UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

GENGHISCOMM HOLDINGS, LLC Plaintiff, v. ASUSTEK COMPUTER INC., Defendant	Case No. 2:22-cv-66-RWS-RSP FIRST AMENDED COMPLAINT FOR PATENT INFRINGEMENT AND JURY TRIAL DEMANDED

FIRST AMENDED 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 Defendant AsusTek Computer Inc. ("Asus" or "Defendant") that relates to five 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"), 11,075,786 (the "'786 Patent"), and 11,223,508 (the "'508 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.

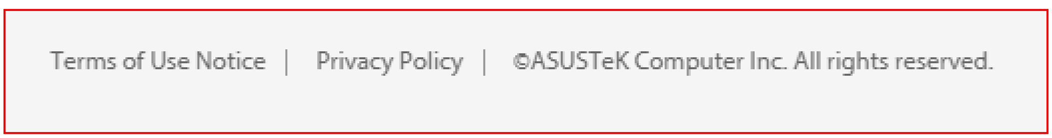
3. Upon information and belief, AsusTek Computer Inc. is a corporation organized under the laws of Taiwan, with a principal place of business at No. 15, Li-Te Road, Beitou

District, Taipei 112, Taiwan and may be served pursuant to the provisions of the Hague Convention.

4. Asus has made, made, makes, used, uses, imports, imported, sold, sells, offers to sell and offered to sell wireless mobile devices including smartphones, tablets, and related applications and services.

5. For example, on November 7, 2022 "ASUSTek Computer Inc." sold undersigned counsel in the U.S. a Zenfone 9.

6. ASUSTek Computer Inc. sold the through Zenfone 9 through ASUSTek Computer Inc.'s website https://www.asus.com/us/, which states the following when viewed from the U.S.



7. The User Guide for the ZenFone 9 is available at https://dlcdnets.asus.com/pub/ASUS/ZenFone/AI2202/E19908_AI2202_ZF9_EM_WEB_1.pdf. In its User Guide, Asus represents to the public that "ASUSTek Computer Inc." is the "manufacturer" of the phone:

Model name: ASUS_AI2202

Manufacturer:	ASUSTeK Computer Inc.
Address:	1F., No.15, Lide RD., Beitou Dist., Taipei City 112
Authorised representative in Europe:	ASUS Computer GmbH
Address:	HARKORT STR. 21-23, 40880 RATINGEN, GERMANY

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8. AsusTek Computer Inc. has applied to the U.S. Federal Communications Commission ("FCC") to sell original equipment in the U.S. over 8,000 times, from at least 1997 through 2022. Exhibit A.

9. Asus telephones and tablets sold and offered for sale in the U.S. bear the Asus trademarks, including as follows:

10. The USPTO shows the current owner of the ASUS trademarks as "ASUSTek Computer Incorporation, TAIWAN," including at least the following:

Serial Number	Reg. Number	Word Mark	Live/Dead
97180242		ASUS	LIVE
97310442		ASUS	LIVE
90046134	6565260	ASUS	LIVE
85892190	4651253	ASUS	LIVE
78979284	3370930	ASUS	LIVE
78342942	3379287	ASUS	LIVE
75617786	2376858	ASUS	LIVE
74526823	1894985	ASUS	LIVE

11. To register a U.S. trademark, the mark must either be currently in use or intended to be used in commerce.

12. The Asus phone sold in the U.S. is shipped in the following packaging:

13. The Asus phone sold in the U.S. is shipped in the following packaging:

14. The back of the phone box appears as follows:

15. When a U.S. consumer enters the Asus website, the below repeatedly pops up:

ASUSTeK COMPUTER INC. and its affiliated entities companies use cookies and similar technologies to perform essential online functions, such as authentication and security. You may disable these by changing your cookies setting through browser, but this may affect how this website functions.

Also, ASUS uses some analytics, targeting, adverting and video-embedded cookies provided by ASUS or third parties. Please click a button here to choose your preference for these types of cookies. Please note that you can configure cookies settings by accessing the browser you install at any time. For detailed information, please visit ASUS Privacy Policy- "Cookies and similar technologies".

Reject Accept

16. Asus' Terms of Use Notice Privacy Policy for the United States, available on its website at https://www.asus.com/us/Terms_of_Use_Notice_Privacy_Policy/Official-Site, states:

> Terms Of Use Notice
> ALL PRODUCTS AND SERVICES ("SERVICE") PROVIDED BY **ASUSTEK COMPUTER INC. ("ASUS")** ARE SUBJECT TO THIS TERMS OF USE NOTICE ("NOTICE"). SERVICE MEANS, INCLUDING BUT NOT LIMITED TO, ANY PRODUCT, SERVICE, SERVICE EVENT (DEFINED AS BELOW), SOFTWARE, APPLICATION AND INFORMATION PROVIDED UNDER ASUS BRAND OR ANY OTHER BRAND OWNED BY ASUS. YOU EXPRESSLY ACKNOWLEDGE THAT YOU HAVE READ THIS NOTICE AND UNDERSTAND THE RIGHTS, OBLIGATIONS, TERMS AND CONDITIONS SET FORTH HEREIN. IF YOU ARE A MINOR, YOU SHALL REGISTER AS THE MEMBER OR ACCESS THE SERVICES ONLY AFTER YOUR PARENTS (OR YOUR GUARDIAN) READ AND UNDERSTAND THE RIGHTS, OBLIGATIONS, TERMS AND CONDITIONS CONTAINED IN THIS NOTICE. BY CONTINUING TO INSTALL, COPY, SURF, DOWNLOAD, ACCESS, PURCHASE, ENTER AND/OR OTHERWISE USE THE SERVICE, YOU OR YOUR PARENTS (OR GUARDIAN) EXPRESSLY CONSENT TO BE BOUND BY THIS NOTICE, INCLUDING UPDATED VERSION, AND ALL APLICABLE LAWS AND REGULATIONS.

17. Asus' Terms of Use Notice Privacy Policy for the United States also states:

> For further information regarding this NOTICE and referenced guidelines, contact ASUS Legal Compliance Department by registered mail, facsimile, e-mail or phone at:
>
> ASUSTeK Computer Inc.
> Company Representative: Mr. Jonney Shih
> Legal Affairs Center
> Legal Compliance Department
> Address: 15, Li-Te Rd., Taipei 112, Taiwan
> Email: LegalCompliance@asus.com
> Telephone: (886) 2 2894 3447
> Fax: (886) 2 2890 7674

18. Asus' website also provides its U.S. users with a "Privacy Policy." At checkout, Asus requires its U.S. phone buyers to agree to the Privacy Policy and the Sales Terms and Conditions discussed above:

> By clicking Place Order, I agree to provide the above information to ASUS for delivery, invoice issuance and customer services, and also agree to Privacy Policy and Sales Terms and Conditions.

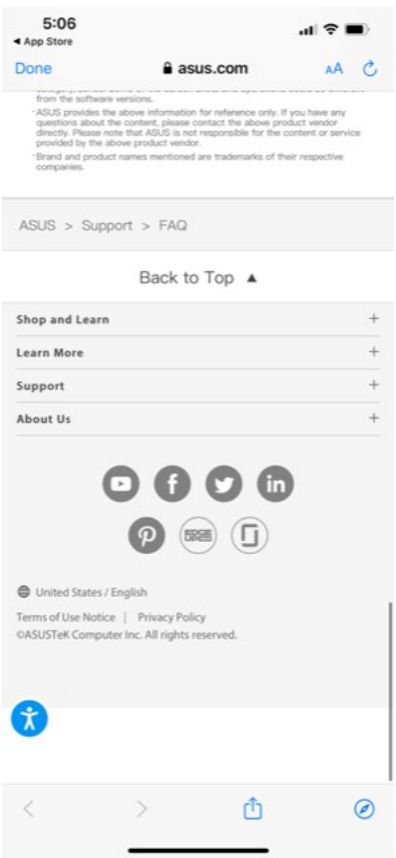
19. Asus' Privacy Policy, available online at https://www.asus.com/Terms_of_Use_Notice_Privacy_Policy/Privacy_Policy, states:

> ASUSTeK COMPUTER INC. and its affiliated entities companies (hereinafter referred to as "**ASUS**", "**we/our/us**") are committed to protecting and respecting your privacy. We endeavor to comply with all applicable laws on privacy protection and personal data security. ASUS Privacy Policy, together with any privacy-related notices or statements that contain supplementary information in connection with particular ASUS products and services you are using (hereinafter referred to as "Privacy Policy"), outline our privacy practices regarding the collection, use and safeguard of your personal data through ASUS products and services, both online and offline we provide. In Privacy Policy, we also outline whom we may share or disclose the collected personal data.

