**IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE**

TOT POWER CONTROL, S.L., Plaintiff, v. APPLE INC., Defendant.	C.A. No. 21-cv-1302-MN

**OPENING EXPERT REPORT OF LAWRENCE E. LARSON
REGARDING INFRINGEMENT**

Submitted this 23rd day of August, 2024.

By: ______________________
Lawrence E. Larson, Ph.D.

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I. INTRODUCTION

1. My name is Dr. Larry Larson. I have been retained by counsel for TOT Power Control, S.L. ("TOT") to provide my opinion concerning U.S. Patent No. 7,532,865 ("the '865 Patent") and U.S. Patent No. 7,496,376 ("the '376 Patent") (collectively, the "Asserted Patents"). Specifically, I have been asked to provide my opinion concerning whether certain products manufactured, used, sold, offered for sale, and imported to the United States by Defendant Apple Inc. ("Apple") infringe certain claims of the Asserted Patents. I have also been asked to provide my opinion regarding certain damages-related issues, such as the degree of benefit realized by Apple through its infringement of the Asserted Patents, Apple's assertions regarding non-infringing alternatives, and technological comparability of license agreements.

2. In reaching the conclusions described herein, I have considered the documents, materials, and testimony discussed herein as well as the documents, materials, and testimony identified in Exhibit B, attached to this report. My opinions are further based upon my education, training, research and related publications, knowledge, and personal and professional experience in the relevant art.

3. I am currently a Professor of Engineering at the School of Engineering at Brown University. I have also held the positions of Interim Provost of Brown University, as well as the Sorensen Family Dean and Founding Dean of the School of Engineering there. I hold a Ph.D. in Electrical Engineering, as well as a M.B.A. degree, from the University of California, Los Angeles, and Master of Engineering and Bachelor of Science degrees in Electrical Engineering from Cornell University. I have over 40 years of experience in the design of high-performance circuits for RF communications and other applications, both in industry and academia. I have published hundreds of papers in referred journals and conference proceedings, and am a named inventor on 43 issued

patents. My experience will be described further below under Qualifications and Background, and in my CV, attached as Exhibit A to this report.

4. I am prepared to testify to the matters set out in this report at trial. To support or summarize my opinions, any testimony I give may include appropriate visual aids, some or all of the documents and information cited herein or identified in Exhibit B, and additional documents and information identified in discovery. I may modify or supplement my opinions and/or the basis for my opinions based on evidence or testimony that Apple or its experts may present or based on any additional discovery or other information provided to me or found by me in this matter.

5. I am being compensated for my work in connection with this matter at my standard hourly consulting rate. My compensation for my work in this matter is not dependent in any way on my conclusions and opinions, the contents of this report, the substance of any further opinions or testimony that I may provide, or the outcome of this matter or any matter involving the Asserted Patents.

II. QUALIFICATIONS AND BACKGROUND

6. My education and professional background is in Electrical Engineering, with a particular focus on high-speed integrated circuit design. I hold a Ph.D. (1986) in Electrical Engineering from the University of California, Los Angeles, as well as a M.B.A. degree (1996) from that university, and Master of Engineering (1980) and Bachelor of Science (1979) degrees in Electrical Engineering from Cornell University.

7. I am currently a Professor of Engineering at the School of Engineering at Brown University. I recently completed an appointment as Interim Provost for Brown University. I have also been the Sorensen Family Dean (Inaugural Chair Holder) and Founding Dean of the School of Engineering there. I held that position beginning in 2011, during which time I oversaw a large

expansion in the number of tenure-track engineering faculty, substantial increases in external research funding, the creation of new graduate programs, and the construction of a state-of-the-art research and teaching facility.

8. Over the course of my career, I have held a variety of positions in academia and industry. These include but are not limited to the following:

9. From 1980 to 1988, I was a Member of Technical Staff at Hughes Aircraft and Hughes Research Laboratories, where I was responsible for the development of CMOS and III-V analog and digital integrated circuits, modeling and characterization of MESFETs and HEMTs and the development of improved III-V process techniques. During my tenure, among other things, I helped developed the first high-performance GaAs switched-capacitor circuits with clock rates in excess of 100 MHz, demonstrated the first use of low-temperature buffer GaAs MESFET technology with digital integrated circuits, setting a record for digital divider performance (22 GHz), and developed GaAs MESFET operational amplifier with record GBW (10 GHz).

10. From 1988 to 1992, I was an Adjunct Associate Professor at UCLA, where I was responsible for senior level digital and analog integrated circuit design courses and graduate analog MOS integrated circuit design course.

11. From 1992 to 1994, I was an Assistant Manager for the DARPA / Hughes MIMIC Program, where I was responsible for Program Management of the Advanced Technology Portion of DARPA/Hughes MIMIC Program, with a budget of approximately $8M/yr. In that capacity, I was responsible for the technical and program direction of GaAs HBT and PHEMT efforts. I also directed insertion of advanced GaAs-based technology into next generation communication and radar systems.

12. From 1988 to 1994, I was also a Manager in the HEMT Technology Department, Microwave Devices and Circuits Laboratory, at Hughes Research Laboratories, where I directed research in high-speed III-V materials, devices, and circuits, and was responsible for approximately $4M/yr. in Corporate IR&D and Government Research Contracts. In that capacity, I helped develop the first space-qualified InP low-noise millimeterwave HEMT. This effort was awarded the 1996 Lawrence Hyland Award - the highest technical achievement award at Hughes Electronics. I also helped develop the first micromachining (MEMS) switch and tuner applications for RF and microwave applications (1991). This technology has now become an extremely active area of worldwide research and development. I also helped demonstrate the first InP-based HEMT low-noise and high- power MMICs from 2 - 60 GHz, with world record noise figures and poweradded efficiencies. I further helped establish a state-of-the-art InP HEMT MMIC foundry at HRL, developed the first low-power/high-speed InP HEMT digital IC technology with ring oscillator delays of 4.2 pS, and directed the research program that demonstrated HEMTs with record fT's and fMAX's above 300 GHz (1993), which produced the highest frequency room temperature integrated circuit ever reported - a 210 GHz VCO (IEDM 1994).

13. From 1994 to 1996, I was a Manager in the Telecommunications Technology Department, Microwave Devices and Circuits Laboratory, at Hughes Research Laboratories, where I directed the research and development of integrated circuits for commercial RF and microwave communications applications, including DBS, cellular telephone, VSAT, and PCS.

14. From 1996 to 2011, I held the CWC Industry Chair Professor in Wireless Communications, in the Department of Electrical and Computer Engineering at the University of California, San Diego (UCSD). Among other things, I helped develop improved integrated circuit techniques and novel device structures for wireless communications applications. This required

development of high-frequency integrated circuits, devices, and packaging techniques for ultra-wide bandwidth telecommunications applications, and development of novel data converter and analog-signal processing architectures that are matched to communications applications.

15. From 2000 to 2001, while on academic leave from UCSD, I was a Director at IBM's West Coast Design Center of Excellence in IBM Research Division, where I directed development of Radio Frequency Integrated Circuits for SiGe RFICs for 3rd Generation wireless cellular applications. I was also responsible for leading the team that developed a complete Wideband CDMA chip set for several "first tier" cellular telephone providers.

16. From 2001 to 2006, I was the Director of the UCSD Center for Wireless Communications (http://cwc.ucsd.edu), which is one of the largest industry-funded University Research Centers in the world. Involving over 20 professors, and supporting roughly 50 PhD graduate students during my tenure, with an annual budget in excess of $3M, the CWC conducted research in all areas of wireless communications, from fundamental devices and materials to software applications. I was responsible for all aspects of the Center, from new member development to financial management and establishing the research direction. In my work at the UCSD Center for Wireless Communications, I became familiar with the 3GPP wireless standards.

17. From 2007 to 2011, I was the Chair of the Department of Electrical and Computer Engineering at the University of California, San Diego. The ECE Department at UCSD is the largest graduate program on the UCSD campus. As Chair, I oversaw the faculty development (hiring, promotion and tenure process), educational policy and teaching, successful accreditation review, department resource allocation, and external relations. I also led the development (with CS) of the Executive Masters of Advanced Study in Embedded Wireless Systems program.

18. I have authored more than 125 refereed journal publications and more than 250 peer reviewed conference publications. I have authored and/or edited 12 books or chapters, including:

- L. E. Larson, P. T. Greiling, and J. F. Jensen, "GaAs Device Physics and Circuit Design", in **Microprocessor Design for GaAs Technology**, V. Milutinovic, Ed., (Prentice Hall, York, 1989).
- L. E. Larson, "High-Speed Analog-to-Digital and Digital-to-Analog Conversion with GaAs Technology: Prospects, Trends, and Obstacles", in **GaAs Technology and Devices and Their Impact on Circuits and Systems**, D. Haigh, Ed., (Peter Peregrinus, Ltd, 1989).
- L. E. Larson and G. C. Temes, "Signal Conditioning and Interface Circuits", in **McGraw-Hill Handbook of Digital Signal Processing**, S. Mitra, Ed., 1993.
- L. E. Larson, "GaAs Operational Amplifier Design", in **High-Speed Analog Integrated Circuits**, R. Goyal, Ed., (Wiley Interscience, York, 1995).
- L. E. Larson, **RF and Microwave Circuit Design for Wireless Communications** (Artech House, Inc., 1996).
- M. Matloubian and L. E. Larson, "InP-Based Power HEMTs", in **Pseudomorphic HEMT Technology and Applications**, Ed. R. L. Ross et al., (Kluwer Academic Publishers, Netherlands, 1996).
- J. Groe, and L. E. Larson, **CDMA Mobile Radio Design: Systems, Algorithms, and Circuits** (Artech House, Inc., 2000).
- L. Larson and F. Chang, "Si/SiGe HBT Technology for Low-Power Mobile Communications Systems Applications," in **RF Technologies for Low-Power Wireless Communications**, Ed. T. Itoh, G. Haddad, and J. Harvey, Wiley Interscience, 2001.
- X. Zhang, L. Larson, and P. Asbeck, **Design of Linear Outphasing Power Amplifiers for Wireless Communications**, Artech House, 2002. 196 pages. BOOK
- **Digital Communications Using Chaos and Nonlinear Dynamics**, Larson, Lawrence E; Liu, Jia-Ming; Tsimring, Lev S. (Eds.) 2006, XIV, Springer.
- **Circuits and Systems for Future Generations of Wireless Communications**, A. Tasic, W. Serdijn, L. Larson, G. Setti, G. (Eds.), 2009, VIII, Springer.

- **Fast Hopping Frequency Generation in Digital CMOS**, Mohammad Farazian, Lawrence E. Larson, Prasad S. Gudem. 2012 Springer.

