842 Patent.

39. The Accused Toyota LTE Devices include a transmitter used for LTE network connectivity and communications.

40. LTE network uplink physical channel transmissions rely on single-carrier frequency-division multiple access (SC-FDMA), and downlink physical channel transmission rely on orthogonal frequency-division multiplexing (OFDM). An SC-FDMA signal is a modulated OFDM signal, and is derived from the OFDM signal sent to the Accused Toyota LTE Devices.

41. The transmitter in Accused Toyota LTE Devices includes an OFDM spreader that is used to spread data symbols onto subcarriers using the LTE Specification's Transform Precoding method according to the equation below:

5.3.3 Transform precoding

The block of complex-valued symbols $d(0),...,d(M_{\text{symb}}-1)$ is divided into $M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to

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

resulting in a block of complex-valued symbols $z(0),...,z(M_{\text{symb}}-1)$. The variable $M_{\text{sc}}^{\text{PUSCH}}=M_{\text{RB}}^{\text{PUSCH}} \cdot N_{\text{sc}}^{\text{RB}}$, where $M_{\text{RB}}^{\text{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil

$$M_{\text{RB}}^{\text{PUSCH}}=2^{\alpha_2} \cdot 3^{\alpha_3} \cdot 5^{\alpha_5} \le N_{\text{RB}}^{\text{UL}}$$

where $\alpha_2, \alpha_3, \alpha_5$ is a set of non-negative integers.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

The LTE Transform Precoding method uses a discrete Fourier transform (highlighted in the above equation) to generate a spread data signal. The transform precoding step is a complex-matrix multiply that spreads each data symbol across multiple subcarriers. One feature resulting from transform precoding is that the superposition of subcarriers has a lower peak-to-average power ratio (PAPR) compared to downlink OFDM signals.

42. The transmitter in Accused Toyota LTE Devices includes a mapper that is used to map the spread data signals onto subcarriers consistent with the LTE Specification section 5.4.3 (Mapping to Physical Resources). The LTE specification requires a resource element mapper for mapping the spread data signals to physical resource elements (subcarriers).

43. The transmitter in Accused Toyota LTE Devices include an OFDM modulator that is used to modulate the mapped and spread data symbols onto the physical resource elements (subcarriers) consistent with the LTE Specification section 5.6 (SC-FDMA baseband signal generation):

5.6 SC-FDMA baseband signal generation

This section applies to all uplink physical signals and physical channels except the physical random access channel.

The time-continuous signal $s_l(t)$ in SC-FDMA symbol l in an uplink slot is defined by

$$s_l(t) = \sum_{k=-\lfloor N_{RB}^{UL} N_{sc}^{RB}/2 \rfloor}^{\lceil N_{RB}^{UL} N_{sc}^{RB}/2 \rceil - 1} a_{k^{(-)},l} \cdot e^{j2\pi(k+1/2)\Delta f(t - N_{CP,l} T_s)}$$

for $0 \le t < (N_{CP,l} + N) \times T_s$ where $k^{(-)} = k + \lfloor N_{RB}^{UL} N_{sc}^{RB}/2 \rfloor$, $N = 2048$, $\Delta f = 15\,\text{kHz}$ and $a_{k,l}$ is the content of resource element (k,l).

The SC-FDMA symbols in a slot shall be transmitted in increasing order of l, starting with $l = 0$, where SC-FDMA symbol $l > 0$ starts at time $\sum_{l'=0}^{l-1} (N_{CP,l'} + N)T_s$ within the slot.

Table 5.6-1lists the values of $N_{CP,l}$ that shall be used. Note that different SC-FDMA symbols within a slot may have different cyclic prefix lengths.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

This process entails modulating the mapped and spread data signals onto OFDM subcarriers for each uplink slot to generate a time-domain OFDM signal. The process of SC-FMDA baseband signal generation results in a signal that consists of a superposition of subcarrier signals that mimic a single carrier signal.

44. Toyota directly infringes claim 1 of the ’842 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

45. Toyota has had knowledge of the ’842 Patent since September 14, 2021.

46. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 1 of the ’842 Patent under 35 U.S.C. § 271(a) directly.

47. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT II: INFRINGEMENT OF U.S. PATENT ’842 CLAIM 2

48. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-43 of this Complaint as though set forth in full herein.

49. Claim 2 of the ’842 Patent provides:

Element A	The OFDM transmitter recited in claim 1, wherein the OFDM spreader comprises an N-point DFT and the OFDM modulator comprises an M-point inverse discrete Fourier Transform, wherein M>N.

50. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 2 of the ’842 Patent.

51. The transmitter in Accused Toyota LTE Devices performs SC-FDMA baseband signal generation consistent with the LTE Specification sections 5.5.3 (transform precoding) and 5.6 (SC-FDMA signal generation).

52. The transform precoding step spreads data symbols to cause the superposition of modulated subcarriers to mimic a single carrier, while the signal generation step modulates the spread signals onto scheduled subcarrier signals for uplink transmission. There are fewer data symbols (N) than the total number of subcarriers in the uplink bandwidth (M) because the number of scheduled subcarriers is less than the total number of subcarriers in the uplink bandwidth.

53. The transform precoding step utilizes an N-point discrete Fourier transform (DFT), as shown in the highlighted portion of the equation below:

5.3.3 Transform precoding

The block of complex-valued symbols $d(0),...,d(M_{\text{symb}}-1)$ is divided into $M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to

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

resulting in a block of complex-valued symbols $z(0),...,z(M_{\text{symb}}-1)$. The variable $M_{\text{sc}}^{\text{PUSCH}} = M_{\text{RB}}^{\text{PUSCH}} \cdot N_{\text{sc}}^{\text{RB}}$, where $M_{\text{RB}}^{\text{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil

$$M_{\text{RB}}^{\text{PUSCH}} = 2^{\alpha_2} \cdot 3^{\alpha_3} \cdot 5^{\alpha_5} \leq N_{\text{RB}}^{\text{UL}}$$

where $\alpha_2, \alpha_3, \alpha_5$ is a set of non-negative integers.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

The N-point DFT transforms data symbols from the time domain into the frequency domain.

54. The SC-FDMA signal generation step utilizes an M-point inverse DFT, as shown in the highlighted portion of the equation below:

5.6 SC-FDMA baseband signal generation

This section applies to all uplink physical signals and physical channels except the physical random access channel.

The time-continuous signal $s_l(t)$ in SC-FDMA symbol l in an uplink slot is defined by

$$s_l(t) = \sum_{k=-\lfloor N_{\text{RB}}^{\text{UL}} N_{\text{sc}}^{\text{RB}}/2 \rfloor}^{\lceil N_{\text{RB}}^{\text{UL}} N_{\text{sc}}^{\text{RB}}/2 \rceil - 1} a_{k^{(-)},l} \cdot e^{j2\pi(k+1/2)\Delta f (t - N_{\text{CP},l} T_s)}$$

for $0 \leq t < (N_{\text{CP},l} + N) \times T_s$ where $k^{(-)} = k + \lfloor N_{RB}^{UL} N_{sc}^{RB}/2 \rfloor$, $N = 2048$, $\Delta f = 15\,\text{kHz}$ and $a_{k,l}$ is the content of resource element (k,l).

The SC-FDMA symbols in a slot shall be transmitted in increasing order of l, starting with $l = 0$, where SC-FDMA symbol $l > 0$ starts at time $\sum_{l'=0}^{l-1} (N_{\text{CP},l'} + N) T_s$ within the slot.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

The M-point inverse DFT is used to generate time-domain symbols from the frequency-domain transform symbols generated during transform precoding.

55. Toyota directly infringes claim 2 of the ’842 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

56. Toyota has had knowledge of the ’842 Patent since September 14, 2021.

57. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 2 of the ’842 Patent under 35 U.S.C. § 271(a) directly.

58. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT III: INFRINGEMENT OF U.S. PATENT ’842 CLAIM 3

59. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-43 of this Complaint as though set forth in full herein.