20. Asus' website https://www.asus.com/support/images/upload/warranty/us_Premium%20Phone.pdf, requests that U.S. customers fill out the "Asus Warranty Information Form." In this Form, Asus states:

> This ASUS manufacturer warranty (hereafter referred to as the "Warranty") is granted by ASUSTeK Computer Inc. (hereafter referred to as"ASUS") to the purchaser (hereafter referred to as "You") of the ASUS phone system (hereafter referred to as the "Product"). This warranty is being delivered with the Product, subject to the following terms and conditions. ASUS accredited Service Agents and Repair Centers will provide the services covered under this Warranty.

21. Additionally, in the US Asus offers "ASUS Support" through its MyASUS app, including for example "[Phone/Pad] Can't use mobile networks." The MyASUS app identifies its "Developer" as "ASUSTek" multiple times. After the user selects "USA/English," the app asks the customer to become an "ASUS member" by agreeing to the "ASUS 'Privacy Policy'" and the "ASUS Terms of Use." The Privacy Policy ends with a copyright by "ASUSTek Computer Inc." as follows:

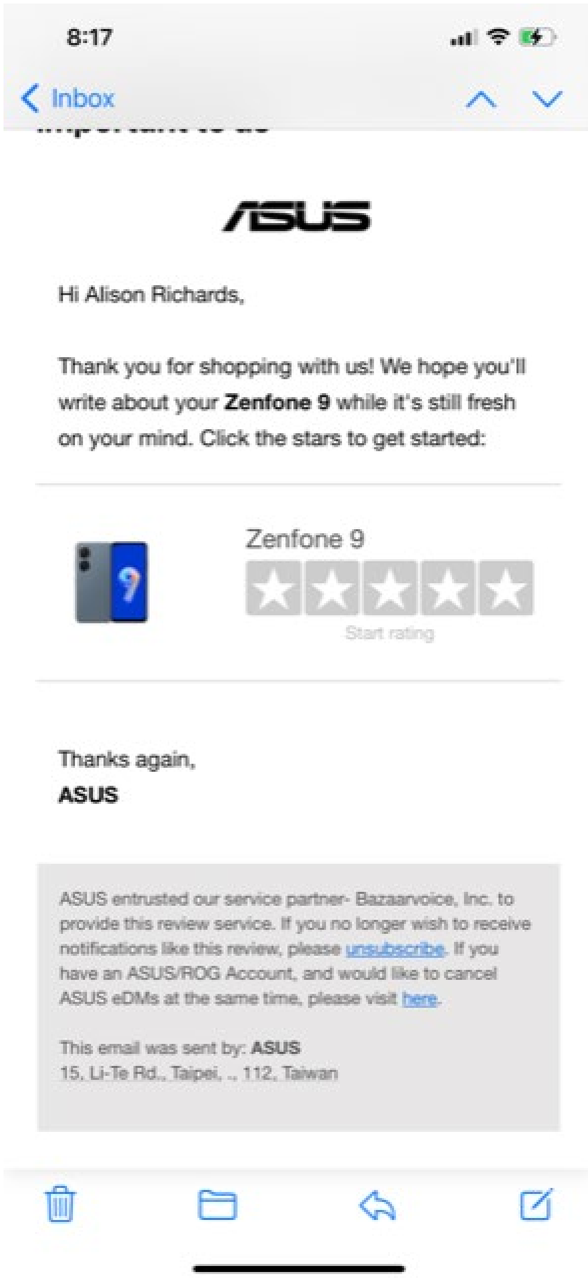


22. Asus then sends the US customer an email "Welcome to be ASUS Account" that ends by stating that "any views or opinions expressed are solely those of the author and do not represent those of ASUSTek."

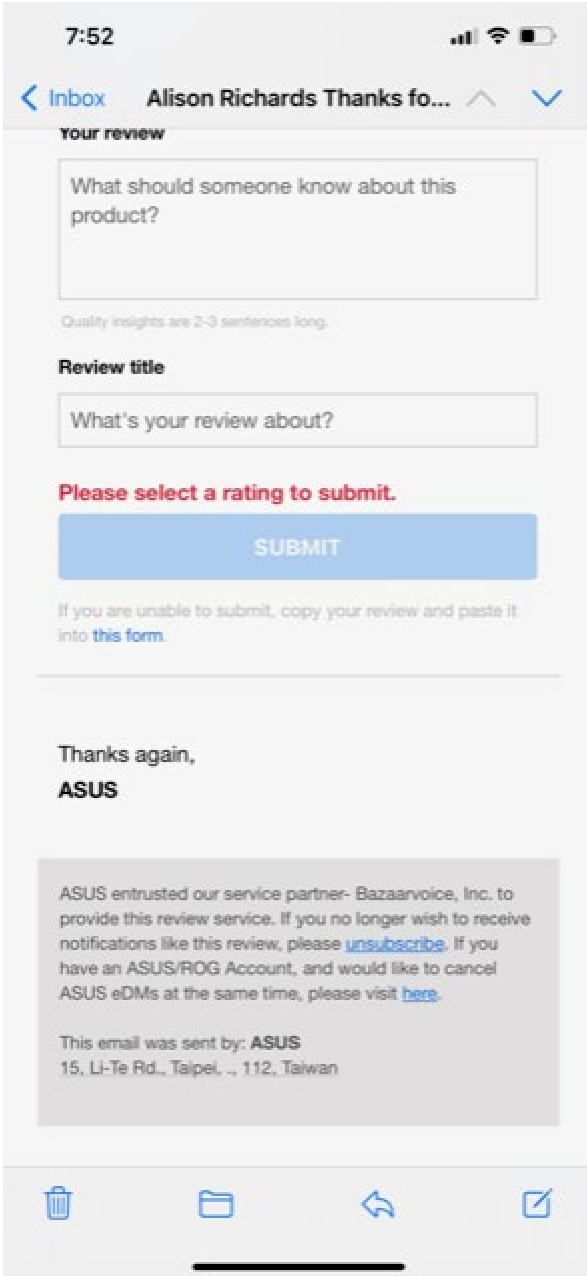
23. Upon opening, the MyAsus app requires the US customer to accept or reject a statement that begins: “ASUSTek COMPUTER INC. and its affiliated companies use cookies and similar technologies to perform essential online functions, such as authentication and security. . . .”