I am also named inventor on at least 43 US patents.

19. I have been elected a Fellow of the IEEE. The Fellow is the highest grade of membership of the IEEE, a world professional body consisting of over 300,000 electrical and electronics engineers, with only one-tenth of one percent (0.1%) of the IEEE membership being elected to the Fellow grade each year. Election to Fellow is based upon votes cast by existing Fellows in IEEE. I have also served on a number of IEEE Committees and as a Paper Reviewer.

20. The following is a list of all cases during the past four years in which I have testified as an expert at trial or by deposition:

- *Theta IP, LLC v. Samsung Electronics Co., Ltd. et al.*, Case No. 6-20-cv-00160 (W.D. Tex.)
- *Lenovo (United States) Inc., et al. v. Theta IP, LLC*, IPR2023-00697 & -00698 (P.T.A.B.)

21. I am being compensated by TOT at a rate of $600 per hour for my work in this case, including time spent testifying. I am also being reimbursed for reasonable fees and expenses, including hotel and travel expenses, incurred as a result of my work in this case. I have not received any additional compensation for my work in this investigation. My compensation is not tied in any way to the substance of my testimony or the outcome of this investigation. I am available to offer these opinions at deposition and at trial if called upon to do so.

22. Exhibit A contains a true and correct copy of my Curriculum Vitae further describing my background and experience.

III. LEGAL STANDARDS AND CLAIM CONSTRUCTIONS APPLIED

23. In this section I describe my understanding of certain legal standards and claim constructions that I have applied in my analysis. I have been informed of these standards by TOT's attorneys.

A. Infringement

24. I have been informed by counsel that a proper patent infringement analysis requires two steps. The first step is to properly construe the patent claims, which is a step taken by the Court. I understand that the parties have proposed certain claim constructions to the Court, but the Court has not yet issued a claim construction order construing claim terms in the Asserted Patents. I have therefore considered infringement based on each parties' proposed claim construction, discussed in further detail below.

25. I understand that claim terms not construed by the Court have their ordinary meaning as would be understood be a person of ordinary skill in the art at the time of the patent and in the context of the patent specification.

26. I am informed that the second step in an infringement analysis is determining whether a patent claim is infringed, considering the meaning of the claim terms as defined by the Court's construction. A patent claim is "literally" infringed only if each and every claim limitation is found in the accused product or method. I understand that TOT has the burden to prove infringement.

27. I understand that if an accused product does not literally infringe all elements of a claim, it may nevertheless infringe under the "doctrine of equivalents." An element in the accused product is an equivalent to a claim limitation if any differences between the two are insubstantial to a person of ordinary skill in the art. A consideration for determining equivalence is whether a person of ordinary skill in the art would have known of the interchangeability. Insubstantiality

may be evidenced by whether the accused product performs substantially the same function in substantially the same way to obtain substantially the same result as the claim limitation, and if any differences between the two are insubstantial to a person of ordinary skill in the art.

28. I understand that there is a dispute in the case as to whether certain limitations in the asserted claims should be construed as "means-plus-function" limitations. For there to be literal infringement of a means-plus-function limitation, the accused product must perform the identical function recited in the claim, and must use the same structure disclosed in the patent specification or equivalent structure. A structure in the accused product constitutes an equivalent to the corresponding structure in the patent only if the accused structure performs the identical function in substantially the same way, with substantially the same result.

B. Person of Ordinary Skill

29. As mentioned above I understand that the disclosures in a patent are viewed from the perspective of a person of ordinary skill in the art (POSITA).

30. I understand that a person having ordinary skill in the art is a hypothetical person and the concept is used to analyze the relevant art without the benefit of hindsight. A person of ordinary skill in the art is presumed to be one who thinks along the lines of conventional wisdom in the art. I understand that the hypothetical person of ordinary skill is presumed to have knowledge of all references that are sufficiently related to one another and to the pertinent art, and to have knowledge of all arts reasonably pertinent to the particular problem that the claimed invention addresses.

31. I understand that factors such as the education level of those working in the field, the sophistication of the technology, the types of problems encountered in the art, prior art solutions to those problems, and the speed at which innovations are made, may help establish the level of skill in the art at the time of the Asserted Patents.

32. I understand that Defendants have argued that a POSITA would have a Master's degree in electrical engineering or a related field and at least three years of experience in cellular network technology. I agree with this definition of a POSITA with respect to the '865 and '376 Patents.

33. As described above, I obtained my Ph.D. in Electrical Engineering in 1986, and I had more than fifteen years of professional experience in the analysis and design of high-performance RF circuits prior to 2005, which I understand is the earliest asserted priority date of the Asserted Patents. I believe that my own education and experience exceeds that of a person of ordinary skill in the art, under my definition or Apple's definition, today and as of the current earliest asserted priority date of the Asserted Patents.

C. Damages Related Issues

34. I understand that the availability or unavailability of non-infringing alternatives to the infringing products at the time of the hypothetical negotiation are relevant factors to consider when calculating damages based on a reasonable royalty. I also understand that if a noninfringing alternative was not on the market at the time of the hypothetical negotiation, in order for the non-infringing alternative to be considered available, relevant factors to consider are the feasibility, commercial acceptability, and cost of the non-infringing alternative. I further understand that if a non-infringing alternative was only theoretically possible at the time of the hypothetical negotiation, that is not sufficient for it to be considered available.

35. I further understand that one of the methodologies for calculating damages is the hypothetical negotiation, in which the parties are assumed to negotiate a patent license, as a willing licensee and licensor, at the time that infringement began. Licenses and licensing terms in a comparable field of technology and relating to similar inventions can be instructive regarding the type of agreement that such a hypothetical negotiation would yield. I have been asked to evaluate

whether certain licenses are technologically comparable. I further understand that there are other aspects to determining whether a license is comparable beyond technological comparability, on which I am not offering any opinions in this matter.

D. Claim Construction

36. I understand that TOT has asserted the '865 and '376 Patents in separate cases against Apple, LG, and Samsung, and that the Court is conducting a single claim construction proceeding for all three cases. I also understand that the parties dispute the meaning of certain claim terms, and that the Court has not yet ruled on the construction of those terms. Where the parties disagree about the construction of a term, I will apply both potential constructions in this Report as appropriate. For any terms where a party has asserted that the claim is invalid or indefinite, I have assumed that the claim is valid and definite, and reserve the right to offer opinions regarding invalidity and indefiniteness at a later date.

37. I understand that the parties agree that the phrase "signal to interference ratio required (SIR_{rec})" in claim 1 of the '865 Patent should be construed as "signal to interference ratio required (SIR_{req})."

38. The disputed terms and parties' proposals for the '865 Patent are set forth below:

Term	**TOT's Proposed Construction**	**Apple's Proposed Construction**	**LG and Samsung's Proposed Construction**
Preamble ("outer loop power control") Claims: 1-8, 10, 12	The preamble is not limiting	No proposal	Preamble is limiting
"setting a desired signal to interference ratio target (SIR_{target}) that is close to a signal to interference ratio required (SIR_{rec}) during the normal	Not indefinite	No proposal	"SIR_{req}" means "theoretical minimum of the desired signal to interference ratio received (SIR_{rec}) that satisfies the target frame error rate (FER_{target})."

mode of the outer loop" Claim: 1 "setting a desired signal to interference ratio target (SIR_{target}) that is close to a signal to interference ratio required (SIR_{req}) during the normal mode of the outer loop" Claim: 5			The phrase "close to" renders the claim as a whole indefinite.
"outer loop wind-up" Claims: 1, 2, 3, 5	Plain and ordinary meaning, which is "an outer loop condition wherein the signal to interference ratio received (SIR_{rec}) does not follow the desired signal to interference ratio target (SIR_{target}), for reasons such as worsening of channel conditions or saturation of the transmitter"	"outer loop condition or mode that would dictate increases to the signal to interference ratio target (SIR_{target}) that cannot be followed by the signal to interference ratio received (SIR_{rec}) because of sustained worsening of the channel's conditions or sustained transmission of the transmitter at the maximum power available for the connection"	"outer loop condition or mode that would dictate increases to the signal to interference ratio target (SIR_{target}) that cannot be followed by the signal to interference ratio received (SIR_{rec}) because of sustained worsening of the channel's conditions or sustained transmission of the transmitter at the maximum power available for the connection"
"outer loop unwinding" Claims: 1, 2, 4, 5	Plain and ordinary meaning, which is "exiting or recovering from outer loop wind-up"	No proposal	"outer loop condition or mode involving the process of lowering the desired signal to interference ratio target (SIR_{target}) set during the outer loop windup"
"wherein the desired signal to interference ratio target (SIR_{target}) is modified at the	Plain and ordinary meaning, which is "wherein the desired signal to interference	"wherein the desired signal to interference ratio target (SIR_{target}) is modified at the start	"the desired signal to interference ratio target (SIR_{target}) is modified at the start (403) of the outer loop

start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up" Claims: 1, 5	ratio target (SIR_{target}) is modified at the start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up"	(403) of the outer loop unwinding to the last specific historical value of the SIRtarget that was previously set for the outer loop power control in normal mode just prior to the start of the outer loop wind up" Patentee disclaimed methods that modify the desired signal to interference ratio target (SIR_{target}) where SIR_{target} converges over some time period to the required SIR, and limited the claim to a modification of SIR_{target} that essentially eliminates the convergence period altogether.	unwinding to the last specific historical value of the SIR_{target} that was previously set for the outer loop power control in normal mode just prior to the start of the outer loop wind up." Patentee disclaimed methods that modify the desired signal to interference ratio target (SIRtarget) where SIRtarget converges over some time period to the required SIR, and limited the claim to a modification of SIRtarget that essentially eliminates the convergence period altogether.
"wherein at the start (403) of the outer loop unwinding the desired signal to interference ratio target (SIR_{target}) is set to a value suitably close to the original value (401) set just before the start moment (402) of the outer loop wind-up" Claim: 2	Not invalid under pre-AIA § 112, ¶ 4 Not indefinite	No proposal	Invalid as improper dependent claim under pre-AIA § 112, ¶ 4 for failure to specify a further limitation of the subject matter claimed. The phrase "suitably close to" renders the claim as a whole indefinite.
"close to" Claims 1, 5 "suitably close to" Claim 2	Not indefinite	No proposal	Indefinite