60. Claim 3 of the ’842 Patent provides:

Element A	The OFDM transmitter recited in claim 1, wherein the OFDM modulator comprises an inverse fast Fourier transform.

61. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 3 of the ’842 Patent.

62. The transmitter in Accused Toyota LTE Devices performs SC-FDMA baseband signal generation consistent with the LTE Specification section 5.6. LTE Specification section 5.6 utilizes an inverse fast Fourier transform to produce the time-continuous signal:

5.6 SC-FDMA baseband signal generation

This section applies to all uplink physical signals and physical channels except the physical random access channel.

The time-continuous signal $s_l(t)$ in SC-FDMA symbol l in an uplink slot is defined by

$$s_l(t)=\sum_{k=-\lfloor N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2\rfloor}^{\lceil N_{\mathrm{RB}}^{\mathrm{UL}}N_{\mathrm{sc}}^{\mathrm{RB}}/2\rceil-1} a_{k^{(-)},l}\cdot e^{j2\pi(k+1/2)\Delta f(t-N_{\mathrm{CP},l}T_s)}$$

for $0\le t<(N_{\mathrm{CP},l}+N)\times T_s$ where $k^{(-)}=k+\lfloor N_{RB}^{UL}N_{sc}^{RB}/2\rfloor$, $N=2048$, $\Delta f=15\,\mathrm{kHz}$ and $a_{k,l}$ is the content of resource element (k,l).

Source: 3GPP TS 36.211 version 8.7.0 Release 8

63. Toyota directly infringes claim 3 of the ’842 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

64. Toyota has had knowledge of the ’842 Patent since September 14, 2021.

65. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 3 of the ’842 Patent under 35 U.S.C. § 271(a) directly.

66. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT IV: INFRINGEMENT OF U.S. PATENT ’842 CLAIM 4

67. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-43 of this Complaint as though set forth in full herein.

68. Claim 4 of the ’842 Patent provides:

Element A	The OFDM transmitter recited in claim 1, wherein the data symbols comprise reference-signal symbols, which comprise at least one of known training symbols and synchronization symbols.

69. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 4 of the ’842 Patent.

70. A later release of the LTE Specification, release 15, introduced requirements (Section 5.5.2.1 and 5.5.3 in release 15) for reference signals used in the physical channel uplink. These reference signal requirements specify that at least one of the data symbols be a reference signal used for demodulation and synchronization. The Accused Toyota LTE Devices comply with this release 15 of the LTE Specification.

71. Demodulation reference signals are used for channel estimation, while synchronization reference signals are used for signal-quality estimation. Both channel estimation and signal-quality estimation are types of training symbols.

72. Toyota directly infringes claim 4 of the ’842 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

73. Toyota has had knowledge of the ’842 Patent since September 14, 2021.

74. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 4 of the ’842 Patent under 35 U.S.C. § 271(a) directly.

75. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT V: INFRINGEMENT OF U.S. PATENT ’842 CLAIM 7

76. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-43 of this Complaint as though set forth in full herein.

77. Claim 7 of the ’842 Patent provides:

Element A	The OFDM transmitter recited in claim 1, further comprising a cyclic prefix appender configured to append at least one of a cyclic prefix, a postfix, and a guard interval to the OFDM transmission signal.

78. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 7 of the '842 Patent.

79. During SC-FDMA baseband signal generation, the inverse DFT used to modulate data symbols onto subcarriers also appends the cyclic prefix, as shown in the highlighted portion of the equation below:

5.6 SC-FDMA baseband signal generation

This section applies to all uplink physical signals and physical channels except the physical random access channel.

The time-continuous signal $s_l(t)$ in SC-FDMA symbol l in an uplink slot is defined by

$$s_l(t) = \sum_{k=-\lfloor N_{RB}^{UL} N_{sc}^{RB}/2 \rfloor}^{\lceil N_{RB}^{UL} N_{sc}^{RB}/2 \rceil - 1} a_{k^{(-)},l} \cdot e^{j2\pi(k+1/2)\Delta f \left(t - N_{CP,l} T_s\right)}$$

for $0 \le t < (N_{CP,l} + N) \times T_s$ where $k^{(-)} = k + \lfloor N_{RB}^{UL} N_{sc}^{RB}/2 \rfloor$, $N = 2048$, $\Delta f = 15\,\text{kHz}$ and $a_{k,l}$ is the content of resource element (k,l).

The SC-FDMA symbols in a slot shall be transmitted in increasing order of l, starting with $l = 0$, where SC-FDMA symbol $l > 0$ starts at time $\sum_{l'=0}^{l-1} (N_{CP,l'} + N) T_s$ within the slot.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

80. Toyota directly infringes claim 7 of the '842 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

81. Toyota has had knowledge of the '842 Patent since September 14, 2021.

82. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 7 of the '842 Patent under 35 U.S.C. § 271(a) directly.

83. As a direct and proximate result of Toyota's acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT VI: INFRINGEMENT OF U.S. PATENT '842 CLAIM 8

84. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-43 of this Complaint as though set forth in full herein.

85. Claim 8 of the '842 Patent provides:

Element A	The OFDM transmitter recited in claim 1, wherein the OFDM spreader is configured to provide channel precoding.

86. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 8 of the '842 Patent.

87. During uplink processing, Accused Toyota LTE Devices employ transform precoding in accordance with the LTE Specification:

5.3.3 Transform precoding

The block of complex-valued symbols $d(0),...,d(M_{\text{symb}}-1)$ is divided into $M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to

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

$$k = 0,...,M_{\text{sc}}^{\text{PUSCH}} - 1$$

$$l = 0,...,M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}} - 1$$

resulting in a block of complex-valued symbols $z(0),...,z(M_{\text{symb}}-1)$. The variable $M_{\text{sc}}^{\text{PUSCH}} = M_{\text{RB}}^{\text{PUSCH}} \cdot N_{\text{sc}}^{\text{RB}}$, where $M_{\text{RB}}^{\text{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil

$$M_{\text{RB}}^{\text{PUSCH}} = 2^{\alpha_2} \cdot 3^{\alpha_3} \cdot 5^{\alpha_5} \leq N_{\text{RB}}^{\text{UL}}$$

where $\alpha_2, \alpha_3, \alpha_5$ is a set of non-negative integers.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

The highlighted portion of the above equation corresponds to a DFT used to spread data symbols using spreading codes. The transform precoding DFT precodes data symbols to be used in transmission.

88. Toyota directly infringes claim 8 of the ’842 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

89. Toyota has had knowledge of the ’842 Patent since September 14, 2021.

90. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 8 of the ’842 Patent under 35 U.S.C. § 271(a) directly.

91. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT VII: INFRINGEMENT OF U.S. PATENT ’842 CLAIM 9

92. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-43 of this Complaint as though set forth in full herein.

93. Claim 9 of the ’842 Patent provides:

Element A	The OFDM transmitter recited in claim 1, wherein the plurality of data symbols are at least one of time-multiplexed with reference-signal symbols, frequency-multiplexed with reference-signal symbols, and code-multiplexed with reference-signal symbols.

94. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 9 of the ’842 Patent.

95. A later release of the LTE Specification, release 15, introduced requirements (Section 5.5.2.1 and 5.5.3 in release 15) for reference signals used in the physical channel uplink.

These reference signal requirements specify that at least one of the data symbols be a reference signal used for demodulation and synchronization. The Accused Toyota LTE Devices comply with this release 15 of the LTE Specification.

96. The reference signals are time multiplexed with other uplink transmissions from the same device, and frequency multiplexed with uplink transmissions from multiple devices.

97. Toyota directly infringes claim 9 of the ’842 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

98. Toyota has had knowledge of the ’842 Patent since September 14, 2021.

99. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 9 of the ’842 Patent under 35 U.S.C. § 271(a) directly.

100. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT VIII: INFRINGEMENT OF U.S. PATENT ’227 CLAIM 22

101. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 of this Complaint as though set forth in full herein.