* MERGEFORMATINET

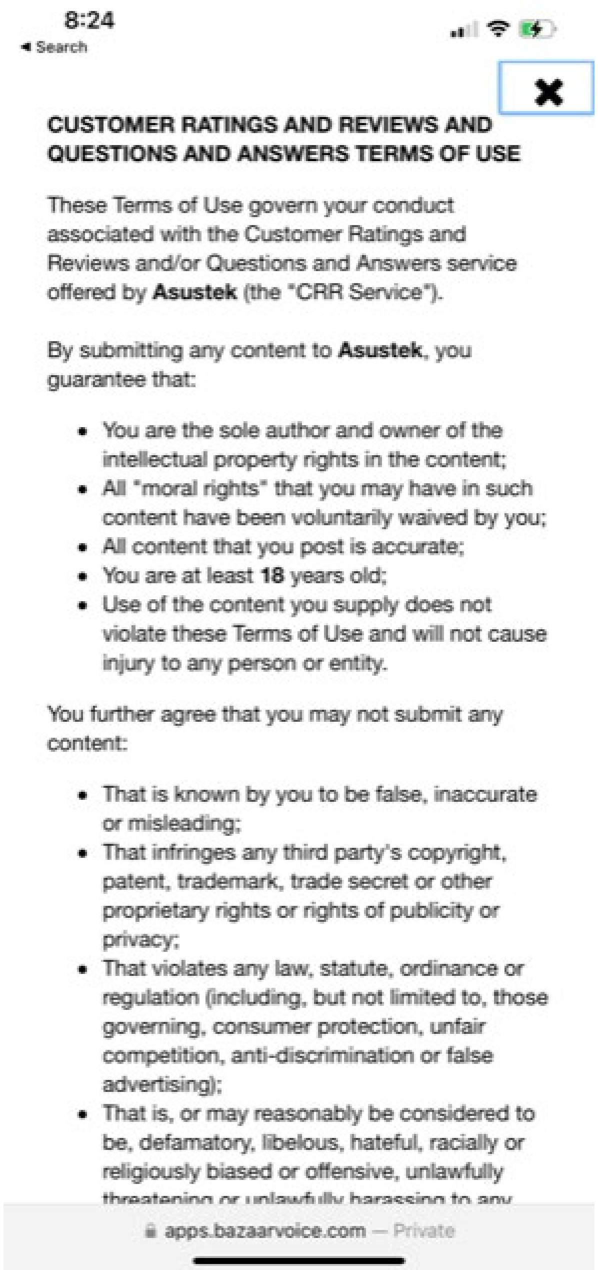
24. After a U.S. consumer buys a phone from AsusTek Computer Inc., it sends the consumer emails including, for example, the email below, which expressly states that it was sent by Asus in Taiwan:



25. The survey itself makes clear that it was sent by Asus in Taiwan:



26. The survey purports to provide its own terms and conditions, which state that the review is a service provided by "Asustek." The document identifies "Asustek" at least 13 times, including as follows:



8:24

◂ Search

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CUSTOMER RATINGS AND REVIEWS AND QUESTIONS AND ANSWERS TERMS OF USE

These Terms of Use govern your conduct associated with the Customer Ratings and Reviews and/or Questions and Answers service offered by **Asustek** (the "CRR Service").

By submitting any content to **Asustek**, you guarantee that:

- You are the sole author and owner of the intellectual property rights in the content;
- All "moral rights" that you may have in such content have been voluntarily waived by you;
- All content that you post is accurate;
- You are at least **18** years old;
- Use of the content you supply does not violate these Terms of Use and will not cause injury to any person or entity.

You further agree that you may not submit any content:

- That is known by you to be false, inaccurate or misleading;
- That infringes any third party's copyright, patent, trademark, trade secret or other proprietary rights or rights of publicity or privacy;
- That violates any law, statute, ordinance or regulation (including, but not limited to, those governing, consumer protection, unfair competition, anti-discrimination or false advertising);
- That is, or may reasonably be considered to be, defamatory, libelous, hateful, racially or religiously biased or offensive, unlawfully threatening or unlawfully harassing to any

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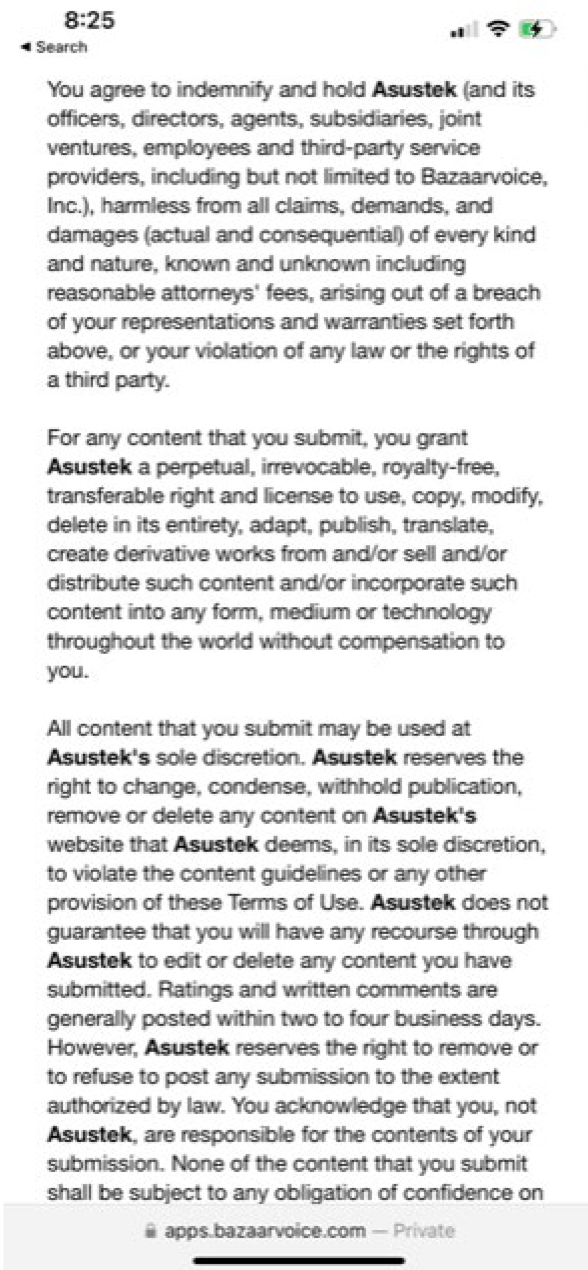

8:25

◂ Search

You agree to indemnify and hold **Asustek** (and its officers, directors, agents, subsidiaries, joint ventures, employees and third-party service providers, including but not limited to Bazaarvoice, Inc.), harmless from all claims, demands, and damages (actual and consequential) of every kind and nature, known and unknown including reasonable attorneys' fees, arising out of a breach of your representations and warranties set forth above, or your violation of any law or the rights of a third party.

For any content that you submit, you grant **Asustek** a perpetual, irrevocable, royalty-free, transferable right and license to use, copy, modify, delete in its entirety, adapt, publish, translate, create derivative works from and/or sell and/or distribute such content and/or incorporate such content into any form, medium or technology throughout the world without compensation to you.

All content that you submit may be used at **Asustek's** sole discretion. **Asustek** reserves the right to change, condense, withhold publication, remove or delete any content on **Asustek's** website that **Asustek** deems, in its sole discretion, to violate the content guidelines or any other provision of these Terms of Use. **Asustek** does not guarantee that you will have any recourse through **Asustek** to edit or delete any content you have submitted. Ratings and written comments are generally posted within two to four business days. However, **Asustek** reserves the right to remove or to refuse to post any submission to the extent authorized by law. You acknowledge that you, not **Asustek**, are responsible for the contents of your submission. None of the content that you submit shall be subject to any obligation of confidence on

apps.bazaarvoice.com — Private

27. Asustek Computer Inc.'s annual reports include its U.S. sales activities. These annual reports are available at https://www.asus.com/EVENT/Investor/ir_report.

28. Asus' 2021 Annual Report states:

Unit: NT$ thousands

Item \ Year	2020		2021	
	Subtotal	Total	Subtotal	Total
Sales to TW		21,419,537		28,999,151
Sales to region outside of		395,773,510		506,239,584
Taiwan	107,573,633		132,380,886	
America	162,267,972		222,885,520	
Asia Pacific / Oceania	123,254,852		145,888,224	
Europe	2,677,053		5,084,954	
Africa				
Net sales		417,193,047		535,238,735
(-) Revenue from contracts with customers from discontinued operations		(4,412,608)		-
Total		412,780,439		535,238,735

2. Market share and market demand and supply and market growth

29. Asus' 2021 Annual Report discloses that Asus owns 100% of its subsidiary "Asus Computer International," which Asus's Annual Report calls an "affiliated enterprise." The defendant includes ACI's U.S. net income/profit in its annual results.

30. As another example of its activities in the U.S., Asus' 2021 Annual Report states that in January 2022 "ASUS breaks its own record to win 20 innovation awards at CES® 2022 in the United States."