39. The disputed terms and parties' proposals for the '376 Patent are set forth below:

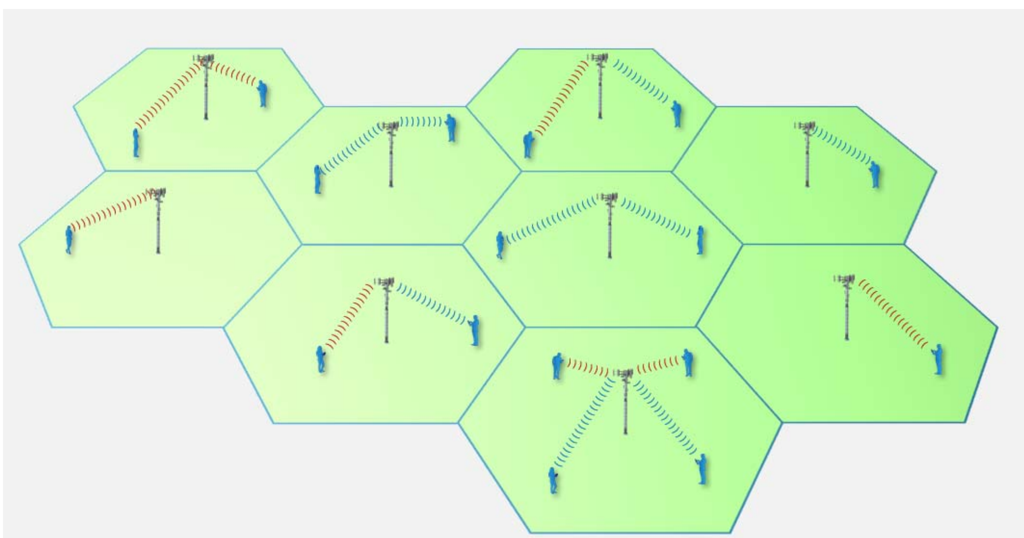
Term	**TOT's Proposed Construction**	**Apple's Proposed Construction**	**LG and Samsung's Proposed Construction**
Preamble ("outer loop power control") (all asserted claims)	Preamble is not limiting	No proposal	Preamble is limiting
"some fading parameters" (claims 1, 6, 13)	"one or more fading parameters"	"more than one fading parameter"	"more than one fading parameter"
"some fading margins" (claims 1, 6, 13)	"one or more fading margins"	"more than one fading margin"	"more than one fading margin"
"some outage probabilities" (claims 1, 6, 13)	"one or more outage probabilities"	"more than one outage probability"	"more than one outage probability"
"by means of a dynamic adjusting function which performs a mapping between a quality criterion based on the outage probabilities ($p_{\sigma 1}$, $p_{\sigma 2}$, . . . , $p_{\sigma N}$) and the quality criterion based on the target block error rate ($BLER_{target}$)" (claims 1, 6, 13)	Plain and ordinary meaning, which is "using or employing a dynamic adjusting function which performs a mapping between a quality criterion based on the outage probabilities ($p_{\sigma 1}$, $p_{\sigma 2}$, . . . , $p_{\sigma N}$) and the quality criterion based on the target block error rate ($BLER_{target}$) Not a means plus function claim. However, if the Court construes as a means plus function claim, the corresponding	Governed by Pre-AIA 35 U.S.C. § 112, ¶ 6 (means plus function) **Function:** performs a mapping between a quality criterion based on the outage probabilities ($p_{\sigma 1}$, $p_{\sigma 2}$, … $p_{\sigma N}$) and the quality criterion based on the target block error rate ($BLER_{target}$) **Structure:** neural network	Governed by Pre-AIA 35 U.S.C. § 112, ¶ 6 (means plus function) **Function**: performs a mapping between a quality criterion based on the outage probabilities ($p_{\sigma 1}$, $p_{\sigma 2}$,. . . , $p_{\sigma N}$) and the quality criterion based on the target block error rate ($BLER_{target}$) **Structure**: neural network

	structure is a linear combination or an adder.		

IV. TECHNOLOGY OF THE ASSERTED PATENTS

A. Background

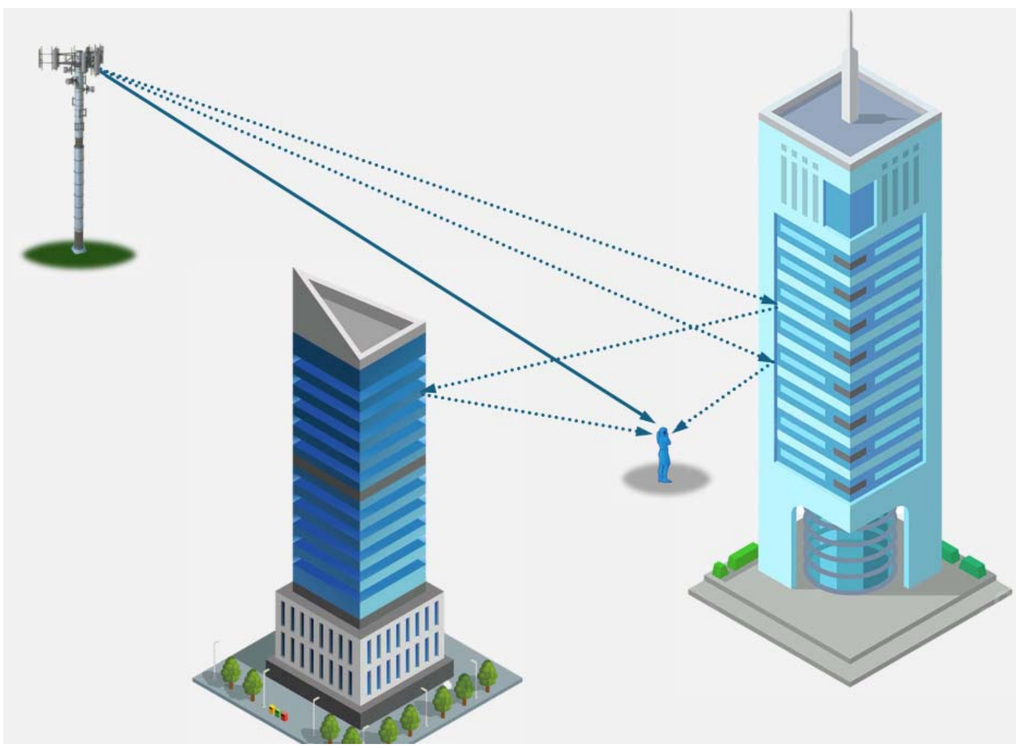
40. The two asserted patents relate to cellular communication systems, in other words the way that cell phones communicate with the wireless communication infrastructure. A cellular network mobile phone system gets its name from dividing the service area into many small cells, each with a base station with a useful range (often on the order of a kilometer). These base stations are located on towers in each cell. Cell towers have a roughly hexagonal shape service area, and in each of these service areas a number of devices can connect to an individual tower:



41. In the above figure, signals to the tower are shown in red, called an uplink, while signals received from the tower are shown in blue, known as a downlink. Of primary interest to this case is the downlink, as the accused products are cell phones and the claims are generally directed to the power at which a signal is transmitted from a base station to a device.

42. A user's connection to the base station may not be perfect. For example, it may be obstructed by buildings or tunnels, and a cell phone signal may bounce off of objects on the way to the base station. This can cause a reduction in the strength of the signal, called attenuation.

43. A related problem is fading, which is a fluctuation in signal strength over time as a result of environmental factors. For example, in some situations, a base station may emit a signal that is received by a cell phone through multiple different paths. To illustrate, in the example shown below a cell tower transmits a signal that arrives at a cell phone through three different paths: one direct path, and two other paths that involve the signal bouncing off of a building before arriving at the phone.



This results in the same signal arriving at the cell phone at three different times. In this particular example, the fading is due to a condition called multipath propagation.

44. In addition, the signals from the various cell phones connected to the tower can interfere with each other, called interference. If there is interference or attenuation on a link, it may be necessary for the base station to transmit a signal at a higher power level to maintain call quality and to avoid dropped calls. At a very general level, if a cell phone determines that call quality is below standard, it asks the base station for more power to maintain quality. This is done through a message called a Transmit Power Control (TPC) message.

45. However, a cell tower only has a limited amount of power available for transmission, and all of the phones in a cell are sharing the code space in the WCDMA spectrum. *See* Prashant Vashi Deposition (3/28/24) at 35:17-36:22; *see also* https://www.qualcomm.com/research/5g/3g at 2:08 ("The more connections in a channel, the more overloaded the channel gets, and the further you get from those peak data rates."). As well, mobile devices should use as little power as possible to reduce the possibility of interfering with other devices. *Id.;* Afzal Ahmad Deposition (3/19/24) at 70:3-74:7, 76:14-18. In the downlink, the air interface capacity is directly determined by the required transmission power, since that determines the transmitted interference. Thus, to maximize the downlink capacity the transmission power needed by one link should be minimized. Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2002) at 236.

46. We can think of network capacity as headroom that ensures that phones do not interfere with each other as the number of phones per base station approaches the capacity limit. As the available base station transmission capacity becomes crowded – such as when many devices ask for more than the minimum they need (e.g. in acquisition, recovery from fading, or during windup) – devices start to interfere with each other. *Signal and Interference Statistics of*

a CDMA System with Feedback Power Control, S. Ariyavisitakul and L.F. Chang, IEEE Transactions on Communications vol. 41 no. 11, 11/1993 at 1626 ("Since these codes cannot be exactly orthogonal for a set of asynchronous users, interuser interference usually adds on a power basis and the radio link performance of any one user becomes poorer as the number of simultaneous users increases.") This can cause issues such as bad call quality or dropped calls for cell phones on an overburdened network.

47. This interference also negatively affects data transmission for mobile devices – interference equals errors, which require retransmission of data packets, which reduces data download speed overall. Thus it is beneficial for the networks to have devices minimize requested power to increase overall capacity, and also is beneficial to the mobile device manufacturers as it improves the performance of individual devices across a cell. Also, in technologies like High Speed Downlink Packet Access (HSDPA), the amount of transmitted data is adaptively chosen based on the received Signal to Interference Ratio (SIR), which I discuss in more detail later in this report. *See* TOT00191801-16 at TOT00191805 ("HSPA/HSPA+ relies on WCDMA for voice"); TOT00194483-501 at TOT00194484-87 (describing HSPA and HSPA+). The SIR is lower (and consequently, less data is transmitted) when interference is high, but also when there is less available power. Therefore, reducing the amount of transmitted power to the rest of the users in a network allows data to be sent at a higher speed. And capacity is higher with technology that improves signal strength and mitigates interference. https://www.qualcomm.com/research/5g/3g at 2:35. As such it is important for a device to only request as much power as is necessary to maintain connection quality. *See* Afzal Ahmad Deposition (3/19/24) at 70:3-74:7, 76:14-18; Prashant Vashi Deposition (3/28/24) at 38:11-17. This is why the standard requires phones to converge down a minimum power request level

needed to maintain an acceptable BLER. *Id.* This is also why converging faster, which both inventions enable in different scenarios, clears capacity faster, reduces interference between phones, and improves data transmission. https://www.qualcomm.com/research/5g/3g at 2:35; *see also* TOT00192970 at TOT00193004 ("Qualcomm, a leader manufacturer is promoting the WCDMA evolution, known as WCDMA+. This evolution is focused on making voice more efficient to support more data.").