102. Claim 22 of the ’227 Patent provides:

Claim 22 Preamble	An apparatus comprising:
Element A	a processor; and
Element B	a non-transitory memory coupled to the processor, the non-transitory memory including a set of instructions stored therein and executable by the processor to:
Element C	perform an invertible transform on a set of data symbols to generate a plurality N of spread data symbols, the invertible transform comprising complex-valued spreading codes;

Element D	map the N spread data symbols to at least N subcarriers of a plurality M of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers to generate a set of complex subcarrier amplitudes; and
Element E	perform an M-point inverse discrete Fourier transform (IDFT) on the set of complex subcarrier amplitudes to generate a time-domain sequence to be transmitted into a wireless channel, the time-domain sequence comprising a superposition of the OFDM subcarriers, wherein the invertible transform is configured to provide the superposition with a reduced peak-to-average power ratio.

103. Toyota makes, uses, sells, offers for sale, and imports wireless devices that utilize 4G LTE networks and that comply with the 4G LTE wireless standards (e.g., 3GPP TS 36.211 version 8.7.0 Release 8; the "LTE Specification") and its requirements for uplink physical channel communications. These communications are sent from Accused Toyota LTE Devices to eNodeB receivers located at cell sites.

104. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 22 of the '227 Patent.

105. The Accused Toyota LTE Devices must have processors and non-transitory memory coupled to the processor in order to apply LTE physical channel signal processing consistent with the LTE Specification.

106. The memory of Accused Toyota LTE Devices includes instructions for performing transform precoding on data symbols according to the LTE Specification. The transform precoding process utilizes a discrete Fourier transform (DFT) to transform OFDM data symbols (N) into spread OFDM complex-valued data symbols used during physical channel uplink communications, as shown in the highlighted portion below (Section 5.3.3 of the LTE Specification):

5.3.3 Transform precoding

The block of complex-valued symbols $d(0),...,d(M_{\text{symb}}-1)$ is divided into $M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to

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

$$k = 0,...,M_{\text{sc}}^{\text{PUSCH}} - 1$$

$$l = 0,...,M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}} - 1$$

resulting in a block of complex-valued symbols $z(0),...,z(M_{\text{symb}}-1)$. The variable $M_{\text{sc}}^{\text{PUSCH}} = M_{\text{RB}}^{\text{PUSCH}} \cdot N_{\text{sc}}^{\text{RB}}$, where $M_{\text{RB}}^{\text{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil

$$M_{\text{RB}}^{\text{PUSCH}} = 2^{\alpha_2} \cdot 3^{\alpha_3} \cdot 5^{\alpha_5} \le N_{\text{RB}}^{\text{UL}}$$

where $\alpha_2, \alpha_3, \alpha_5$ is a set of non-negative integers.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

The DFT is invertible.

107. One feature resulting from transform precoding using the invertible DFT of Section 5.3.3 of the LTE Specification is that it generates complex-valued data symbols that, when mapped and modulated onto physical resource subcarriers, results in a superposition of subcarriers having a lower peak-to-average power ratio (PAPR) compared to downlink OFDM signals.

108. The memory of Accused Toyota LTE Devices includes instructions for mapping the N spread data signals onto N subcarriers consistent with the LTE Specification section 5.4.3 (Mapping to Physical Resources):

5.3.4 Mapping to physical resources

The block of complex-valued symbols $z(0),...,z(M_{\text{symb}}-1)$ shall be multiplied with the amplitude scaling factor β_{PUSCH} in order to conform to the transmit power P_{PUSCH} specified in Section 5.1.1.1 in [4], and mapped in sequence starting with $z(0)$ to physical resource blocks assigned for transmission of PUSCH. The mapping to resource elements (k,l) corresponding to the physical resource blocks assigned for transmission and not used for transmission of reference signals and not reserved for possible SRS transmission shall be in increasing order of first the index k, then the index l, starting with the first slot in the subframe.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

The N spread data symbols correspond to the "$z(0)$…" complex-valued symbols described in Section 5.3.4 of the LTE Specification, and are mapped onto the same number (N) of subcarriers assigned to the UE out of the total number of subcarriers in the uplink bandwidth (M).

109. The complex valued data symbols (N spread data symbols) are multiplied by an amplitude scaling factor, and then mapped to M physical resource blocks (OFDM subcarriers) to generate complex subcarrier amplitudes used during the SC-FDMA baseband signal generation step.

110. The memory of Accused Toyota LTE Devices includes instructions for modulating the mapped and spread data symbols onto N physical resource elements (subcarriers) consistent with the LTE Specification section 5.6 (SC-FDMA baseband signal generation). This process entails modulating the mapped and spread data signals onto OFDM subcarriers for each uplink slot to generate a time-domain OFDM signal. The process of SC-FMDA baseband signal generation results in a signal that consists of a superposition of subcarrier signals that mimic a single carrier signal.

111. The SC-FDMA baseband signal generation step uses an M-point inverse DFT:

5.6 SC-FDMA baseband signal generation

This section applies to all uplink physical signals and physical channels except the physical random access channel.

The time-continuous signal $s_l(t)$ in SC-FDMA symbol l in an uplink slot is defined by

$$s_l(t) = \sum_{k=-\lfloor N_{RB}^{UL} N_{sc}^{RB}/2 \rfloor}^{\lceil N_{RB}^{UL} N_{sc}^{RB}/2 \rceil - 1} a_{k^{(-)},l} \cdot e^{j2\pi(k+1/2)\Delta f (t - N_{CP,l} T_s)}$$

for $0 \le t < (N_{CP,l} + N) \times T_s$ where $k^{(-)} = k + \lfloor N_{RB}^{UL} N_{sc}^{RB}/2 \rfloor$, $N = 2048$, $\Delta f = 15\,\text{kHz}$ and $a_{k,l}$ is the content of resource element (k,l).

The SC-FDMA symbols in a slot shall be transmitted in increasing order of l, starting with $l = 0$, where SC-FDMA symbol $l > 0$ starts at time $\sum_{l'=0}^{l-1} (N_{CP,l'} + N) T_s$ within the slot.

Table 5.6-1lists the values of $N_{CP,l}$ that shall be used. Note that different SC-FDMA symbols within a slot may have different cyclic prefix lengths.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

112. N (number of subcarriers) < M (total number of subcarriers) allows for the pulse-shaping seen in SC-FDMA. That is, the subcarriers in the SC-FDMA signal combine in phase at uniformly spaced intervals in each SC-FDMA symbol duration to produce a pulse waveform in each interval, which allows multiple subcarriers to mimic a single carrier signal. OFDM baseband signal generation typically upsamples the data being transmitted, which means that the size of the inverse DFT is larger than the number of assigned subcarriers onto which the data is modulated. This is also the case for SC-FDMA baseband signal generation (Section 5.6). DFT spreading (i.e., transform precoding, Section 5.3.3) is applied to the data before mapping to the inverse DFT, so the DFT size is smaller than the inverse DFT size. This causes the DFT to shape the output of the inverse DFT into uniformly spaced pulses in each SC-FDMA symbol duration, which causes the SC-FDMA signal to resemble a single-carrier signal.

113. Toyota directly infringes claim 22 of the ’227 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

114. Toyota has had knowledge of the ’227 Patent since September 14, 2021.

115. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 22 of the ’227 Patent under 35 U.S.C. § 271(a) directly.

116. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT IX: INFRINGEMENT OF U.S. PATENT ’227 CLAIM 24

117. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 and 97-112 of this Complaint as though set forth in full herein.

118. Claim 24 of the ’227 Patent provides:

Element A	The apparatus recited in claim 22, configured to reside on a User Equipment.

119. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 24 of the ’227 Patent.

120. Accused Toyota LTE Devices are User Equipment that include the processor and memory described in paragraph 101 above.

121. Toyota directly infringes claim 24 of the ’842 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

122. Toyota has had knowledge of the ’842 Patent since September 14, 2021.

123. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 24 of the ’227 Patent under 35 U.S.C. § 271(a) directly.