31. Asus' 2021 Annual Report states:

> The Company's main area s of business are the design, research, development and sales of electronics and information products. In many of its electronics-integrated products, the Company has offered excellent quality and industry-leading technology, which have won many awards. In 2021, ASUS again was recognized as one of the "World's Most Admired Companies" by "Fortune Magazine" of the United States. The product categories span motherboards, graphics cards, laptops, smart phones, displays, routers and a full range of technology product solutions; the Company is also actively expanding its esports products and creates a variety of applications in new areas of AIoT. ASUS is committed to pursuing unparalleled technological innovations, creating a thoughtful intelligent life and ubiquitous happiness for global users; the vision of the brand is to become "a leading technology innovative enterprise highly respected by the new digital generation." ASUS has about 15,000

employees around the world, and has a world-class R&D team of more than 5,000 people. **<u>Its products are sold in more than 70 countries around the world</u>** and have won more than 11 awards every day on average. The product innovation, design and quality have been recognized by the global market.

32. Asus' 2021 Annual Report also states:

> "ROG and all e-sports-related products, along with the expansion of the esports industry and esports user base, become the important long-term growth momentum, the annual growth rate will be targeted on double-digits, and gradually become a lion in the industry. For mobile phones, the focus will be on esports users and expert users, establishing a market leading position and brand value for a specific user group."

33. Asus' 2021 Annual Report also states:

> ASUS has committed to R&D excellence since the day of its incorporation to rely on inhouse innovation for the R&D, production, and marketing of advanced motherboards, graphics cards, laptops, tablets, servers and smartphones; and to develop 4C (computers, communications, consumer electronics, and automobile electronics) integrated products.

34. Asus' 2021 Annual Report also states:

> R&D planned in 2022:
> Smartphones
> d. High-performance thin-and-light laptops
> e. Dual-screen ScreenPad Plus laptops
> f. ProArt creator laptops

35. Asus' 2021 Annual Report also states:

> "ASUS provided recycling service in Taiwan, Europe, **North America**, China and India. Through recycling and resource circulation, replaced electronic products were given new value and life, which created the next wave of opportunity for economic development and became the key of the circular economy."

36. Asus' 2021 Annual Report also states:

> "In 2020, ASUS acquired a total of 7 Green Marks in Europe, North America and Asia for maximizing resource benefits, promoting energy conservation and reducing emission of greenhouse gases."

37. Asus' 2021 Annual Report also states:

> "Sales and marketability:
>
> (1) Advantages
> a. Under the operation of a strong sales management program, ASUS has achieved competitive computer sales in most regions, limiting the impact that adverse economic situations in one area has on the corporate operations. By deploying product lines across the market, the Company can properly reduce the impact of economic risks.
> b. The pandemic has driven inelastic demand for computers and computer peripherals, and demand is strong in markets around the world, including Europe, America, and the Asia-Pacific region. ASUS has planned and acquired good brand and channel positioning."

38. In the alternative, Asustek Computer Inc., is also responsible for the infringement by its subsidiary ASUS Computer International, which Asustek Computer Inc. owns, controls and directs, based on all on the facts set forth above. ASUS Computer International is Asustek Computer Inc.'s agent and alter ego, based on all on the facts set forth above.

39. The facts above illustrate the extensive relationship ASUS Computer International and its wholly owned subsidiary Asustek Computer Inc. The "close association" between ASUS Computer International and its wholly owned subsidiary Asustek Computer Inc. justifies imputing notice to ASUS Computer International. On information and belief, ASUS Computer International could not import or sell Asus' accused products in the U.S., which bear Asus' trademarks, without Asustek Computer Inc.'s approval and direction.

JURISDICTION AND VENUE

40. 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.

41. 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.

42. Asus 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 solicited business in the State of Texas, transacted business within the State of Texas and attempted to derive 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; (ii) 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 (iii) having committed the complained of tortious acts in Texas and in this District.

43. Asus, directly and/or through subsidiaries and agents (including distributors, retailers, and others), makes, imports, ships, distributes, offers for sale, sells, uses, and advertises (including offering products and services through its website, https://store.asus.com/us/, as well as other retailers) its products and/or services in the United States, the State of Texas, and the Eastern District of Texas. Asus, 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. Asus has committed acts of patent infringement within the State of Texas and, more particularly, within the Eastern District of Texas.

44. Venue is proper as to Defendant because 28 U.S.C. § 1391(c)(3) provides that "a defendant not resident in the United States may be sued in any judicial district, and the joinder of

such a defendant shall be disregarded in determining where the action may be brought with respect to other defendants."

BACKGROUND FACTS REGARDING THE GENGHISCOMM PATENTS

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

46. 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.

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

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

49. 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.

50. 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.

51. On September 19, 2017, the '508 Patent entitled "Wireless communications using flexible channel bandwidth" was duly and legally issued by the USPTO.

ASUS'S INFRINGING PRODUCTS

52. 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 smartphones, tablets, and other mobile wireless devices in this District and elsewhere in the United States that include the apparatuses claimed in the Patents-in-Suit.

53. Defendant's infringing products include its mobile devices that have LTE network connectivity and that adhere to the LTE standards, including, but not limited to, its ZenFone 5, 6, 7, and 8 series mobile phones, and its ZenPad 7, 8, and 9 series tablets. Defendant's infringing LTE products are collectively referred to as the "Accused Asus LTE Devices."

54. Defendant's infringing products further include its mobile devices that have 5G network connectivity and that adhere to the 5G wireless standards, including, but not limited to, its ZenFone 7 and 8 series mobile phones. Defendant's infringing 5G products are collectively referred to as the "Accused Asus 5G Devices."

ASUS'S KNOWLEDGE OF THE PATENTS-IN-SUIT AND CONTINUED INFRINGEMENT DESPITE THAT KNOWLEDGE

55. On November 19, 2020, counsel for GenghisComm sent a letter to Mr. Vincent Hong, General Counsel for Asustek Computer Inc., and Mr. Jacky Lu, Manager of Asustek Computer Inc. informing Defendant of GenghisComm's patents, and how Defendant infringed GenghisComm's patents. Defendant has been aware of at least the '842, '227 and '568 Patents since at least November 19, 2020. With the claim charts, the letter was 105 pages.

56. Counsel received an email response from Defendant on November 22, 2020, indicating that Defendant was investigating the matter.

57. On June 29, 2021, GenghisComm's counsel emailed Asus: "We hope all is well on your end. I just wanted to let you know that our client has directed us to try to wrap up the licensing negotiations phase of this project by Labor Day. Please let us know if it would help to talk by phone."

58. On July 8, 2021, Asus indicated that it was discussing the claim charts with the R&D team and would send Asus's feedback in two or three weeks.

59. Asus did not further respond.

60. To Genghiscomm's knowledge, Defendant never raised any non-infringement defense related to the Patents-in-Suit and never raised any prior art issues related to the Patents-in-Suit.

61. Defendant has not agreed to enter into a licensing agreement with GenghisComm.

62. This Complaint serves as notice to Asus to at least the '786 and '508 Patents, and serves as additional notice for the '842, '227 and '568 Patents and the manner in which the Patents-in-Suit are infringed.

63. 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, Asus has continued to infringe, and/or induce the infringement of, the Patents-in-Suit.

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

64. Genghiscomm incorporates by reference the allegations set forth in paragraphs 1-28 of this Complaint as though set forth in full herein.

65. 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.

66. Asus 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 Asus LTE Devices to eNodeB receivers located at cell sites.

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

68. The Accused Asus LTE Devices include a transmitter used for LTE network connectivity and communications. For example, the Asus ZenFone 8 uses the Qualcomm Snapdragon 888 5G Mobile Platform system-on-a-chip, with the chip including LTE connectivity using its transmitter.

69. 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 Asus LTE Devices.

70. The transmitter in Accused Asus 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.

71. The transmitter in Accused Asus 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).

72. The transmitter in Accused Asus 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

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

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).

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

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.

73. Asus directly infringes claim 1 of the '842 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

74. Asus has had knowledge of the '842 Patent since November 19, 2020.

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

76. As a direct and proximate result of Asus'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

77. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-41 of this Complaint as though set forth in full herein.