48. Call quality can be measured in a number of different ways. One way is block error rate (BLER). '865 Patent at 2:36-39. Block error rate is the measure of quality based on the rate of data blocks containing errors. It is calculated by dividing the number of erroneous blocks received by the total number of blocks transmitted over a specific number of frames. Typically, a BLER requirement for a voice call is 1%, which means that there should be no more than one in a hundred received blocks containing errors. An erroneous block is often determined by detecting that it fails a cyclic redundancy check (CRC). *See* US 2003/0148769 (incorporated by reference in the '865 Patent) at ¶ [0031]. At a high level, the transmitting device generates a checksum, which is a data value generated based on the remainder of a polynomial division of the block's contents. This value is attached to the block. On retrieval, the receiving device calculates the checksum of the received data. If the checksums do not match, then it can be determined that the data has been corrupted.

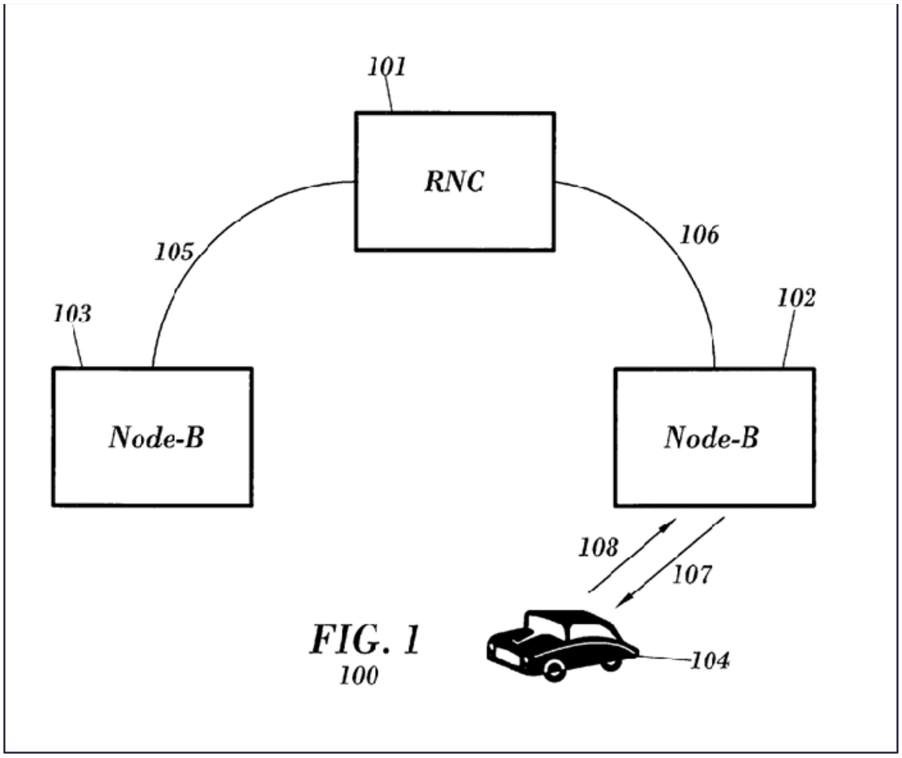
49. Another option to determine call quality is a Frame Error Rate (FER), which is similar to BLER but is the ratio of frames received in error to the total count of frames. In addition, one could measure signal quality over the course of number of bits with an error, which is called the Bit Error Rate or BER.

50. Another concept related to signal quality is the Signal to Interference Ratio (SIR). SIR represents the ratio of received signal power compared to the received interference. It can be derived in various ways including signal measurements at various frequencies, measurement before and after filtering, or calculation based on received error rates. This interference (also referred to as crosstalk) is the unwanted bleedover of signals from other communication channels. A higher SIR requires more transmit power but may be needed to ensure call quality. A lower SIR requires less power but may not meet the established call quality criterion, and in some cases, may even result in a call being dropped.

B. U.S. Patent No. 7,532,865

51. The '865 Patent, entitled "Outer loop power control method and device for wireless communication systems," issued on May 12, 2009. *See* '865 Patent, cover page. The filing date of the U.S. application for the patent is December 1, 2005, and the patent claims priority to a foreign patent application filed in Spain, ES 200502057, on August 17, 2005. *Id*. The named inventors of the '865 Patent are Alfonso Campo Camacho, Miguel Blanco Carmona, Luis Mendo Tomas, José M. Hernando Rabanos, and Alvaro Lopez Medrano. *Id*. The original assignee of the patent is T.O.P. Optimized Technologies, S.L., which I understand to be TOT's parent corporation. *Id*.

52. The technology of the '865 Patent relates to downlink power control within a cellular communication system. '865 Patent at 1:14-33. Specifically, the claims of the '865 Patent are directed to methods for outer loop power control (OLPC) for systems using the Wideband Code Division Multiple Access (WCDMA) protocol. *See,*'865 Patent at 2:12-46; claim 1. An exemplary mobile communication system is shown in Fig. 1 of the '865 Patent, showing base stations (102 and 103), the mobile station (the car 104), and a radio network controller (RNC, 101)



'865 Patent at Fig. 1. The base stations and the mobile station represent the end points of the wireless interface. '865 Patent at 6:31-37. Each base station is associated with an RNC. *Id*. The mobile station communicates with a base station via a downlink data signal (107) and an uplink data signal (108). *Id.*

53. Fig. 2 breaks out an example of a base station and/or mobile station into component parts:

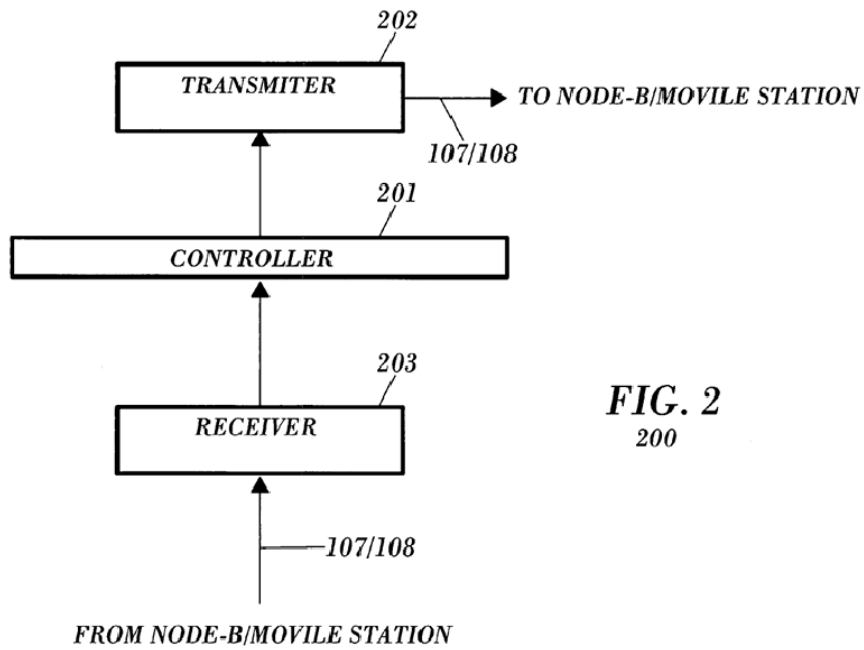


FIG. 2
200

'865 Patent at Fig. 2. Each device contains a receiver for receiving data, a transmitter for transmitting data, and a controller for controlling the operations of the device (including the power control algorithm). *See* '865 Patent at 6:39-56.

54. Power control is important in a cellular network because all users utilize the same frequency band, and so may cause interference – in other words if a device is transmitting or requesting transmission from the base station with too much power, it may interfere with other devices trying to use the same limited frequency spectrum capacity. '865 Patent at 1:28-33, 1:55-61. Indeed, it was a known problem at the time that CDMA networks had interference issues. Bernd Adler Deposition (3/27/2024) at 36:18-37:5. On the other hand, a certain amount of downlink power is required to maintain quality of service for a connection. '865 Patent at 1:62-67. In general terms, a device should use the minimum level of transmission power while guaranteeing a desired quality of service level. *See Radio Resource Management in Wireless Communication: Beamforming, Transmission power Control, and Rate Allocation*, Hasu (June

2007) at 18. The need to control transmission can be illustrated in a real-world scenario by the "cocktail party problem," which was well-expressed by Vesa Hasu in a 2007 PhD thesis:

> A famous source separation metaphor is the so-called cocktail party problem, wherein several people are talking simultaneously at a cocktail party and one is trying to follow a single discussion. If somebody does not hear the speech well enough, the speaker must increase the volume. Unfortunately, this simultaneously increases the interference in other discussions at the cocktail party and the other parties have to increase their volume also. To avoid this upward spiral being realised in multiple access radio communication, transmission power control must be used.
>
> *Id.* at 2.

55. As the '865 Patent describes, there are three procedures for implementing power control in a WCDMA system: (1) open loop, (2) closed or inner loop, and (3) outer loop. '865 Patent at 2:12-46. In open loop, at the start of a connection the base station estimates power loss in the uplink/downlink and adjusts its transmission power accordingly. '865 Patent at 2:14-17. In closed or inner loop, the receiver compares the value of the desired signal-to-interference ratio received (SIR_{rec}) to a desired signal to interference ratio target that the receiving device has determined would provide optimal call quality (SIR_{target}). '865 Patent at 2:21-25. If the SIRrec is above or below the SIR_{target}, the receiver sends power control bits (e.g. TPC commands) to the base station requesting that the downlink power be increased or reduced by a certain value. '865 Patent at 2:27-29. Finally, the transmitter increases or decreases power by that amount. '865 Patent at 2:31-32.