124. As a direct and proximate result of Toyota's acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT X: INFRINGEMENT OF U.S. PATENT '227 CLAIM 25

125. GenghisComm incorporates by reference the allegations set forth in paragraphs - 30 and 97-112 of this Complaint as though set forth in full herein.

126. Claim 25 of the '227 Patent provides:

Element A	The apparatus recited in claim 22, wherein M>N.

127. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 25 of the '227 Patent.

128. During processing for the physical channel uplink, the number of subcarriers available for use, M, exceeds the number of data symbols and subcarriers, N, that are ultimately modulated onto those subcarriers. The number of subcarriers and data symbols actually used (N) by user equipment in the uplink is less than the overall number of subcarriers in the uplink bandwidth (M) to allow for the pulse-shaping seen in SC-FDMA.

129. N (number of subcarriers) < M (total number of subcarriers) allows for the pulse-shaping seen in SC-FDMA. That is, the subcarriers in the SC-FDMA signal combine in phase at uniformly spaced intervals in each SC-FDMA symbol duration to produce a pulse waveform in each interval, which allows multiple subcarriers to mimic a single carrier signal. OFDM baseband signal generation typically upsamples the data being transmitted, which means that the size of the inverse DFT is larger than the number of assigned subcarriers onto which the data is modulated. This is also the case for SC-FDMA baseband signal generation (Section 5.6). DFT spreading (i.e., transform precoding, Section 5.3.3) is applied to the data before mapping to the

inverse DFT, so the DFT size is smaller than the inverse DFT size. This causes the DFT to shape the output of the inverse DFT into uniformly spaced pulses in each SC-FDMA symbol duration, which causes the SC-FDMA signal to resemble a single-carrier signal.

130. Toyota directly infringes claim 25 of the '227 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

131. Toyota has had knowledge of the '227 Patent since September 14, 2021.

132. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 25 of the '227 Patent under 35 U.S.C. § 271(a) directly.

133. As a direct and proximate result of Toyota's acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XI: INFRINGEMENT OF U.S. PATENT '227 CLAIM 26

134. GenghisComm incorporates by reference the allegations set forth in paragraphs - 30 and 97-112 of this Complaint as though set forth in full herein.

135. Claim 26 of the '227 Patent provides:

Element A	The apparatus recited in claim 22, wherein the IDFT comprises an inverse fast Fourier transform.

136. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 26 of the '227 Patent.

137. Accused Toyota LTE Devices perform SC-FDMA baseband signal generation consistent with the LTE Specification section 5.6. LTE Specification section 5.6 utilizes an inverse fast Fourier transform to produce the SC-FDMA time-continuous signal.

138. Toyota directly infringes claim 26 of the ’227 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

139. Toyota has had knowledge of the ’227 Patent since September 14, 2021.

140. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 26 of the ’227 Patent under 35 U.S.C. § 271(a) directly.

141. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XII: INFRINGEMENT OF U.S. PATENT ’227 CLAIM 28

142. GenghisComm incorporates by reference the allegations set forth in paragraphs -30 and 97-112 of this Complaint as though set forth in full herein.

143. Claim 28 of the ’227 Patent provides:

Element A	The apparatus recited in claim 22, wherein the non-transitory memory further comprises instructions to append at least one of a cyclic prefix, a postfix, and a guard interval to the time-domain sequence.

144. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 28 of the ’227 Patent.

145. During SC-FDMA baseband signal generation, the inverse DFT used to modulate data symbols onto subcarriers also appends the cyclic prefix, as shown in the highlighted portion of the equation below:

5.6 SC-FDMA baseband signal generation

This section applies to all uplink physical signals and physical channels except the physical random access channel.

The time-continuous signal $s_l(t)$ in SC-FDMA symbol l in an uplink slot is defined by

$$s_l(t)=\sum_{k=-\left\lfloor N_{RB}^{UL}N_{sc}^{RB}/2\right\rfloor}^{\left\lceil N_{RB}^{UL}N_{sc}^{RB}/2\right\rceil-1} a_{k^{(-)},l}\cdot e^{j2\pi(k+1/2)\Delta f\left(t-N_{CP,l}T_s\right)}$$

for $0\le t<\left(N_{CP,l}+N\right)\times T_s$ where $k^{(-)}=k+\left\lfloor N_{RB}^{UL}N_{sc}^{RB}/2\right\rfloor$, $N=2048$, $\Delta f=15\,\text{kHz}$ and $a_{k,l}$ is the content of resource element (k,l).

The SC-FDMA symbols in a slot shall be transmitted in increasing order of l, starting with $l=0$, where SC-FDMA symbol $l>0$ starts at time $\sum_{l'=0}^{l-1}(N_{CP,l'}+N)T_s$ within the slot.

Table 5.6-1lists the values of $N_{CP,l}$ that shall be used. Note that different SC-FDMA symbols within a slot may have different cyclic prefix lengths.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

146. Toyota directly infringes claim 28 of the '227 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

147. Toyota has had knowledge of the '227 Patent since September 14, 2021.

148. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 28 of the '227 Patent under 35 U.S.C. § 271(a) directly.

149. As a direct and proximate result of Toyota's acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XIII: INFRINGEMENT OF U.S. PATENT '568 CLAIM 24

150. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 of this Complaint as though set forth in full herein.

151. Claim 24 of the ’568 Patent provides:

Claim 24 Preamble	An apparatus comprising:
Element A	a processor; and
Element B	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 for:
Element C	dividing a block of complex-valued symbols into a plurality of sets of complex-valued symbols;
Element D	transform precoding each of the plurality of sets of complex-valued symbols into a block of transform-precoded complex-valued symbols; and
Element E	generating an Orthogonal Frequency Division Multiplex (OFDM) signal comprising a plurality of OFDM subcarriers modulated by the transform-precoded complex-valued symbols, 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.

152. Toyota makes, uses, sells, offers for sale, and imports wireless devices that utilize 4G LTE networks and that comply with the 4G LTE wireless standards (e.g., 3GPP TS 36.211 version 8.7.0 Release 8; the “LTE Specification”) and its requirements for uplink physical channel communications. These communications are sent from Accused Toyota LTE Devices to eNodeB receivers located at cell sites.

153. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 24 of the ’568 Patent.

154. The Accused Toyota LTE Devices must have processors and non-transitory memory coupled to the processor in order to apply LTE physical channel signal processing consistent with the LTE Specification.

155. The memory in Accused Toyota LTE Devices stores instructions for processing physical channel uplink (from user equipment to eNode B) and downlink (from eNode B to user equipment) consistent with the LTE Specification.

156. For the uplink, the LTE Specification employs a Transform Precoding step (section 5.3.3):

5.3.3 Transform precoding

The block of complex-valued symbols $d(0),...,d(M_{\text{symb}}-1)$ is divided into $M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to

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

$$k=0,...,M_{\text{sc}}^{\text{PUSCH}}-1$$

$$l=0,...,M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}}-1$$

resulting in a block of complex-valued symbols $z(0),...,z(M_{\text{symb}}-1)$. The variable $M_{\text{sc}}^{\text{PUSCH}}=M_{\text{RB}}^{\text{PUSCH}} \cdot N_{\text{sc}}^{\text{RB}}$, where $M_{\text{RB}}^{\text{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil

$$M_{\text{RB}}^{\text{PUSCH}}=2^{\alpha_2} \cdot 3^{\alpha_3} \cdot 5^{\alpha_5} \leq N_{\text{RB}}^{\text{UL}}$$

where $\alpha_2, \alpha_3, \alpha_5$ is a set of non-negative integers.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

where OFDM data symbols are divided into M_{symb}/M_{sc}^{PUSCH} sets, with each set corresponding to one SC-FDMA symbol. The division process results in multiple sets of complex-valued symbols. These complex-valued symbols are transform precoded using a discrete Fourier transform to generate blocks of transform precoded complex-valued symbols. The transform precoding step is a complex-matrix multiply that spreads the complex-valued symbols across multiple subcarriers. One feature resulting from transform precoding is that the superposition of subcarriers has a lower peak-to-average power ratio (PAPR) compared to downlink OFDM signals.