78. 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.

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

80. The transmitter in Accused Asus 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).

81. 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.

82. 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.

83. 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.

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

85. Asus has had knowledge of the ’842 Patent since November 19, 2020.

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

87. As a direct and proximate result of Asus’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

88. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-41 of this Complaint as though set forth in full herein.

89. 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.

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

91. The transmitter in Accused Asus 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

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

for $0 \le t < (N_{\mathrm{CP},l} + N) \times T_s$ 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).

Source: 3GPP TS 36.211 version 8.7.0 Release 8

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

93. Asus has had knowledge of the ’842 Patent since November 19, 2020.

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

95. As a direct and proximate result of Asus’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

96. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-41 of this Complaint as though set forth in full herein.

97. 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.

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

99. 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 Asus LTE Devices comply with this release 15 of the LTE Specification.

100. 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.

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

102. Asus has had knowledge of the ’842 Patent since November 19, 2020.

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

104. As a direct and proximate result of Asus’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

105. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-41 of this Complaint as though set forth in full herein.

106. 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.

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

108. 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

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

for $0\leq t<(N_{CP,l}+N)\times T_s$ 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

109. Asus directly infringes claim 7 of the ’842 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

110. Asus has had knowledge of the ’842 Patent since November 19, 2020.

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

112. As a direct and proximate result of Asus'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

113. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-41 of this Complaint as though set forth in full herein.

114. 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.

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

116. During uplink processing, Accused Asus 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

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

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 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.

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

118. Asus has had knowledge of the ’842 Patent since November 19, 2020.

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

120. As a direct and proximate result of Asus’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

121. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-41 of this Complaint as though set forth in full herein.

122. 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.

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

124. 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 Asus LTE Devices comply with this release 15 of the LTE Specification.

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

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

127. Asus has had knowledge of the ’842 Patent since November 19, 2020.

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

129. As a direct and proximate result of Asus’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

130. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 of this Complaint as though set forth in full herein.

131. 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.

132. Asus 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 Asus LTE Devices to eNodeB receivers located at cell sites.

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

134. The Accused Asus LTE Devices have processors (e.g., Qualcomm Snapdragon 888 5G Mobile Platform, Adreno 660) and non-transitory memory coupled to the processor (e.g., LPRDDR up to 16GB). The memory includes instructions for applying LTE physical channel processing consistent with the LTE Specification.

135. The memory of Accused Asus 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.

136. 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.

137. The memory of Accused Asus 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).

138. 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.

139. The memory of Accused Asus 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.

140. 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

141. 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.

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

143. Asus has had knowledge of the ’227 Patent since November 19, 2020.

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

145. As a direct and proximate result of Asus’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

146. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 95-110 of this Complaint as though set forth in full herein.

147. Claim 24 of the ’227 Patent provides:

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

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

149. Accused Asus LTE Devices are User Equipment that include the processor and memory described in paragraph 99 above.

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

151. Asus has had knowledge of the ’842 Patent since November 19, 2020.

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

153. As a direct and proximate result of Asus'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

154. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 95-110 of this Complaint as though set forth in full herein.

155. Claim 25 of the '227 Patent provides:

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

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

157. 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.

158. 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.

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

160. Asus has had knowledge of the '227 Patent since November 19, 2020.

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

162. As a direct and proximate result of Asus'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

163. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 95-110 of this Complaint as though set forth in full herein.

164. Claim 26 of the '227 Patent provides:

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

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

166. Accused Asus 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.

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

168. Asus has had knowledge of the ’227 Patent since November 19, 2020.

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

170. As a direct and proximate result of Asus’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

171. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 95-110 of this Complaint as though set forth in full herein.

172. 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.

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

174. 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.

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

175. Asus directly infringes claim 28 of the ’227 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

176. Asus has had knowledge of the ’227 Patent since November 19, 2020.

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

178. As a direct and proximate result of Asus’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

179. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 of this Complaint as though set forth in full herein.

180. 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.

181. Asus 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 Asus LTE Devices to eNodeB receivers located at cell sites.

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

183. The Accused Asus LTE Devices have processors (e.g., Qualcomm Snapdragon 888 5G Mobile Platform, Adreno 660) and non-transitory memory coupled to the processor (e.g., LPRDDR up to 16GB). The memory includes instructions for applying LTE physical channel processing consistent with the LTE Specification.

184. The memory in Accused Asus 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.

185. 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.

186. 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

187. 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

188. 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.

189. Asus directly infringes claim 24 of the ’568 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

190. Asus has had knowledge of the ’568 Patent since November 19, 2020.

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

192. As a direct and proximate result of Asus’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

193. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 144-157 of this Complaint as though set forth in full herein.

194. 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.

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

196. 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 $d(0),...,d(M_{\text{symb}}-1)$ 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

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

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

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

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

200. Asus has had knowledge of the ’568 Patent since November 19, 2020.

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

202. As a direct and proximate result of Asus'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

203. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 144-167 of this Complaint as though set forth in full herein.

204. Claim 26 of the '568 Patent provides:

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

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

206. 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

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

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

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

208. Asus has had knowledge of the ’568 Patent since November 19, 2020.

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

210. As a direct and proximate result of Asus’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

211. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 144-157 of this Complaint as though set forth in full herein.

212. 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.

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

214. 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

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

216. Asus directly infringes claim 29 of the '568 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

217. Asus has had knowledge of the '568 Patent since November 19, 2020.

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

219. As a direct and proximate result of Asus'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

220. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28, 144-157, and 176-184 of this Complaint as though set forth in full herein.

221. 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.

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

223. 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.

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

225. 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

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

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.

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.

226. Asus directly infringes claim 32 of the '568 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

227. Asus has had knowledge of the '568 Patent since November 19, 2020.

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

229. As a direct and proximate result of Asus'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

230. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 144-157 of this Complaint as though set forth in full herein.

231. 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.

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

233. 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

234. 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

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

236. Asus has had knowledge of the '568 Patent since November 19, 2020.

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

238. As a direct and proximate result of Asus’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

239. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28, 144-157, and 195-203 of this Complaint as though set forth in full herein.

240. 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.

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

242. 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 $b(0),...,b(M_{\text{bit}}-1)$, 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

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

244. Asus has had knowledge of the ’568 Patent since November 19, 2020.

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

246. As a direct and proximate result of Asus’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

247. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 144-157 of this Complaint as though set forth in full herein.

248. 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.

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

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

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

252. Asus has had knowledge of the ’568 Patent since November 19, 2020.

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

254. As a direct and proximate result of Asus'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

255. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 of this Complaint as though set forth in full herein.

256. 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.

257. Asus 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 Asus LTE Devices to eNodeB receivers located at cell sites.

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

259. The Accused Asus 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.

260. The Accused Asus LTE Devices have processors (e.g., Qualcomm Snapdragon 888 5G Mobile Platform, Adreno 660) and non-transitory memory coupled to the processor (e.g., LPRDDR up to 16GB). The memory includes instructions for applying LTE physical channel processing consistent with the LTE Specification.

261. The memory in Accused Asus 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.

262. 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

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

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

263. 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.

264. In accordance with the LTE Specification, Accused Asus 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 Asus LTE Devices select subcarriers based on the number of resource blocks assigned to the device.

265. During uplink signal processing, Accused Asus LTE Devices transform precoded 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

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

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

266. 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, $z(0),\ldots z((M_{\text{symb}}-1)$.

267. 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

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

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

268. 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 Asus LTE Devices to base stations.

269. Asus directly infringes claim 10 of the ’786 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

270. As a direct and proximate result of Asus’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>

271. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 220-235 of this Complaint as though set forth in full herein.

272. 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.

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

274. In accordance with the LTE Specification, Accused Asus 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.

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

276. As a direct and proximate result of Asus’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

277. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 220-235 of this Complaint as though set forth in full herein.

278. 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.

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

280. 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.

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

282. As a direct and proximate result of Asus’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

283. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 220-235 of this Complaint as though set forth in full herein.

284. 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.