56. Outer loop power control sets the desired SIR_{target} to maintain a pre-set quality objective. '865 Patent at 2:33-36. Criteria for the quality may include frame error rate (FER), bit error rate (BER) or a block error rate (BLER). '865 Patent at 2:36-37; Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2004) at 57 ("Outer loop power control adjust the SIR setpoint in the base

station according to the needs of the individual radio link and aims at constant quality, usually defined as a certain target bit error rate (BER) or block error rate (BLER)."). An equivalent alternative quality measure could be to use a bit error rate, such as one derived from received TPC commands. *See, e.g.*, R1-050066, TSG-RAN Working Group 1 Meeting #40, February 14-18, 2005 (TOT00155727-30). If the received error rate is greater than the target error rate, the call quality is degraded. '865 Patent at 2:54-61. In that event, the OLPC algorithm increases the desired SIR_{target} to try and reach the target quality criterion. '865 Patent at 2:60-3:2. The OLPC algorithm continues to increase the SIR_{target} until the desired error rate is achieved. '865 Patent at 3:3-5. If SIRrec is higher than required, the receiver will then lower the SIRtarget and send commands to the base station to note that it needs less power. '865 Patent at 3:8-27. A picture of the overall power control loop is reproduced here:

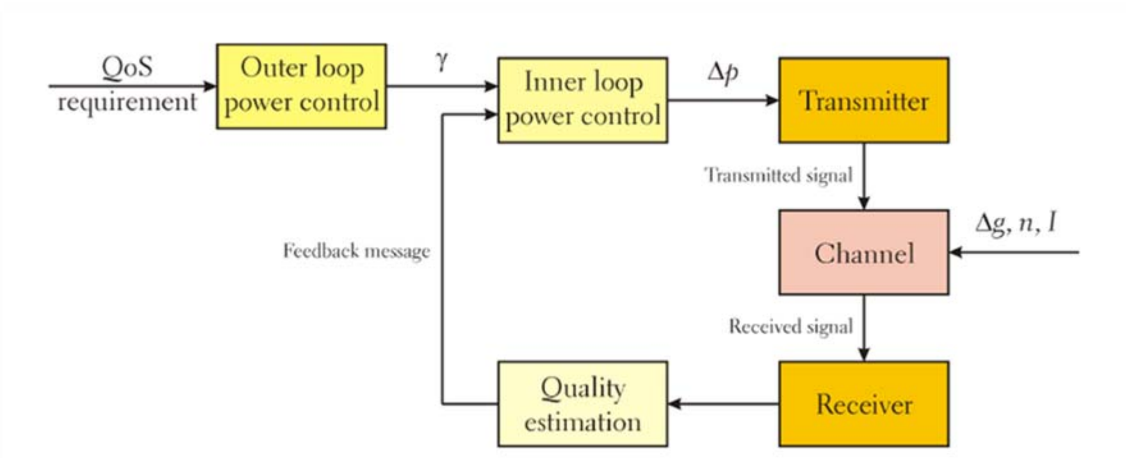


Fig. 3.1: A sketch of the general components in the PC loop.

Radio Resource Management in Wireless Communication: Beamforming, Transmission power Control, and Rate Allocation, Hasu (June 2007) at 21.

57. Inner loop power control and outer loop power control are interrelated as described below:

2.1. Reference Algorithm Description

The PC framework in Rel'99 systems is constituted by three main components: an Open Loop Power Control which, based on path-loss, estimates an initial SIR-target (dependent on the type of service) sets the initial transmit power to reach such target, and two closed-loop components which interact with each other, namely ILPC and OLPC.

The schematic representation of the two closed loops is given in Figure 4.

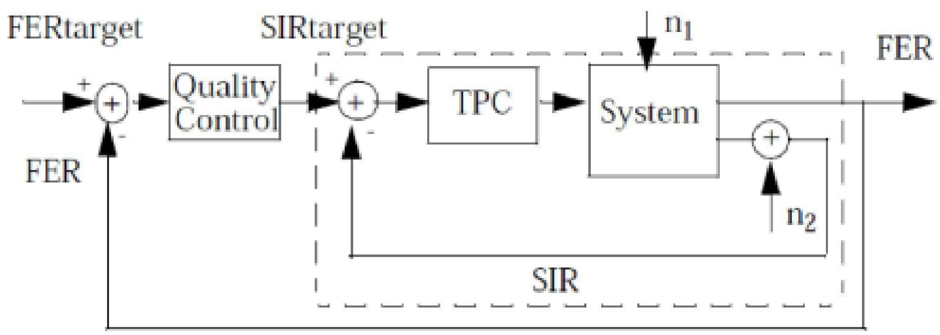


Figure 1. Representation of the interaction between ILPC and OLPC

TOT00190774-91 at TOT00190780.

58. At low UE speed, fast power control can compensate for the fading of the channel, keeping the received power level fairly constant. Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2004) at 233-234 Holma and Toskala present simulations of fast power control demonstrating that in normal conditions, fast power control works efficiently in compensating for fading:

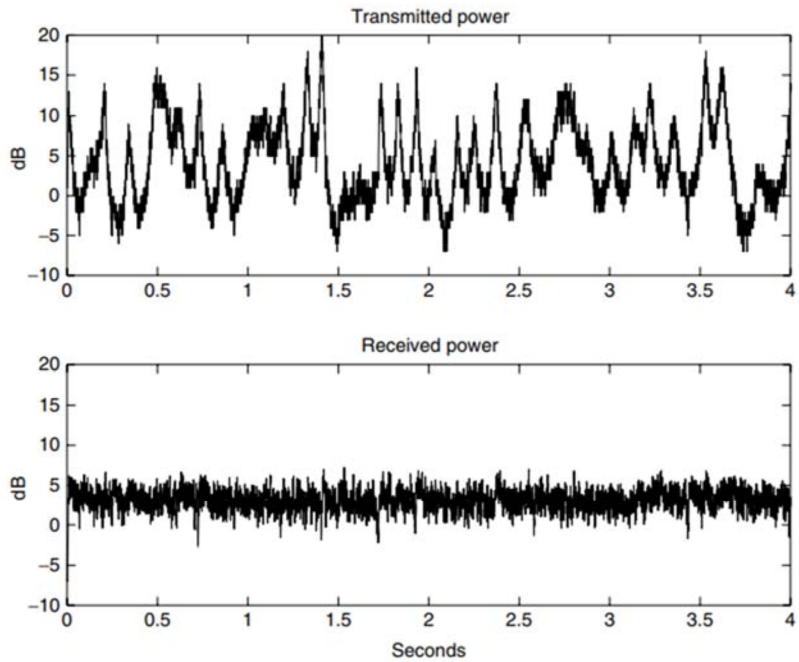


Figure 9.2. Transmitted and received powers in two-path (average tap powers 0 dB, −10 dB) Rayleigh fading channel at 3 km/h

Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2004) at 234.

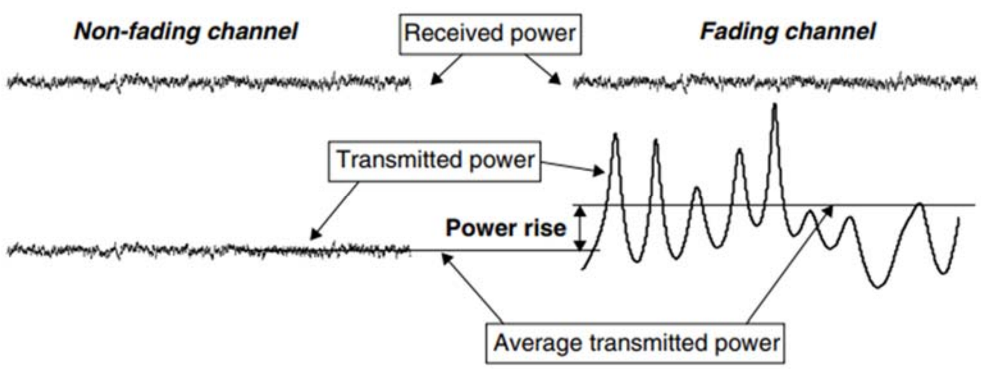


Figure 9.4. Power rise in fading channel with fast power control

Holma & Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2004) at 235.

59. Ideally, if power control were perfect, the transmitted signal would mirror the inverted variations of the channel. *Signal and Interference Statistics of a CDMA System with Feedback Power Control*, S. Ariyavisitakul and L.F. Chang, IEEE Transactions on Communications vol. 41 no. 11, 11/1993 at 1627. However, this is not the case; some channel fading cannot be fully compensated, leading to fading in the received signal after power control. Ariyavisitakul at 1627:

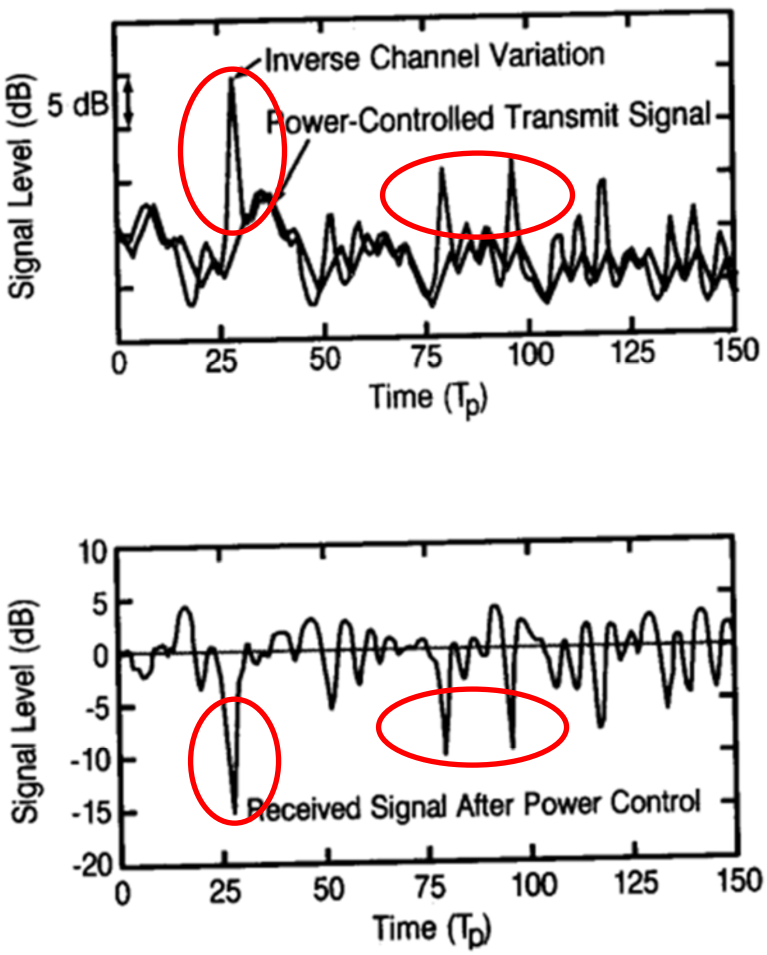


Fig. 3. Simulated signal waveforms showing residual fading of the received signal after power control. The simulation assumes two-branch antenna diversity, Rayleigh fading, and 1 dB fixed-step power control (no return-link errors, loop delay $k = 0$). $f_D T_p = 0.1$.

Id. (emphasis added).