157. The block of transform precoded complex-valued symbols are then mapped to physical resources (subcarriers) consistent with LTE Specification section 5.4.3 (Mapping to Physical Resources):

5.3.4 Mapping to physical resources

The block of complex-valued symbols $z(0),...,z(M_{\text{symb}}-1)$ shall be multiplied with the amplitude scaling factor β_{PUSCH} in order to conform to the transmit power P_{PUSCH} specified in Section 5.1.1.1 in [4], and mapped in sequence starting with $z(0)$ to physical resource blocks assigned for transmission of PUSCH. The mapping to resource elements (k,l) corresponding to the physical resource blocks assigned for transmission and not used for transmission of reference signals and not reserved for possible SRS transmission shall be in increasing order of first the index k, then the index l, starting with the first slot in the subframe.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

158. Once mapped, the pre-coded complex-valued symbols are then modulated on physical resources (subcarriers) in accordance with LTE Specification 5.6 (SC-FDMA Baseband Signal Generation). The SC-FDMA Baseband Signal Generation step utilizes an inverse DFT to generate a time-domain signal, as shown in the highlighted portion below

5.6 SC-FDMA baseband signal generation

This section applies to all uplink physical signals and physical channels except the physical random access channel.

The time-continuous signal $s_l(t)$ in SC-FDMA symbol l in an uplink slot is defined by

$$s_l(t) = \sum_{k=-\lfloor N_{\text{RB}}^{\text{UL}} N_{\text{sc}}^{\text{RB}}/2 \rfloor}^{\lceil N_{\text{RB}}^{\text{UL}} N_{\text{sc}}^{\text{RB}}/2 \rceil - 1} a_{k^{(-)},l} \cdot e^{j2\pi(k+1/2)\Delta f(t-N_{\text{CP},l}T_s)}$$

for $0 \le t < (N_{\text{CP},l}+N)\times T_s$ where $k^{(-)} = k + \lfloor N_{RB}^{UL} N_{sc}^{RB}/2 \rfloor$, $N = 2048$, $\Delta f = 15\,\text{kHz}$ and $a_{k,l}$ is the content of resource element (k,l).

The SC-FDMA symbols in a slot shall be transmitted in increasing order of l, starting with $l=0$, where SC-FDMA symbol $l>0$ starts at time $\sum_{l'=0}^{l-1}(N_{\text{CP},l'}+N)T_s$ within the slot.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

159. SC-FDMA itself stands for single-carrier frequency division multiple division access, and is a modulated version of an OFDM signal that uses the same subcarriers as regular OFDM. The process of transform precoding and SC-FMDA baseband signal generation results in a transmitted signal that consists of a superposition of OFDM subcarrier signals that mimic a

single carrier signal.Toyota directly infringes claim 24 of the ’568 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

160. Toyota has had knowledge of the ’568 Patent since September 14, 2021.

161. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 24 of the ’568 Patent under 35 U.S.C. § 271(a) directly.

162. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XIV: INFRINGEMENT OF U.S. PATENT ’568 CLAIM 25

163. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 and 146-159 of this Complaint as though set forth in full herein.

164. Claim 25 of the ’568 Patent provides:

Element A	The apparatus of claim 24, 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.

165. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 25 of the ’568 Patent.

166. During transform precoding in accordance with the LTE Specification, complex-valued symbols are spread onto orthogonal spreading codes consistent with the below equation that employs a discrete Fourier transform:

5.3.3 Transform precoding

The block of complex-valued symbols $d(0),...,d(M_{\mathrm{symb}}-1)$ is divided into $M_{\mathrm{symb}}/M_{\mathrm{sc}}^{\mathrm{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to

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

$$k=0,...,M_{\mathrm{sc}}^{\mathrm{PUSCH}}-1$$

$$l=0,...,M_{\mathrm{symb}}/M_{\mathrm{sc}}^{\mathrm{PUSCH}}-1$$

resulting in a block of complex-valued symbols $z(0),...,z(M_{\mathrm{symb}}-1)$. The variable $M_{\mathrm{sc}}^{\mathrm{PUSCH}}=M_{\mathrm{RB}}^{\mathrm{PUSCH}}\cdot N_{\mathrm{sc}}^{\mathrm{RB}}$, where $M_{\mathrm{RB}}^{\mathrm{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil

$$M_{\mathrm{RB}}^{\mathrm{PUSCH}}=2^{\alpha_2}\cdot 3^{\alpha_3}\cdot 5^{\alpha_5}\leq N_{\mathrm{RB}}^{\mathrm{UL}}$$

where $\alpha_2,\alpha_3,\alpha_5$ is a set of non-negative integers.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

In the above equation, the complex-valued coefficients correspond to the variable $e^{-j\frac{2\pi ik}{M_{sc}^{PUSCH}}}$.

167. One property of the DFT used in transform precoding is that it is an orthogonal matrix, such that symbols will be spread orthogonally.

168. The transform precoding step generates a block of transform precoded complex-valued symbols, $z(0),\ldots z(M_{\mathrm{symb}}-1)$.

169. Toyota directly infringes claim 25 of the ’568 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

170. Toyota has had knowledge of the ’568 Patent since September 14, 2021.

171. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 25 of the ’568 Patent under 35 U.S.C. § 271(a) directly.

172. As a direct and proximate result of Toyota's acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XV: INFRINGEMENT OF U.S. PATENT '568 CLAIM 26

173. GenghisComm incorporates by reference the allegations set forth in paragraphs 11-30 and 146-169 of this Complaint as though set forth in full herein.

174. Claim 26 of the '568 Patent provides:

Element A	The apparatus of claim 25, wherein the DFT is a fast Fourier transform (FFT).

175. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim26 of the '568 Patent.

176. Transform precoding in accordance with the LTE Specification employs a DFT which is a fast Fourier transform, as shown in the equation below:

5.3.3 Transform precoding

The block of complex-valued symbols $d(0),...,d(M_{\text{symb}}-1)$ is divided into $M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to

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

$$k=0,...,M_{\text{sc}}^{\text{PUSCH}}-1$$

$$l=0,...,M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}}-1$$

resulting in a block of complex-valued symbols $z(0),...,z(M_{\text{symb}}-1)$. The variable $M_{\text{sc}}^{\text{PUSCH}}=M_{\text{RB}}^{\text{PUSCH}}\cdot N_{\text{sc}}^{\text{RB}}$, where $M_{\text{RB}}^{\text{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil

$$M_{\text{RB}}^{\text{PUSCH}}=2^{\alpha_2}\cdot 3^{\alpha_3}\cdot 5^{\alpha_5}\le N_{\text{RB}}^{\text{UL}}$$

where $\alpha_2,\alpha_3,\alpha_5$ is a set of non-negative integers.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

177. Toyota directly infringes claim 26 of the ’568 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

178. Toyota has had knowledge of the ’568 Patent since September 14, 2021.

179. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 26 of the ’568 Patent under 35 U.S.C. § 271(a) directly.

180. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XVI: INFRINGEMENT OF U.S. PATENT ’568 CLAIM 29

181. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 and 146-159 of this Complaint as though set forth in full herein.

182. Claim 29 of the ’568 Patent provides:

Element A	The apparatus of claim 24, comprising instructions for: mapping the block of transform-precoded complex-valued symbols to physical resource blocks assigned for transmission of a physical uplink shared channel.

183. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 29 of the ’568 Patent.