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

286. Accused Asus 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.

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

288. As a direct and proximate result of Asus'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

289. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 220-235 of this Complaint as though set forth in full herein.

290. 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.

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

292. Accused Asus 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

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

for $0\le t<\left(N_{CP,l}+N\right)\times T_s$ 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

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

294. As a direct and proximate result of Asus’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

295. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 220-235 of this Complaint as though set forth in full herein.

296. 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.

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

298. Accused Asus 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

299. Asus directly infringes claim 18 of the ’786 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

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

COUNT XXVII: INFRINGEMENT OF U.S. PATENT ’508 CLAIM 17

301. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 of this Complaint as though set forth in full herein.

302. Claim 17 of the ’508 Patent provides:

Claim 17 Preamble	An apparatus for communicating in a mobile radio communications network, comprising:
Element A	a transceiver-control circuitry configured for:
Element B	provisioning a consecutive series of Orthogonal Frequency Division Multiplexing (OFDM) subcarriers for uplink or downlink communications;

Element C	provisioning a plurality of different selectable subcarrier spacings for the consecutive series of OFDM subcarriers; and
Element D	performing discrete Fourier transform (DFT) coding on a plurality of data symbols to produce DFT coded symbols; and
Element E	an OFDM transceiver communicatively coupled to the transceiver-control circuitry and configured for:
Element F	performing an inverse-DFT on the coded symbols to produce a single-carrier frequency division multiple access signal that comprises a sum of the consecutive series of OFDM subcarriers; and
Element G	transmitting the single-carrier frequency division multiple access signal in the mobile radio communications network;
Element H	wherein provisioning the plurality of different selectable subcarrier spacings comprises providing the single-carrier frequency division multiple access signal with a particular one of a set of different symbol periods by selecting one of the plurality of different selectable subcarrier spacings.

303. Asus makes, uses, sells, offers for sale, and imports wireless devices that utilize 5G networks and 5G LTE wireless standards (e.g., 3GPP TS 38.211 version 15.2.0 release 15; the "5G Specification") and the requirements for uplink and downlink physical channel communications. These communications are sent from Accused Asus 5G Devices, as defined in paragraph 19, to eNodeB receivers located at cell sites.

304. Asus has and continues to make, use, sell, import, and/or offer for sale the Accused Asus 5G Devices that meet each and every element of claim 17 of the '508 Patent.

305. The Accused Asus 5G Devices have transceiver-control circuitry, including the Qualcomm Snapdragon 888 5G Mobile Platform, which incorporates a 5G modem and transceiver, configured for 5G physical channel uplink and downlink communications in accordance with the 5G Specification.

306. The 5G Specification requires defining OFDM symbols for use with subcarriers (resource elements) in either the uplink or downlink. The subcarriers used in uplink or downlink communications are allowed to have different subcarriers spacings for selection and use: 15, 30,

60, 120, or 240 kHz. These different spacings are defined in Section 4.3.2 of the 5G Specification:

4.3.2 Slots

For subcarrier spacing configuration μ, slots are numbered $n_s^\mu \in \{0,\ldots,N_{\text{slot}}^{\text{subframe},\mu}-1\}$ in increasing order within a subframe and $n_{s,f}^\mu \in \{0,\ldots,N_{\text{slot}}^{\text{frame},\mu}-1\}$ in increasing order within a frame. There are $N_{\text{symb}}^{\text{slot}}$ consecutive OFDM symbols in a slot where $N_{\text{symb}}^{\text{slot}}$ depends on the cyclic prefix as given by Tables 4.3.2-1 and 4.3.2-2. The start of slot n_s^μ in a subframe is aligned in time with the start of OFDM symbol $n_s^\mu N_{\text{symb}}^{\text{slot}}$ in the same subframe.

OFDM symbols in a slot can be classified as 'downlink', 'flexible', or 'uplink'. Signaling of slot formats is described in subclause 11.1 of [5, TS 38.213].

In a slot in a downlink frame, the UE shall assume that downlink transmissions only occur in 'downlink' or 'flexible' symbols.

In a slot in an uplink frame, the UE shall only transmit in 'uplink' or 'flexible' symbols.

A UE not capable of full-duplex communication is not expected to transmit in the uplink earlier than $N_{\text{Rx-Tx}}T_c$ after the end of the last received downlink symbol in the same cell where $N_{\text{Rx-Tx}}$ is given by [TS 38.101].

Table 4.3.2-1: Number of OFDM symbols per slot, slots per frame, and slots per subframe for normal cyclic prefix.

μ	$N_{\text{symb}}^{\text{slot}}$	$N_{\text{slot}}^{\text{frame}\mu}$	$N_{\text{slot}}^{\text{subframe}\mu}$
0	14	10	1
1	14	20	2
2	14	40	4
3	14	80	8
4	14	160	16

Source: 5G Specification, 3GPP TS 38.211 version 15.2.0 release 15

307. These selectable subcarrier spacings allow for different numbers of slots (or subframes) to be used for a given radio frame. For example, if a 15Khz spacing is selected, then there will be 1 slot in the frame (OFDM symbol period of ~ 66.6 □s); 30kHz allows for 2 slots (~33.3 □s OFDM symbol period); 60kHz allows for 4 slots (~16.66 □s symbol period); 120kHz allows for 8 slots (8.3□s symbol period). Thus, for each subcarrier spacing, there are different possible symbol periods.

308. The Accused Asus 5G Devices perform transform precoding in accordance with the 5G Specification (section 6.3.1.4):

6.3.1.4 Transform precoding

If transform precoding is not enabled according to 6.1.3 of [6, TS38.214], $y^{(\lambda)}(i) = x^{(\lambda)}(i)$ for each layer $\lambda = 0,1,...,\upsilon - 1$.

If transform precoding is enabled according to 6.1.3 of [6, TS38.214], $\upsilon = 1$ and $\tilde{x}^{(0)}(i)$ depends on the configuration of phase-tracking reference signals.

If the procedure in [6, TS 38.214] indicates that phase-tracking reference signals are not being used, the block of complex-valued symbols $x^{(0)}(0),...,x^{(0)}(M_{\text{symb}}^{\text{layer}} - 1)$ for the single layer $\lambda = 0$ shall be divided into $M_{\text{symb}}^{\text{layer}} / M_{\text{sc}}^{\text{PUSCH}}$ sets, each corresponding to one OFDM symbol and $\tilde{x}^{(0)}(i) = x^{(0)}(i)$.

If the procedure in [6, TS 38.214] indicates that phase-tracking reference signals are being used, the block of complex-valued symbols $x^{(0)}(0),...,x^{(0)}(M_{\text{symb}}^{\text{layer}} - 1)$ shall be divided into sets, each set corresponding to one OFDM symbol, and where set l contains $M_{\text{sc}}^{\text{PUSCH}} - \varepsilon_l N_{\text{samp}}^{\text{group}} N_{\text{group}}^{\text{PTRS}}$ symbols and is mapped to the complex-valued symbols $\tilde{x}^{(0)}(lM_{\text{sc}}^{\text{PUSCH}} + i')$ corresponding to OFDM symbol l prior to transform precoding, with $i' \in \{0,1,...,M_{\text{sc}}^{\text{PUSCH}} - 1\}$ and $i' \neq m$. The index m of PT-RS samples in set l, the number of samples per PT-RS group $N_{\text{samp}}^{\text{group}}$, and the number of PT-RS groups $N_{\text{group}}^{\text{PTRS}}$ are defined in clause 6.4.1.2.2.2. The quantity $\varepsilon_l = 1$ when OFDM symbol l contains one or more PT-RS samples, otherwise $\varepsilon_l = 0$.

Transform precoding shall be applied according to

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

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

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

resulting in a block of complex-valued symbols $y^{(0)}(0),...,y^{(0)}(M_{\text{symb}}^{\text{layer}} - 1)$. 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

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

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

Source: 5G Specification, 3GPP TS 38.211 version 15.2.0 release 15

The transform precoding entails applying a discrete Fourier transform to blocks of complex-valued data symbols $x^{(0)}(0),\ldots x^{(0)}(M_{symb}^{layer}$ - 1) to generate transform pre-coded complex-valued data symbols $y^{(0)}(0),\ldots\ y^{(0)}(\ M_{symb}^{layer}$ - 1) .