60. Outer loop power control is typically implemented by the radio network controller in the user device, so that the function can be performed during situations such handover – where the device is moving from sector to another. Holma & Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2004) at 57-58. During "softer" handover, a mobile station is in the overlapping cell coverage area of two adjacent sectors of a base station. *Id.* at 58. This typically occurs in 5-15% of connections. *Id.* In "soft" handover, a mobile device is in the overlapping cell coverage area of two sectors belonging to different base stations. *Id.* at 59. This typically occurs in 20-40% of connections. *Id.* An inter-frequency "hard" handover hands a mobile device from one WCDMA frequency carrier to another, while an inter-system hard handover takes place between two different systems, such as WCDMA to GSM or vice versa. *Id.*

61. The ability to transfer between cells as well as sectors within a cell is an important feature of a mobile device such as a cellular telephone. Moreover, by the mid-2000's, the cellular communication chips in most cell phones had the ability to communicate using multiple radio access technologies (RATs), and thus the ability to transfer between RATs also became important. This mobility between sectors, cells, and RATs allows users to make and maintain calls and data connections while on the go, for example while in a moving car. The 3GPP has specifications that require compliant phones to be able to accomplish various types of handover, including soft handovers, and hard handovers. *See* 3GPP TS 22.129 v.10.0.0 (2011-03) at 10-11. And indeed, carriers require devices that operate on their networks to be able to change bands and technologies on the fly. For example, an AT&T requirements document requires that "[t]erminals with multi-band support shall automatically transition between all supported bands" and "shall automatically transition between all supported RATs." APL-TOTDDE_00836097 at APL-

TOTDDE_00836187. Similarly, Verizon wireless requirements document has requirements for handovers of different types, such as requirements that "[t]he device shall successfully reselect from a WCDMA network to a GSM network in a slow fading environment," and that "[t]he device shall comply with the call drop rate requirements given in Table 8-3 while performing intra-frequenc[y handover]." VZTOT0000022 at VZTOT0000040; *see also* VZTOT0001281 at VZTOT0001822 (test cases for "LTE to HRPD Handover."). T-Mobile has similar requirements for Inter-RAT handover and inter-frequency cell change and reselection. APL-TOTDDE_00813942 at APL-TOTDDE_00813949-00813950.

62. The WCDMA standards also include certain requirements relating to power control, but the '865 and '376 Patents are directed to improvements in power control that are beyond what is required in the standards. For example, the WCDMA standards do not test for certain conditions where transmissions can be sent at lower power, such as after the demand for transmission power is high. In addition, the standards provide for static testing, which is unable to account for dynamic changing conditions.

63. Wind-up occurs when radio conditions degrade to the point a base station cannot react to TPC commands. This may happen when uplink control messages become corrupted, and the user device has received only bad blocks. It also may happen when a base station is saturated under high usage loads and temporarily cannot send with more power to a particular device that requests it. The device will set SIR_{target} higher to increase SIR, but the base station cannot decode those commands or cannot send with more power and does not modify the transmitted power, so that SIRrec stays the same. This creates a situation called wind-up as the UE will continue to increase SIR_{target}, resulting in increasing deviance between SIR_{target} and SIRrec. It is important for a device to detect wind-up such that it does not continue increasing SIRtarget indefinitely when

the commands to the base station are not having an effect. *See also* Afzal Ahmad Deposition (3/19/2024) at 87:21-91:6.

64. For example, at the edge of the coverage area, the device may reach its maximum transmission power. When this happens, the received BLER can be higher than desired, and increasing the SIR target will not improve uplink quality if the Node B is already sending only power-up commands to the device. Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications* (2004) at 243.

65. When conditions improve, the OLPC algorithm lowers the SIR_{target} to attempt to reset to a suitable value, which is called unwinding. '865 Patent at 3:8-27. This process is summarized in Fig. 3 of the patent:

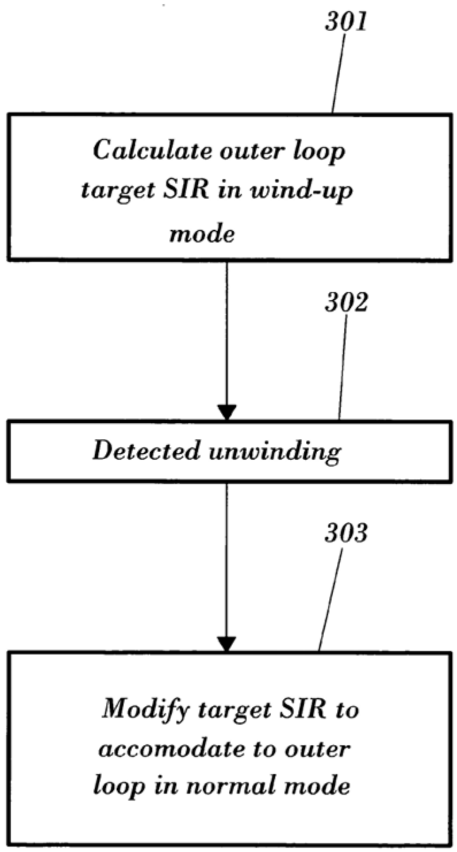
66. 

FIG. 3
300

'865 Patent at Fig. 3.

67. The period of reducing SIRtarget after unwinding is called convergence. When converging, it is undesirable to request more downlink power than you need. Afzal Ahmad Deposition (3/19/2024) at 70:17-20; 71:15-74:7. That causes interference and limits the number of other phones that can be on the same sort of equipment. *Id.* at 70:5-72:16, 76:16-20; *see also* Prashant Vashi Deposition (3/28/24) at 35:17-36:22, 38:3-39:22; Afzal Ahmad Deposition (3/19/2024) at 91:15-93:1 (windup is bad). That is, if the algorithm does not lower SIRtarget quickly enough, the received FERrec will be much lower than necessary, the device will request and use more power than necessary, and therefore will increase the interference in the channel,

reducing capacity and degrading quality and data throughput in other connections. '865 Patent at 3:8-17; *see also* TOT00189283 at 5 (describing "Slow outer loop power control" convergence as a key limitation of WCDMA Release 99). This problem is described further in the patent:

> The problem is that due to the properties of the outer loop power control (OLPC) algorithm used normally (see Holma H, Toskala A, "WCDMA for UMTS, Wiley, 2002), the process of lowering the desired signal to interference ratio target (SIR) is very slow. This slow convergence is because the down step size used by the algorithm is, measured in dB, of the order of the target frame error rate (FER) (typical values are 10° for the voice service and 10 for the video calls service), that is, very small, which means that dozens of seconds are needed for each dB decrease. '865 Patent at 28-37.

68. Various answers have been proposed to speed the process of convergence. The '865 Patent describes that a problem with existing OLPC methods is that lowering the SIR$_{\text{target}}$ at the end of a wind-up condition can be a slow process:

> The problem is that due to the properties of the outer loop power control (OLPC) algorithm used normally (see Holma H, Toskala A, "WCDMA for UMTS, Wiley, 2002), the process of lowering the desired signal to interference ratio target (SIR$_{target}$) is very slow. This slow convergence is because the down step size used by the algorithm is, measured in dB, of the order of the target frame error rate (FER$_{target}$) (typical values are 10^{-2} for the voice service and 10^{-3} for the video calls service), that is, very small, which means that dozens of seconds are needed for each dB decrease.

'865 Patent at 3:28-37.

69. The invention of the '865 Patent addresses this problem by providing a novel method and apparatus for quickly returning the SIR$_{target}$ to a suitable value during the unwinding process. As described in the '865 Patent:

> The proposed outer loop power control method and device for mobile communications systems, especially designed for third generation (3G) technologies based on some of the standard Code Division Multiple Access (CDMA) protocols modifies the desired signal to interference ratio target (SIR$_{target}$) when it has exited the wind-up condition, when the unwinding process has started.

> More specifically, using the method and apparatus of the invention, at the start of unwinding, the target (SIR_{target}) is made equal to a value suitably close to that which the desired signal to interference ratio target (SIR_{target}) had before the start of the wind-up. This suitable value with which the invention sets this desired signal to interference ratio target (SIR_{target}) when the outer loop power control enters the unwinding mode is as close as possible to the value set for the desired signal to interference ratio target (SIR_{target}) just before it entered the wind-up condition, so that immediately after the outer loop unwinding state ends, the power control follows the variation determined in normal mode.
>
> This suitable changing of the desired signal to interference ratio target (SIR_{target}) by the invention when unwinding starts in the outer loop power control (OLPC) quickly matches the target (SIR_{target}) and, therefore, the power to the outer loop in normal mode.

Id. at 4:16-39.

70. One embodiment of the '865 invention is described as follows:

> One aspect of the invention is therefore an outer loop power control method for wireless communications systems which, based on the data signal received from the base or mobile station, involves the following phases:
>
> i) Estimating the desired signal to interference ratio received (SIR_{rec}) based on the data signal from a base or mobile station.
>
> ii) Setting the desired signal to interference ratio target (SIR_{target}) that is close to the desired signal to interference ratio required (SIR_{req}) during the normal mode of the outer loop.
>
> iii) Detecting the start of the outer loop wind-up mode.
>
> iv) Setting a desired signal to interference ratio target (SIR_{target}) during the outer loop wind-up state.
>
> v) Detecting the start of the outer loop unwinding mode.
>
> vi) Changing the ratio of the signal required to interference (SIR_{target}) at the start of the outer loop unwinding, to thus finally match it to the outer loop power control in normal mode.

71. Figure 4 in the '865 Patent depicts an example of how SIR_{target} is adjusted using the patented method:

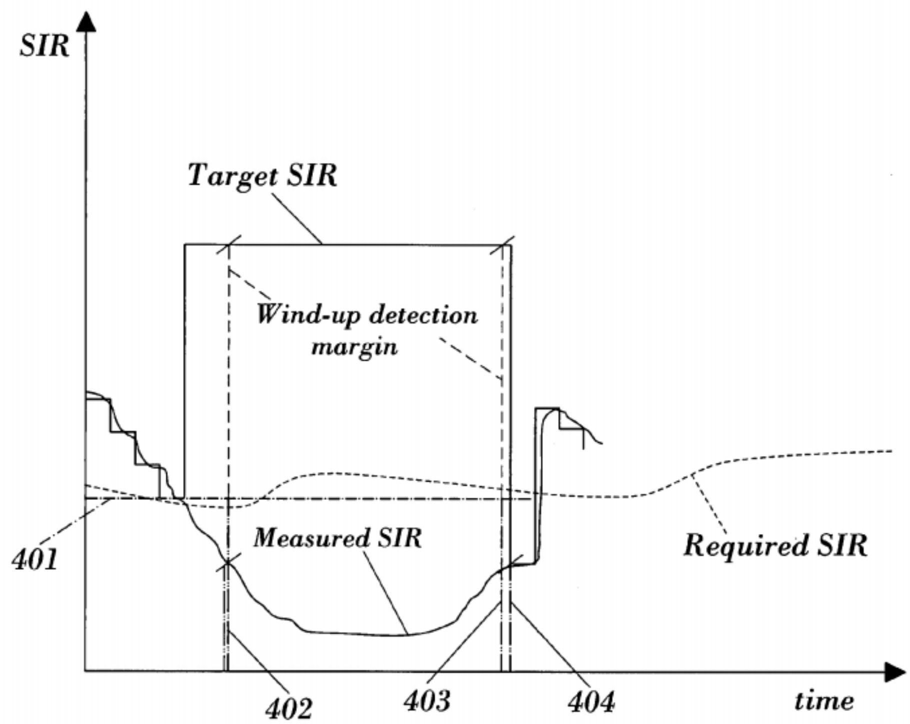


FIG. 4
400

'865 Patent at Fig. 4; *see also* 7:36-8:3.