184. During signal processing for the physical channel uplink, transform-precoded complex-valued symbols $z(0),\ldots z(M_{\text{symb}}-1)$ are mapped onto physical resource blocks in accordance with section 5.3.4 of the LTE Specification:

5.3.4 Mapping to physical resources

The block of complex-valued symbols $z(0),...,z(M_{\text{symb}}-1)$ shall be multiplied with the amplitude scaling factor β_{PUSCH} in order to conform to the transmit power P_{PUSCH} specified in Section 5.1.1.1 in [4], and mapped in sequence starting with $z(0)$ to physical resource blocks assigned for transmission of PUSCH. The mapping to resource elements (k,l) corresponding to the physical resource blocks assigned for transmission and not used for transmission of reference signals and not reserved for possible SRS transmission shall be in increasing order of first the index k, then the index l, starting with the first slot in the subframe.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

185. The physical resource blocks are assigned to user equipment for the purpose of physical channel uplink transmissions.

186. Toyota directly infringes claim 29 of the ’568 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

187. Toyota has had knowledge of the ’568 Patent since September 14, 2021.

188. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 29 of the ’568 Patent under 35 U.S.C. § 271(a) directly.

189. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XVII: INFRINGEMENT OF U.S. PATENT ’568 CLAIM 32

190. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30, 146-159 and 176-186 of this Complaint as though set forth in full herein.

191. Claim 32 of the ’568 Patent provides:

Element A	The apparatus of claim 29, 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-hoping scheme.

192. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 32 of the '568 Patent.

193. During signal processing for the physical channel uplink, transform-precoded complex-valued symbols $z(0),\ldots z(M_{\text{symb}}\text{-}1)$ are mapped onto physical resource blocks in accordance with section 5.3.4 of the LTE Specification.

5.3.4 Mapping to physical resources

The block of complex-valued symbols $z(0),...,z(M_{\text{symb}}-1)$ shall be multiplied with the amplitude scaling factor β_{PUSCH} in order to conform to the transmit power P_{PUSCH} specified in Section 5.1.1.1 in [4], and mapped in sequence starting with $z(0)$ to physical resource blocks assigned for transmission of PUSCH. The mapping to resource elements (k,l) corresponding to the physical resource blocks assigned for transmission and not used for transmission of reference signals and not reserved for possible SRS transmission shall be in increasing order of first the index k, then the index l, starting with the first slot in the subframe.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

This mapping process further entails selecting from physical resource elements within the physical resource blocks.

194. The physical resource elements within a block correspond to OFDM subcarriers.

195. Once mapped, the complex-valued symbols are modulated onto the physical resources (OFDM subcarriers) during SC-FDMA baseband signal generation, in accordance with Section 5.6 of the LTE Specification.

5.6 SC-FDMA baseband signal generation

This section applies to all uplink physical signals and physical channels except the physical random access channel.

The time-continuous signal $s_l(t)$ in SC-FDMA symbol l in an uplink slot is defined by

$$s_l(t)=\sum_{k=-\lfloor N_{RB}^{UL}N_{sc}^{RB}/2\rfloor}^{\lceil N_{RB}^{UL}N_{sc}^{RB}/2\rceil-1} a_{k^{(-)},l}\cdot e^{j2\pi(k+1/2)\Delta f\left(t-N_{CP,l}T_s\right)}$$

for $0\le t<(N_{CP,l}+N)\times T_s$ where $k^{(-)}=k+\lfloor N_{RB}^{UL}N_{sc}^{RB}/2\rfloor$, $N=2048$, $\Delta f=15\,\text{kHz}$ and $a_{k,l}$ is the content of resource element (k,l).

The SC-FDMA symbols in a slot shall be transmitted in increasing order of l, starting with $l=0$, where SC-FDMA symbol $l>0$ starts at time $\sum_{l'=0}^{l-1}(N_{CP,l'}+N)T_s$ within the slot.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

SC-FDMA stands for single carrier frequency division multiple access. The subcarriers are selected and mapped according to at least a frequency division multiple access scheme.

196. Toyota directly infringes claim 32 of the ’568 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

197. Toyota has had knowledge of the ’568 Patent since September 14, 2021.

198. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 32 of the ’568 Patent under 35 U.S.C. § 271(a) directly.

199. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XVIII: INFRINGEMENT OF U.S. PATENT ’568 CLAIM 33

200. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 and 146-159 of this Complaint as though set forth in full herein.

201. Claim 33 of the ’568 Patent provides:

Element A	The apparatus of claim 24, comprising instructions for: scrambling a block of bits of one subframe of a physical uplink shared channel resulting in a block of scrambled bits; and
Element B	modulating the block of scrambled bits resulting in the block of complex-valued symbols.

202. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 33 of the '568 Patent.

203. During physical channel uplink signal processing, a block of bits on the physical uplink shared channel are scrambled using a scrambling sequence to generate a block of scrambled bits in accordance with Section 5.3.1 of the LTE Specification:

5.3.1 Scrambling

The block of bits $b(0),...,b(M_{\text{bit}}-1)$, where M_{bit} is the number of bits transmitted on the physical uplink shared channel in one subframe, shall be scrambled with a UE-specific scrambling sequence prior to modulation, resulting in a block of scrambled bits $\tilde{b}(0),...,\tilde{b}(M_{\text{bit}}-1)$ according to the following pseudo code

Source: 3GPP TS 36.211 version 8.7.0 Release 8

204. After scrambling, the block of scrambled bits are modulated to generate a block of complex-valued symbols in accordance with Section 5.3.2 of the LTE Specification:

5.3.2 Modulation

The block of scrambled bits $\tilde{b}(0),...,\tilde{b}(M_{\text{bit}}-1)$ shall be modulated as described in Section 7.1, resulting in a block of complex-valued symbols $d(0),...,d(M_{\text{symb}}-1)$. Table 5.3.2-1 specifies the modulation mappings applicable for the physical uplink shared channel.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

205. Toyota directly infringes claim 33 of the '568 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

206. Toyota has had knowledge of the '568 Patent since September 14, 2021.

207. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 33 of the ’568 Patent under 35 U.S.C. § 271(a) directly.

208. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XIX: INFRINGEMENT OF U.S. PATENT ’568 CLAIM 34

209. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30, 146-159 and 197-205 of this Complaint as though set forth in full herein.

210. Claim 34 of the ’568 Patent provides:

Element A	The apparatus of claim 33, wherein the scrambling is configured to scramble the block of bits into a block of scrambled bits with at least one pseudo-noise code.

211. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 34 of the ’568 Patent.

212. The LTE Specification section 5.3.1 requires that the scrambling of the block of bits use pseudo noise code:

5.3.1 Scrambling

The block of bits $b(0),...,b(M_{bit}-1)$, where M_{bit} is the number of bits transmitted on the physical uplink shared channel in one subframe, shall be scrambled with a UE-specific scrambling sequence prior to modulation, resulting in a block of scrambled bits $\tilde{b}(0),...,\tilde{b}(M_{bit}-1)$ according to the following pseudo code

Source: 3GPP TS 36.211 version 8.7.0 Release 8

213. Toyota directly infringes claim 34 of the ’568 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

214. Toyota has had knowledge of the ’568 Patent since September 14, 2021.

215. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 34 of the ’568 Patent under 35 U.S.C. § 271(a) directly.

216. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XX: INFRINGEMENT OF U.S. PATENT ’568 CLAIM 44

217. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 and 146-159 of this Complaint as though set forth in full herein.

218. Claim 44 of the ’568 Patent provides:

Element A	The method of claim 24, wherein each of the plurality of sets of complex-valued symbols is a single carrier frequency division multiple access (SC-FDMA) symbol.

219. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 44 of the ’568 Patent.

220. The LTE Specification section 5.6 (SC-FDMA baseband signal generation) defines how to generate SC-FDMA symbols of a time-continuous signal.

221. Toyota directly infringes claim 44 of the ’568 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

222. Toyota has had knowledge of the ’568 Patent since September 14, 2021.

223. Toyota makes, uses, and/or imports the Accused Toyota LTE Devices knowing that Toyota infringed and continues to infringe at least claim 44 of the ’568 Patent under 35 U.S.C. § 271(a) directly.