309. Accused Asus 5G Devices include an OFDM transceiver for sending and receiving physical communications. The OFDM transceiver is in communication with the transceiver-control circuitry. The OFDM transceiver is configured to perform OFDM baseband

signal processing in accordance with the 5G Specification (section 5.3.1 OFDM baseband signal generation):

5.3.1 OFDM baseband signal generation for all channels except PRACH

The time-continuous signal $s_l^{(p,\mu)}(t)$ on antenna port p and subcarrier spacing configuration μ for OFDM symbol $l \in \{0,1,...,N_{\text{slot}}^{\text{subframe},\mu} N_{\text{symb}}^{\text{slot}} - 1\}$ in a subframe for any physical channel or signal except PRACH is defined by

$$s_l^{(p,\mu)}(t) = \sum_{k=0}^{N_{\text{grid}}^{\text{size},\mu} N_{\text{sc}}^{\text{RB}} - 1} a_{k,l}^{(p,\mu)} \cdot e^{j2\pi\left(k + k_0^\mu - N_{\text{grid},x}^{\text{size},\mu} N_{\text{sc}}^{\text{RB}}/2\right)\Delta f\left(t - N_{\text{CP},l}^\mu T_c - t_{\text{start},l}^\mu\right)}$$

$$k_0^\mu = \left(N_{\text{grid},x}^{\text{start},\mu} + N_{\text{grid},x}^{\text{size},\mu}/2\right) N_{\text{sc}}^{\text{RB}} - \left(N_{\text{grid},x}^{\text{start},\mu_0} + N_{\text{grid},x}^{\text{size},\mu_0}/2\right) N_{\text{sc}}^{\text{RB}} 2^{\mu_0 - \mu}$$

where $t_{\text{start},l}^\mu \le t < t_{\text{start},l}^\mu + \left(N_u^\mu + N_{\text{CP},l}^\mu\right) T_c$ is the time within the subframe,

$$N_u^\mu = 2048\kappa \cdot 2^{-\mu}$$

$$N_{\text{CP},l}^\mu = \begin{cases} 512\kappa \cdot 2^{-\mu} & \text{extended cyclic prefix} \\ 144\kappa \cdot 2^{-\mu} + 16\kappa & \text{normal cyclic prefix, } l = 0 \text{ or } l = 7 \cdot 2^\mu \\ 144\kappa \cdot 2^{-\mu} & \text{normal cyclic prefix, } l \ne 0 \text{ and } l \ne 7 \cdot 2^\mu \end{cases}$$

Δf is given by clause 4.2, μ is the subcarrier spacing configuration, and μ_0 is the largest μ value among the subcarrier spacing configurations provided to the UE for this carrer. The starting position of OFDM symbol l for subcarrier spacing configuration μ in a subframe is given by

Source: 5G Specification, 3GPP TS 38.211 version 15.2.0 release 15

OFDM baseband signal generation entails the use of an inverse discrete Fourier transform (highlighted in the equation above) on the pre-coded complex-valued data symbols to generate a single carrier frequency division multiple access (SC-FDMA) signal. Application of the inverse DFT results in modulating the pre-coded complex-valued data symbols onto the OFDM signals. These SC-FDMA signals are then transmitted by Accused Asus 5G Devices to base stations/eNode Bs.

310. Asus directly infringes claim 17 of the '508 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

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

COUNT XXVIII: INFRINGEMENT OF U.S. PATENT '508 CLAIM 18

312. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 266-276 of this Complaint as though set forth in full herein.

313. Claim 18 of the '508 Patent provides:

Element A	The apparatus of claim 17, wherein at least one of the plurality of different selectable subcarrier spacings equals at least one other of the plurality of different selectable subcarrier spacings multiplied by a scaling factor that is a power of two.

314. Asus has and continues to make, use, sell, import, and/or offer for sale the Accused Asus LTE Devices that meet each and every element of claim 18 of the '508 Patent.

315. Accused Asus 5G Devices perform physical channel uplink and downlink processing in accordance with the 5G Specification. The 5G Specification (section 4.2 numerologies) includes selectable subcarrier spacings, ranging from 15kHz to 240kHz:

4.2 Numerologies

Multiple OFDM numerologies are supported as given by Table 4.2-1 where μ and the cyclic prefix for a bandwidth part are obtained from the higher-layer parameter *subcarrierSpacing* and *cyclicPrefix*, respectively.

Table 4.2-1: Supported transmission numerologies.

μ	$\Delta f = 2^{\mu} \cdot 15$ [kHz]	Cyclic prefix
0	15	Normal
1	30	Normal
2	60	Normal, Extended
3	120	Normal
4	240	Normal

Source: 5G Specification, 3GPP TS 38.211 version 15.2.0 release 15

The subcarrier spacings are defined as $\square f = 2^{\square} * 15$[kHz], where $\square$ is a subcarrier spacing configuration that represents a scaling factor that is a power of 2.

316. Asus directly infringes claim 18 of the ’508 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

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

COUNT XXIX: INFRINGEMENT OF U.S. PATENT ’508 CLAIM 19

318. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 266-276 of this Complaint as though set forth in full herein.

319. Claim 19 of the ’508 Patent provides:

Element A	The apparatus of claim 17, wherein the OFDM transceiver is further configured to add a cyclic prefix to the single-carrier frequency division multiple access signal.

320. Asus has and continues to make, use, sell, import, and/or offer for sale the Accused Asus LTE Devices that meet each and every element of claim 19 of the ’508 Patent.

321. The transceiver in Accused Asus 5G Devices is configured to perform physical channel uplink and downlink processing in accordance with the 5G Specification. The 5G Specification includes OFDM baseband signal generation (Section 5.3.1). This step includes adding a cyclic prefix to the SC-FDMA signal:

5.3 OFDM baseband signal generation

5.3.1 OFDM baseband signal generation for all channels except PRACH

The time-continuous signal $s_l^{(p,\mu)}(t)$ on antenna port p and subcarrier spacing configuration μ for OFDM symbol $l \in \{0,1,...,N_{\text{slot}}^{\text{subframe},\mu} N_{\text{symb}}^{\text{slot}} - 1\}$ in a subframe for any physical channel or signal except PRACH is defined by

$$s_l^{(p,\mu)}(t) = \sum_{k=0}^{N_{\text{grid}}^{\text{size},\mu} N_{\text{sc}}^{\text{RB}} - 1} a_{k,l}^{(p,\mu)} \cdot e^{j2\pi\left(k + k_0^\mu - N_{\text{grid},x}^{\text{size},\mu} N_{\text{sc}}^{\text{RB}}/2\right)\Delta f\left(t - N_{\text{CP},l}^{\mu} T_{\text{c}} - t_{\text{start},l}^{\mu}\right)}$$

$$k_0^\mu = \left(N_{\text{grid},x}^{\text{start},\mu} + N_{\text{grid},x}^{\text{size},\mu}/2\right) N_{\text{sc}}^{\text{RB}} - \left(N_{\text{grid},x}^{\text{start},\mu_0} + N_{\text{grid},x}^{\text{size},\mu_0}/2\right) N_{\text{sc}}^{\text{RB}} 2^{\mu_0 - \mu}$$

where $t_{\text{start},l}^{\mu} \le t < t_{\text{start},l}^{\mu} + \left(N_{\text{u}}^{\mu} + N_{\text{CP},l}^{\mu}\right) T_{\text{c}}$ is the time within the subframe,

$$N_{\text{u}}^{\mu} = 2048\kappa \cdot 2^{-\mu}$$

$$N_{\text{CP},l}^{\mu} = \begin{cases} 512\kappa \cdot 2^{-\mu} & \text{extended cyclic prefix} \\ 144\kappa \cdot 2^{-\mu} + 16\kappa & \text{normal cyclic prefix, } l = 0 \text{ or } l = 7 \cdot 2^{\mu} \\ 144\kappa \cdot 2^{-\mu} & \text{normal cyclic prefix, } l \ne 0 \text{ and } l \ne 7 \cdot 2^{\mu} \end{cases}$$

Source: 5G Specification, 3GPP TS 38.211 version 15.2.0 release 15

In the above equation, $N_{CP,l}^{\mu}$ is defined as the cyclix prefix length.