72. In this figure, at t0, the measured SIR is above the dotted line, which is the required SIR. The target SIR is stepped down until the measured SIR and required SIR are at the same level. However, the measured SIR continues to drop, and the target SIR is increased to request more power in this figure, which is an unexpected behavior. The difference between SIRtarget and SIRrec increases as measured SIR does not respond to the receiver's request for more power. At 402, wind-up is detected. '865 Patent at 7:20-35. Target SIR is not increased after this point. At 403 the algorithm detects the starting point of unwinding where the measured SIR has increased to a point that it is no longer within the wind-up threshold. '865 Patent at 7:53-8:3. At 404, immediately after unwinding has been detected, the patented algorithm sets the SIRtarget to the value from 401, just before the wind-up:

> To choose this last correct value (401) for the desired signal to interference ratio target (SIRtarget), the invention's method proposes the following mechanism, preferentially applicable if the wind-up detection has been planned using a detection margin (M) between the desired signal to interference ratio target (SIRtarget) and the desired signal to interference ratio received (SIRrec), as specified in FIG. 4. In this case, the detection of the wind-up situation by the detector (302) occurs at the starting point (402) of the outer loop wind-up. Later, this detector (302) also determines the end of the wind-up mode and thus detects the starting point (403) of the unwinding. At this point (403), this mechanism reduces the desired signal to interference ratio target (SIRtarget) by the same amount as the detection margin (M). This mechanism thus allows the value of the desired signal to interference ratio target (SIRtarget) to return to a value that is very close to the original value (401) it had at the point before the start (402) of the wind-up. '865 Patent at 7:53-8:3.

Id. at 4:57-5:8.

73. Setting the SIRtarget to the value from just before wind-up drastically reduces the convergence time of the OLPC on exiting windup as compared to a slow stepping down as we can see from the very left hand side of the chart. '865 Patent at 8:23-27. This prevents complications such as unnecessary interference that would reduce the system's overall capacity, and so the patented algorithm allows carriers to service more phones in a cell than would otherwise be possible:

> The great advantage of the new unwinding mechanism that includes the method proposed for wireless communications systems is that it drastically reduces the convergence time of the outer loop power control on exiting the wind-up state and, thanks to it, prevents unnecessary interferences that reduce the system's capacity.

Id. at 8:23-28. *See also id.*, Abstract ("Thus, the unwinding time is shortened and the interference in the mobile communication system is reduced, while its capacity and the quality of its wireless connections are increased.").

C. U.S. Patent No. 7,496,376

74. The '376 Patent, entitled "Outer loop power control method and apparatus for wireless communication systems," issued on February 24, 2009. *See* '376 Patent, cover page. The filing date of the U.S. application for the patent is December 1, 2005, and the patent claims priority to a foreign patent application filed in Spain, ES 200502056, on August 17, 2005. *Id.* The named inventors of the '376 Patent are Alfonso Campo Camacho, Miguel Blanco Carmona, Luis Mendo Tomas, José M. Hernando Rabanos, and Alvaro Lopez Medrano. *Id.* The original assignee of the patent is T.O.P. Optimized Technologies, S.L. *Id.*

75. Like the '865 Patent, the '376 Patent relates to methods of power control for devices in a wireless communications system, such as a CDMA or WCDMA cellular network. Figure 1 in the '376 Patent provides a high-level diagram of one such system, where base stations for a cellular network (102 and 103) are able to communicate with a mobile station (104) through downlink (107) and uplink (108) data signals:

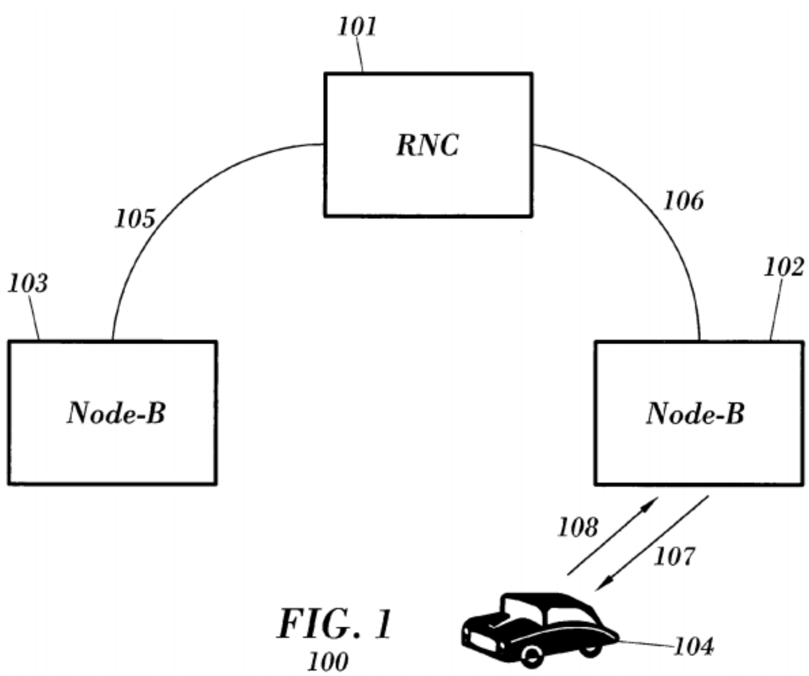


FIG. 1
100

'376 Patent, Fig. 1. *See also id.* at 8:47-51; 9:16-35.

76. At a high level, the '376 Patent discloses a novel method of outer loop power control that addresses the problems that are associated with a certain type of fading in the wireless channel. As discussed earlier, "fading" refers generally to a change in the received level of signal even when the distance between the mobile device and base station does not change, and can occur as the result of a variety of conditions such as multipath propagation (referred to as multipath-induced fading), weather (particularly rain), or shadowing from obstacles affecting the wave propagation (sometimes referred to as shadow fading). Channel fading can result in either constructive or destructive interference, amplifying or attenuating the signal power seen at the receiver. The '376 Patent enables better reaction to changes in signal propagation conditions by (i) measuring the amount of fading within the channel and (ii) accounting for that fading as part of the outer loop power control. *See* '376 Patent at 5:47-6:6. One major benefit of this improved method is that the quality of the connection between the mobile device and the base station can be maintained while minimizing the amount of power used for the connection. *See id.* at 6:7-12.

77. The Abstract of the '376 Patent provide the following description of the subject matter of the patent:

> Outer loop power control (OLPC) method and apparatus for mobile communications systems which allow rapid adjustment of the target desired signal to interference ratio (SIR_{target}) satisfying a target block error rate ($BLER_{target}$). Specifically, the outer loop power control method proposed herein is termed "Outage-Based OLPC and establishes that the target desired signal to interference ratio (SIR_{target}) is given as the sum of two components: the first component ($SIR_{outage\text{-}tgt}$) is calculated by means of a dynamic adjusting function, for example, a neural network which makes a quality criterion based on outage probabilities correspond with one based on the target block error rate ($BLER_{target}$), taking as input the fading margins associated with the different outage probabilities considered; the other component ($SIR_{BLER\text{-}tgt}$) is that which acts to correct the possible deviations in the target block error rate ($BLER_{target}$) due to the non-ideal behavior of the previous component ($SIR_{outage\text{-}tgt}$).

78. The '376 specification also includes an "Object of the Invention" section that describes the objectives of the patent as follows:

> The present invention has its application within the telecommunications sector and, especially, in the industrial area engaged in the production of both base stations and mobile terminals in cellular infrastructures for wireless communications systems.
>
> More particularly, the invention described herein, within communications relates to a method and device for the system of outer loop power control in a cellular mobile telephony network.
>
> An object of the invention is to permit power control by means of the outer loop procedure which, supplemented with the method of the invention and which is termed herein "Outage-Based OLPC, adapts to the changing propagation conditions of the communication channel.
>
> It is also an object of the invention to provide a device adapted to be incorporated in the controller of a base station or of a mobile terminal, which carries out the dynamic adjustment of the power level according to the target desired signal to interference ratio established by the Outage-Based OLPC method which is disclosed.

Id. at 1:14-34.

79. As background, the '376 specification describes why power control is important in WCDMA cellular networks:

> The system of power control in WCMDA-based cellular networks, is necessary since it concerns a technology limited by interference, because all the users share the same frequency spectrum and their codes are not totally orthogonal (see Holma & Toskala: "WCDMA for UMTS, Radio Access for Third Generation Mobile Communications", John Wiley & Sons).
>
> The ultimate goal of the power control system in WCDMA is to attain the required quality of service in a particular connection, downlink from the base station to the mobile terminal or terminal unit, or, uplink from the mobile terminal to the base station, with a minimum level of transmitted power (this aspect is precisely that on which the invention is centred).
>
> The main objectives of the system of power control in WCDMA networks are:
>
>> Cancellation of the near-far effect: in the event of all the mobile stations transmitting the same power without taking into account the distance or the

> fading to the base station, the mobiles nearest the same would signify substantial interference for the most remote terminals.
>
> Protection against deep fading.
>
> Minimization of the interference in the network with the ensuing improvement in capacity.
>
> Enhanced duration of the battery of the mobile stations.

Id. at 1:57-2:15.