224. As a direct and proximate result of Toyota's acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XXI: INFRINGEMENT OF U.S. PATENT '786 CLAIM 10

225. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 of this Complaint as though set forth in full herein.

226. Claim 10 of the '786 Patent provides:

Claim 10 Preamble	An apparatus for communication in a wireless communication network that employs a first set of complex-valued codes to encode data symbols to be transmitted, and employs a second set of complex-valued codes to recover transmitted data symbols from a received signal, the apparatus comprising:
Element A	at least one processor; and
Element B	a non-transitory computer-readable memory communicatively coupled to the at least one processor, the non-transitory computer-readable memory including a set of instructions stored thereon and executable by the at least one processor for:
Element C	selecting a plurality of subcarriers to be transmitted;
Element D	encoding the data symbols with the first set of complex-valued codes to produce encoded data symbols;
Element E	applying the encoded data symbols to the plurality of subcarriers to produce a spread-Orthogonal Frequency Division Multiplexing (OFDM) signal; and
Element F	wherein the first set of complex-valued codes are complex conjugates of the second set of complex-valued codes.

227. Toyota makes, uses, sells, offers for sale, and imports wireless devices that utilize 4G LTE networks and that comply with the 4G LTE wireless standards (e.g., 3GPP TS 36.211 version 8.7.0 Release 8; the "LTE Specification") and its requirements for uplink physical channel communications. These communications are sent from Accused Toyota LTE Devices to eNodeB receivers located at cell sites.

228. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 10 of the '786 Patent.

229. The Accused Toyota LTE Devices are devices that are used in LTE wireless communication networks. The LTE radio network uses both physical channel uplink communications from the device to eNode B, and physical channel downlink communications from the eNode B to the device. The uplink relies on a single-carrier frequency division multiple access (SC-FDMA) scheme, which entails the use of transform precoding data using complex-valued codes to encode data symbols to be sent from the device. The eNode B receives the SC-FDMA signals from the device, and decodes the signals using a second set of complex-valued codes that are the inverse of the first set of complex-valued codes.

230. The Accused Toyota LTE Devices must have processors and non-transitory memory coupled to the processor in order to apply LTE physical channel signal processing consistent with the LTE Specification.

231. The memory in Accused Toyota LTE Devices stores instructions for processing physical channel uplink (from user equipment to eNode B) and downlink (from eNode B to user equipment) consistent with the LTE Specification.

232. For the uplink, the LTE Specification employs a Transform Precoding step (section 5.3.3), where OFDM data symbols are divided into $M_{symb} / M_{sc}^{PUSCH}$ sets, with each set corresponding to one SC-FDMA symbol. The division process results in the first set of complex-valued symbols. These complex-valued symbols are transform precoded using a discrete Fourier transform (DFT) to generate blocks of transform precoded complex-valued symbols. The DFT includes complex-valued codes used to encode the complex-valued data symbols that are to be transmitted, as shown in the highlighted portion of the equation below:

5.3.3 Transform precoding

The block of complex-valued symbols $d(0),...,d(M_{\text{symb}}-1)$ is divided into $M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to

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

$$k = 0,...,M_{\text{sc}}^{\text{PUSCH}} - 1$$

$$l = 0,...,M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}} - 1$$

resulting in a block of complex-valued symbols $z(0),...,z(M_{\text{symb}}-1)$. The variable $M_{\text{sc}}^{\text{PUSCH}} = M_{\text{RB}}^{\text{PUSCH}} \cdot N_{\text{sc}}^{\text{RB}}$, where $M_{\text{RB}}^{\text{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil

$$M_{\text{RB}}^{\text{PUSCH}} = 2^{\alpha_2} \cdot 3^{\alpha_3} \cdot 5^{\alpha_5} \le N_{\text{RB}}^{\text{UL}}$$

where $\alpha_2, \alpha_3, \alpha_5$ is a set of non-negative integers.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

233. The DFT used in transform precoding for the uplink is the inverse of the DFT used by the eNodeB to decode the transform-precoded uplink signals. Because the DFT used for transform-precoding in the uplink is a unitary matrix, its complex conjugate is also its inverse.

234. In accordance with the LTE Specification, Accused Toyota LTE Devices are assigned physical resource blocks to be used for uplink transmissions to base stations. Each physical resource block includes twelve subcarriers, and determine the number of inputs for SC-FDMA signal generation. Accused Toyota LTE Devices select subcarriers based on the number of resource blocks assigned to the device.

235. During uplink signal processing, Accused Toyota LTE Devices transform precode complex valued symbols in accordance with Section 5.3.3 of the LTE Specification. The transform precoding step generates complex-valued data symbols by using the complex-valued codes of the discrete Fourier transform used in transform precoding, as shown in the highlighted portion of the equation below:

5.3.3 Transform precoding

The block of complex-valued symbols $d(0),...,d(M_{\text{symb}}-1)$ is divided into $M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one SC-FDMA symbol. Transform precoding shall be applied according to

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

$$k = 0,...,M_{\text{sc}}^{\text{PUSCH}} - 1$$

$$l = 0,...,M_{\text{symb}}/M_{\text{sc}}^{\text{PUSCH}} - 1$$

resulting in a block of complex-valued symbols $z(0),...,z(M_{\text{symb}}-1)$. The variable $M_{\text{sc}}^{\text{PUSCH}} = M_{\text{RB}}^{\text{PUSCH}} \cdot N_{\text{sc}}^{\text{RB}}$, where $M_{\text{RB}}^{\text{PUSCH}}$ represents the bandwidth of the PUSCH in terms of resource blocks, and shall fulfil

$$M_{\text{RB}}^{\text{PUSCH}} = 2^{\alpha_2} \cdot 3^{\alpha_3} \cdot 5^{\alpha_5} \leq N_{\text{RB}}^{\text{UL}}$$

where $\alpha_2, \alpha_3, \alpha_5$ is a set of non-negative integers.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

236. During transform precoding, complex-valued symbols $d(0),\ldots d(M_{\text{symb}} - 1)$ are encoded with the complex-valued codes to produce encoded complex-valued data symbols, $z(0),\ldots z((M_{\text{symb}} - 1)$.

237. The encoded complex-valued data symbols are then mapped to, and modulated onto, physical resources (subcarriers) during SC-FDMA baseband signal generation in accordance with the LTE Specification Section 5.6:

5.6 SC-FDMA baseband signal generation

This section applies to all uplink physical signals and physical channels except the physical random access channel.

The time-continuous signal $s_l(t)$ in SC-FDMA symbol l in an uplink slot is defined by

$$s_l(t) = \sum_{k=-\left\lfloor N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}/2 \right\rfloor}^{\left\lceil N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}/2 \right\rceil - 1} a_{k^{(-)},l} \cdot e^{j2\pi (k+1/2)\Delta f \left(t - N_{\mathrm{CP},l} T_s\right)}$$

for $0 \le t < \left(N_{\mathrm{CP},l} + N\right) \times T_s$ where $k^{(-)} = k + \left\lfloor N_{RB}^{UL} N_{sc}^{RB}/2 \right\rfloor$, $N = 2048$, $\Delta f = 15\,\mathrm{kHz}$ and $a_{k,l}$ is the content of resource element (k,l).

The SC-FDMA symbols in a slot shall be transmitted in increasing order of l, starting with $l = 0$, where SC-FDMA symbol $l > 0$ starts at time $\sum_{l'=0}^{l-1} (N_{\mathrm{CP},l'} + N) T_s$ within the slot.

Table 5.6-1lists the values of $N_{\mathrm{CP},l}$ that shall be used. Note that different SC-FDMA symbols within a slot may have different cyclic prefix lengths.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

238. The SC-FDMA baseband signal generation step employs another DFT that spreads OFDM data into a form that resembles a single carrier. The SC-FDMA signal (spread OFDM signal) is then transmitted from Accused Toyota LTE Devices to base stations.