322. Asus directly infringes claim 19 of the '508 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

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

COUNT XXX: INFRINGEMENT OF U.S. PATENT '508 CLAIM 20

324. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 266-276 of this Complaint as though set forth in full herein.

325. Claim 20 of the '508 Patent provides:

Element A	The apparatus of claim 17, wherein the plurality of different selectable subcarrier spacings comprise integer multiples of a first subcarrier spacing.

326. Asus has and continues to make, use, sell, import, and/or offer for sale the Accused Asus LTE Devices that meet each and every element of claim 20 of the ’508 Patent.

327. Accused Asus 5G Devices perform physical channel uplink and downlink processing in accordance with the 5G Specification. The 5G Specification (section 4.2 numerologies) includes selectable subcarrier spacings: 15kHz, 30kHz, 60kHz, 120kHz, and 240kHz. The subcarrier spacings are integers of a first subcarrier spacing, with the integers being 2, 4, 8 and 16.

328. Asus directly infringes claim 20 of the ’508 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

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

COUNT XXXI: INFRINGEMENT OF U.S. PATENT ’508 CLAIM 21

330. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 266-276 of this Complaint as though set forth in full herein.

331. Claim 21 of the ’508 Patent provides:

Element A	The apparatus of claim 17, wherein each of the plurality of different selectable subcarrier spacings is configured for one of a plurality of different deployment scenarios, the plurality of different deployment scenarios comprising different system requirements or different channel characteristics.

332. Asus has and continues to make, use, sell, import, and/or offer for sale the Accused Asus LTE Devices that meet each and every element of claim 21 of the ’508 Patent.

333. Accused Asus 5G Devices perform physical channel uplink and downlink processing in accordance with the 5G Specification. The 5G Specification (section 4.2 numerologies) includes selectable subcarrier spacings: 15kHz, 30kHz, 60kHz, 120kHz, and 240kHz. The different subcarrier spacings are provided because of the wide range of frequency channels allowed for in 5G communication, with each channel having different characteristics. For example, the 5G Specification section 5.5.4.1 explains that two frequency ranges are allowed: FR1 and FR2. FR1 encompasses 410MHz-7125Mhz, and FR2 encompasses 24250MHz-52600Mhz frequencies. The subcarrier spacings allow for different numbers of slots within radio subframes, with the number of subframes utilized for different frequency ranges: subcarrier spacings of 15 and 30kHz are suitable for use with FR1; subcarrier spacing of 60Khz is suitable for both FR1 and FR2; subcarrier spacings of 120 and 240kHz are suitable for use with FR2.

334. The lower frequency ranges have limited spectrum such that smaller subcarrier spacings are used to maximize the data communicated. Conversely, in higher frequency ranges, such as mmWave, frequency drift increases (Doppler spread). To compensate for the drift, larger subcarrier spacings are used.

335. Asus directly infringes claim 21 of the ’508 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

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

COUNT XXXII: INFRINGEMENT OF U.S. PATENT ’508 CLAIM 22

337. GenghisComm incorporates by reference the allegations set forth in paragraphs 1-28 and 266-276 of this Complaint as though set forth in full herein.

338. Claim 22 of the ’508 Patent provides:

Element A	The apparatus of claim 17, wherein each of the plurality of different selectable subcarrier spacings produces a different number of symbols per frame.

339. Asus has and continues to make, use, sell, import, and/or offer for sale the Accused Asus LTE Devices that meet each and every element of claim 22 of the ’508 Patent.

340. Accused Asus 5G Devices perform physical channel uplink and downlink processing in accordance with the 5G Specification. The 5G Specification (section 4.2 numerologies) includes selectable subcarrier spacings: 15kHz, 30kHz, 60kHz, 120kHz, and 240kHz. Each spacing allows for a different number of subframes and a different number of symbols per frame.

341. Section 4.3.1 of the 5G Specification defines transmissions as organized into frames, with each frame consisting of 10 subframes, with the number of consecutive OFDM symbols per subframe defined as $N_{\text{symb}}^{\text{slot}} \times N_{\text{slot}}^{\text{frame},\mu}$:

4.3.1 Frames and subframes

Downlink and uplink transmissions are organized into frames with $T_f = (\Delta f_{max} N_f / 100) \cdot T_c = 10\,\text{ms}$ duration, each consisting of ten subframes of $T_{sf} = (\Delta f_{max} N_f / 1000) \cdot T_c = 1\,\text{ms}$ duration. The number of consecutive OFDM symbols per subframe is $N_{\text{symb}}^{\text{subframe},\mu} = N_{\text{symb}}^{\text{slot}} N_{\text{slot}}^{\text{subframe},\mu}$. Each frame is divided into two equally-sized half-frames of five subframes each with half-frame 0 consisting of subframes 0 – 4 and half-frame 1 consisting of subframes 5 – 9.

Source: 5G Specification, 3GPP TS 38.211 version 15.2.0 release 15

342. Section 4.3.2 of the 5G Specification further defines subcarrier spacings and the number of OFDM symbols per slot, slots per frame, and slots per subframe:

4.3.2 Slots

For subcarrier spacing configuration μ, slots are numbered $n_s^\mu \in \{0,...,N_{slot}^{subframe,\mu}-1\}$ in increasing order within a subframe and $n_{s,f}^\mu \in \{0,...,N_{slot}^{frame,\mu}-1\}$ in increasing order within a frame. There are N_{symb}^{slot} consecutive OFDM symbols in a slot where N_{symb}^{slot} depends on the cyclic prefix as given by Tables 4.3.2-1 and 4.3.2-2. The start of slot n_s^μ in a subframe is aligned in time with the start of OFDM symbol $n_s^\mu N_{symb}^{slot}$ in the same subframe.

OFDM symbols in a slot can be classified as 'downlink', 'flexible', or 'uplink'. Signaling of slot formats is described in subclause 11.1 of [5, TS 38.213].

In a slot in a downlink frame, the UE shall assume that downlink transmissions only occur in 'downlink' or 'flexible' symbols.

In a slot in an uplink frame, the UE shall only transmit in 'uplink' or 'flexible' symbols.

A UE not capable of full-duplex communication is not expected to transmit in the uplink earlier than $N_{Rx\text{-}Tx}T_c$ after the end of the last received downlink symbol in the same cell where $N_{Rx\text{-}Tx}$ is given by [TS 38.101].

Table 4.3.2-1: Number of OFDM symbols per slot, slots per frame, and slots per subframe for normal cyclic prefix.

μ	N_{symb}^{slot}	$N_{slot}^{frame,\mu}$	$N_{slot}^{subframe,\mu}$
0	14	10	1
1	14	20	2
2	14	40	4
3	14	80	8
4	14	160	16

Source: 5G Specification, 3GPP TS 38.211 version 15.2.0 release 15

343. Thus, for $\mu = [0, 1, 2, 3, 4]$ the number of OFDM symbols per frame are equal to $N_{symb}^{slot} \times N_{slot}^{frame,\mu} = [140, 280, 560, 1120, 2240]$, where ▯ is a subcarrier spacing configuration.

344. Asus directly infringes claim 22 of the '508 Patent by selling, offering to sell, and using the Accused Asus LTE Devices.

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

WILLFUL INFRINGEMENT

346. Asus 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 Asus LTE Devices, were and are using the technology claimed by the since November 19, 2020, and the objectively high likelihood that its acts constitute patent infringement.

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

348. Asus’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 Asus as follows:

A. Adjudging, finding, and declaring that Asus 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 Asus’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 Asus'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.

February 21, 2023

Respectfully submitted,

By: */s/ Alison Aubry Richards*

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CERTIFICATE OF SERVICE

I hereby certify that on February 21, 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