239. Toyota directly infringes claim 10 of the '786 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

240. As a direct and proximate result of Toyota's acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

<u>COUNT XXII: INFRINGEMENT OF U.S. PATENT '786 CLAIM 11</u>

241. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 and 222-236 of this Complaint as though set forth in full herein.

242. Claim 11 of the '786 Patent provides:

Element A	The apparatus of claim 10, wherein selecting is responsive to spectrum allocation or is configured to provide for orthogonal frequency division multiple access.

243. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 11 of the ’786 Patent.

244. In accordance with the LTE Specification, Accused Toyota LTE Devices are assigned physical resources (subcarriers) to be used for the uplink. This assignment of subcarriers is spectrum allocation. Subcarriers are then selected for use from those assigned.

245. Toyota directly infringes claim 11 of the ’786 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

246. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XXIII: INFRINGEMENT OF U.S. PATENT ’786 CLAIM 15

247. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 and 222-236 of this Complaint as though set forth in full herein.

248. Claim 15 of the ’786 Patent provides:

Element A	The apparatus of claim 10, wherein the plurality of subcarriers are contiguous subcarriers or interleaved subcarriers.

249. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 15 of the ’786 Patent.

250. The use of SC-FDMA (or spread OFDM) allows for subcarriers to be distributed in two manners: contiguously, where subcarriers for a given device are contiguous in the

frequency spectrum; or interleaved, where subcarriers for a given device are interspersed with other device subcarriers in the same frequency spectrum.

251. Toyota directly infringes claim 15 of the ’786 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

252. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XXIV: INFRINGEMENT OF U.S. PATENT ’786 CLAIM 16

253. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 and 222-236 of this Complaint as though set forth in full herein.

254. Claim 16 of the ’786 Patent provides:

Element A	The apparatus of claim 10, wherein encoding comprises multiplying a vector or matrix of data symbols with a vector or matrix comprising the first set of complex-valued codes.

255. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 16 of the ’786 Patent.

256. Accused Toyota LTE Devices perform transform precoding in accordance with the LTE Specification. The transform precoding step employs a DFT, which itself represents a vector multiplication. The DFT can be represented as a complex matrix multiplication, where data symbols are multiplied by the matrix of complex-valued codes.

257. Toyota directly infringes claim 16 of the ’786 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

258. As a direct and proximate result of Toyota's acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XXV: INFRINGEMENT OF U.S. PATENT '786 CLAIM 17

259. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 and 222-236 of this Complaint as though set forth in full herein.

260. Claim 17 of the '786 Patent provides:

Element A	The apparatus of claim 10, wherein applying comprises modulating the encoded data symbols onto the plurality of subcarriers.

261. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 17 of the '786 Patent.

262. Accused Toyota LTE Devices process signals for uplink transmission in accordance with the LTE Specification. As part of the signal processing, complex-valued (encoded) data symbols are mapped to, and then modulated onto subcarriers. The modulation of encoded data symbols onto subcarriers is given by Section 5.6 of the LTE Specification.:

5.6 SC-FDMA baseband signal generation

This section applies to all uplink physical signals and physical channels except the physical random access channel.

The time-continuous signal $s_l(t)$ in SC-FDMA symbol l in an uplink slot is defined by

$$s_l(t)=\sum_{k=-\left\lfloor N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}/2\right\rfloor}^{\left\lceil N_{\mathrm{RB}}^{\mathrm{UL}} N_{\mathrm{sc}}^{\mathrm{RB}}/2\right\rceil-1} a_{k^{(-)},l} \cdot e^{j2\pi(k+1/2)\Delta f\left(t-N_{\mathrm{CP},l}T_s\right)}$$

for $0 \le t < \left(N_{\mathrm{CP},l}+N\right)\times T_s$ where $k^{(-)}=k+\left\lfloor N_{RB}^{UL}N_{sc}^{RB}/2\right\rfloor$, $N=2048$, $\Delta f=15\,\mathrm{kHz}$ and $a_{k,l}$ is the content of resource element (k,l).

The SC-FDMA symbols in a slot shall be transmitted in increasing order of l, starting with $l=0$, where SC-FDMA symbol $l>0$ starts at time $\sum_{l'=0}^{l-1}(N_{\mathrm{CP},l'}+N)T_s$ within the slot.

Table 5.6-1lists the values of $N_{\mathrm{CP},l}$ that shall be used. Note that different SC-FDMA symbols within a slot may have different cyclic prefix lengths.

Source: 3GPP TS 36.211 version 8.7.0 Release 8

263. Toyota directly infringes claim 17 of the ’786 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

264. As a direct and proximate result of Toyota’s acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

COUNT XXVI: INFRINGEMENT OF U.S. PATENT ’786 CLAIM 18

265. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-30 and 222-236 of this Complaint as though set forth in full herein.

266. Claim 18 of the ’786 Patent provides:

Element A	The apparatus of claim 10, wherein the non-transitory computer-readable memory further includes instructions stored thereon and executable by the processor for adding a cyclic prefix to the spread-OFDM signal before transmitting the spread-OFDM signal.

267. Toyota has and continues to make, use, sell, import, and/or offer for sale the Accused Toyota LTE Devices that meet each and every element of claim 18 of the '786 Patent.

268. Accused Toyota LTE Devices process signals for uplink transmission in accordance with the LTE Specification. As part of the signal processing, the LTE Specification section 5.2.3 (and Table 5.2.3-1) requires adding a cyclic prefix to the spread OFDM signal.

Table 5.2.3-1: Resource block parameters.

Configuration	N_{sc}^{RB}	N_{symb}^{UL}
Normal cyclic prefix	12	7
Extended cyclic prefix	12	6

Source: 3GPP TS 36.211 version 8.7.0 Release 8

269. Toyota directly infringes claim 18 of the '786 Patent by selling, offering to sell, and using the Accused Toyota LTE Devices.

270. As a direct and proximate result of Toyota's acts of patent infringement, GenghisComm has been and continues to be injured, and has sustained and will continue to sustain damages.

WILLFUL INFRINGEMENT

271. Toyota has infringed and continues to infringe the above identified claims of each of the Patents-in-Suit despite its knowledge of the '842, '227 and '568 Patents and its knowledge that at least Accused Toyota LTE Devices, were and are using the technology claimed by the since September 14, 2021, and the objectively high likelihood that its acts constitute patent infringement.

272. Toyota's infringement of the Patents-in-Suit is willful and deliberate, entitling GenghisComm to enhanced damages under 35 U.S.C. § 284.

273. Toyota's willful infringement and unwillingness to enter into license negotiations with GenghisComm make this an exceptional case such that GenghisComm should be entitled to recover its attorneys' fees and costs incurred in relation to this matter pursuant to 35 U.S.C. §285.

JURY DEMAND

GenghisComm demands a trial by jury on all issues so triable.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff GenghisComm requests that this Court enter judgment in its favor and against Toyota as follows:

A. Adjudging, finding, and declaring that Toyota has infringed of the above-identified claims of each of the Patents-in-Suit under 35 U.S.C. § 271;

B. Awarding the past and future damages arising out of Toyota's infringement of the Patents-in-Suit to GenghisComm in an amount no less than a reasonable royalty, together with prejudgment and post-judgment interest, in an amount according to proof;

C. Adjudging, finding, and declaring that Toyota's infringement is willful and enhanced damages and fees as a result of that willfulness under 35 U.S.C. § 284;

D. Adjudging, finding, and declaring that this is an "exceptional" case pursuant to 35 U.S.C. § 285;

E. Awarding attorney's fees, costs, or other damages pursuant to 35 U.S.C. §§ 284 or 285 or as otherwise permitted by law; and

F. Granting GenghisComm such other further relief as is just and proper, or as the Court deems appropriate.

May 24, 2023

Respectfully submitted,

By: */s/ Alison Aubry Richard*s

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CERTIFICATE OF SERVICE

I hereby certify that on May 24, 2023, the foregoing was electronically filed with the CM/ECF system, which will send a notification of such filing to all counsel of record.

/s/*Alison A. Richards*
Attorney for Plaintiff