80. The '376 specification also describes WCDMA power control methods that existed prior to the '376 invention:

> A system of power control for WCMDA is implemented overall by means of three distinct procedures:
>
> By open loop: during the random access process when setting up a connection, the base/mobile station estimates the loss of power in the uplink/downlink connection and in terms thereof adjusts its transmission power.
>
> By closed or inner loop: also termed fast power control (1500 Hz) which consists of the following three steps:
>
> 1. The corresponding receiving terminal (the base station or the mobile unit) compares the value of the received desired signal to interference ratio (SIR_{rec}) with the target desired signal to interference ratio (SIR_{target}) which depends on the quality of service required for that specific connection and which is fixed by the outer loop procedure explained below.
>
> 2. The same receiving terminal sends power control bits indicating that the transmission power should be increased (if $SIR_{rec} < SIR_{target}$) or decreased (if $SIR_{rec} > SIR_{target}$) in a certain value (usually 1 dB).
>
> 3. The transmitting unit (base station or mobile) increases or decreases its power in the previously fixed amount.
>
> By outer loop (OLPC, Outer Loop Power Control): this is much slower than the closed loop (10-100Hz)and establishes the target desired signal to interference ratio (SIR_{target}) which causes a predetermined quality objective to be maintained. A criterion or a measurement of the quality of a connection is the frame error rate (FER) or equivalently the block error rate (BLER), which is a function of the desired signal to interference ratio (SIR_{rec}). Since the inner loop helps to maintain the desired signal to interference ratio (SIR_{rec}) near the target (SIR_{target}), the block

> error rate (BLER) is, ultimately, determined by this target value. Thus, to attain a quality of service in a determined fading environment, the target (SIR_{target}) needs to be adjusted to the value appropriatefor that environment.

Id. at 2:16-50.

81. The '376 specification then goes on to discuss the shortcomings of these then-existing power control methods, one of the major problems stemming from the fact that measuring the block error rate (BLER) can be a slow process:

> Unfortunately, a target (SIR_{target}) does not exist which can attain the block error rate (BLER) required for all the fading environments in the wireless communication channel. For this reason, the dynamic adjustment of this target desired signal to interference ratio (SIR_{target}) is today an object of study and mechanisms have been described to adjust said ratio conveniently.
>
> The commonly accepted design for outer loop power control (OLPC) is that based on the target block error rate ($BLER_{target}$) and termed "BLER-Based OLPC", which measures this metric and changes the target desired signal to interference ratio (SIR_{target}) in consequence, depending on whether the target block error rate ($BLER_{target}$) is above or below the desired threshold (see Sampath A, Kumar P S & Holtzman J M (1997), "On setting reverse link target SIR in a CDMA system", Proceedings of the IEEE Vehicular Technology Conference, Phoenix, Ariz., pp. 929-933.). The drawback is that, bearing in mind that the technique of measuring the block error rate (BLER) is quite slow, especially for high quality services, the features of these systems are greatly impaired in dynamic environments with fading characteristics changing in very short intervals of time (see Holma H., "WCDMA for UMTS", John Wiley& Sons, Ltd., 2002). The aforementioned slowness for the services that require a low block error rate (BLER) (for example: 0.1%) is due to the "BLER-based OLPC" method being based on counting the errors by means of the Cyclic Redundancy Code (CRC), which implies an excessively high number of data blocks to arrive at a precise estimate of the block error rate (BLER).
>
> The most serious problem is that which arises when a favourable change occurs in the propagation conditions in which event the "BLER-based OLPC" method reacts very slowly, causing the target desired signal to interference ratio (SIR_{target}) fixed by said outer loop power control method to be greater than that necessary for a long period of time, with the consequent increase in interference and, therefore, the loss of system capacity.

Id. at 2:51-3:20. Slowness in arriving at the correct operating point after a change in conditions, resulting in more power than necessary being requested and used by the device, causes the same interference and loss of network capacity as described above for the '865 Patent—and for the same reasons. The '376 Patent is also directed to solving the slow convergence (*e.g.*, settling) problem.

82. As described in the '376 specification, solutions developed by others to try to address these shortcomings still had their own limitations:

> Much investigation has been applied aimed at resolving the slow convergence of the power control method which, as has been explained, occurs in the "BLER-Based OLPC". One of the options most employed as a possible solution consists in carrying out modifications to the size of the adjusting steps for the target desired signal to interference ratio (SIR_{target}) which is imposed by the cited BLER-based OLPC method (see again Sampath A, Kumar PS & Holtzman J M (1997), "On setting reverse link target SIR in a CDMA system'. Proc. IEEE Vehicular Technology Conference, Phoenix, Ariz., pp 929-933.). However, that option does not overcome the inherent problem with this type of power control method since it also involves a very high number of data blocks for the precise estimation of the block error rate (BLER). Based on this principle of the quality criterion which obeys the target block error rate ($BLER_{target}$), some methods can be cited which have been object of the following patent applications in the United States: US 2004/0137860, US 2004/O157636 and US 2003/OO31135.
>
> Another of the most usual alternatives to overcome the problem of the slow convergence of the BLER-Based OLPC method is the consideration of other metrics (the so-called "soft metrics"), among which are: Bit Error Rate (BER), re-encoded Symbol Error Rate (SER), a metric of re-encoded power, number of decoding iterations, modified metric of Yamamoto and the Euclidean Distance (ED) (see Rege Kiran, "On Link Quality Estimation for 3G Wireless Communication Networks", in the Proceedings of the IEEE VTS Fall VTC2000. 52nd Vehicular Technology Conference). These metrics have the advantage over the block error rate (BLER) that they can be estimated with much greater speed.
> Since the purpose of the OLPC is that of meeting a target of constant block error rate ($BLER_{target}$) and for a moderate change in the block length due to the propagation conditions of the channel, a practically fixed ratio is established between the block error rate (BLER) and the aforementioned "soft metric' parameters, with which it is possible to find the target block error rate ($BLER_{target}$) based on an estimate of any one of said metrics. By way of example, mention can be made of some designs of methods based on these metrics which have been object of the following patents: U.S. Pat. No. 6,434,124 and U.S. Pat. No. 6,763,244.
>
> Nevertheless, the drawback of the outer loop power control based on Such metrics arises when a change in the propagation conditions of the channel substantially affects the block length. In this situation, the correlation between the block error rate (BLER) and the metrics considered as "soft metrics" are no longer fixed and therefore a constant block error rate ($BLER_{target}$) is not obtained (see Avidor, Dan,

> "Estimating the Block Error Rate at the Output of the Frame Selector in the UMTS System", in Proceedings of the Wireless Networks and Emerging Technologies (WNET 2002), Wireless and Optical Communications (WOC2002), July 2002, Banff, Alberta, Canada.).
>
> On the other hand, Jonas Blom, Fredrik Gunnarson and Fedrik Gustafsson in their patent application U.S. Pat. No. 6,449.462, establish a method to control the target desired signal to interference ratio (SIR_{target}) also based on measuring the block error rate (BLER), but together with the calculation of some determined representative parameters of the different conditions of the radio frequency channel and of the statistical distribution of the interfering signals. The method is based on the determination of a quality function defined as the errored frame probability conditioned by the aforementioned parameters. Although this strategy implies gains in capacity of the order of 30%, the process for obtaining said quality function imposes a delay which impairs the benefits of this type of model. Separately, in the article by the same authors in which the invention is described in more technical detail: "Estimation and Outer Loop Power Control in Cellular Radio Systems" presented at ACM Wireless Networks, it is stated that the system can be degraded due to fading in the radiofrequency channel.

Id. at 3:21-4:26.

83. I have reviewed documents and testimony confirming that attempts to solve this problem by others were deemed inferior to the TOT solution. For example, Bernd Adler, then Head of Wireless System Engineering at Intel Mobile Communications, reviewed the TOT patents and confirmed to colleagues that they were directed to "solve one of the key CDMA problem ... slow outer power control convergence." He discussed the solution and then referred to it as a "nice idea, I wish I have had it instead of [Intel's approach]." *See, e.g.*, Email from Bernd Adler re: Top optimized Technologies (3PS 1302 INTEL 000061). Mr. Adler also stated that the benefits claimed by TOT would be greater than those Intel had been able to reach with its approach. *Id.*; Bernd Adler Deposition (3/27/24) at 42:2-43:17.

84. The '376 specification notes that one of the co-inventors, Mr. Medrano, previously proposed an outer loop power control method that would use outage probability to improve the speed of the power control method, but this solution also had some limitations:

> The applicant of the present patent, Alvaro López Medrano in Spanish patent application ES 200202947 . . . proposes an outer loop of the power control system in 3G systems based on a quality criterion different to that of the target block error rate ($BLER_{target}$). This quality criterion on which the method described in ES 200202947 is based, is the outage probability (P_{outage}), with which the aforesaid inherent low speed of convergence of the BLER-based OPLC method is avoided. As is explained in ES 200202947, the outage probability (P_{outage}) constitutes another habitually applied quality parameter in cellular infrastructures, which is established previously, during the planning phase of the communications network, in terms of the class of service covered by the communication link, the characteristics of the cells and, inside each cell, the characteristics of the service area. Based on this outage probability (P_{outage}), it is proposed in the aforementioned patent application to determine the fading margin ($M_{(Sii)}$ (dB)) corresponding to the desired signal to interference ratio and, therefore, the target desired signal to interference ratio (SIR_{target}) for a quality of service criterion given by the outage probability (P_{outage}) and some characteristic statistical moments of the radiofrequency channel under consideration.
>
> . . .
>
> In brief, the outer loop power control method proposed by López Medrano in the previous patent application ES 200202947 is based on the quality criterion of outage probability (P_{outage}), but a final commitment of an outer loop must be to maintain constant a target block error rate ($BLER_{target}$) which corresponds to a determined service (see the specification documents of the Third Generation Standard 3GPP: TS 25.101, "UE radio transmission and reception (FDD), section 8.8.1 and the TS 25.104, "Base station (BS) radio transmission and reception (FDD), section 8). Consequently, it is not possible to maintain a constant outage probability (P_{outage}) for all propagation conditions, as the actual block error rate (BLER) does not remain constant. This is because there is no fixed ratio between the outage probability (P_{outage}) and the block error rate (BLER), but instead it depends on the propagation conditions in the radio link that are taking place at that moment.
>
> As the fading margin, which is the outcome of the outer loop power control method disclosed in ES 200202947, is a function of such an outage probability (P_{outage}) among other variables, the dynamic adaptation thereof implies changes in said margin. And in conclusion, the target desired signal to interference ratio (SIR_{target}) ought to be adjustable contemplating the changes in the fading margin, to adapt the outer loop power level to whatever propagation conditions, the power to be transmitted being minimum.

Id. at 4:27-5:29.

85. The specification explains that the '376 invention solves these problems by providing an improved outer loop power control method that maintains quality of service of the communications signal while also allowing for fast adaptation to changing channel conditions:

> The method and device of outer loop power control for mobile communications systems which are disclosed, specially conceived for third generation (3G) technologies based on any of the standardized protocols of Code Division Multiple Access (CDMA), guarantee on one hand a quality of service (QoS) criterion in terms of a pre-established block error rate (BLER) and, on the other, they are able to adapt quickly to changing conditions in the radiofrequency channel following a new quality criterion, in addition to the previous one (the BLER criterion), which is based on the outage probability.

Id. at 5:36-46.

86. The '376 specification provides the following description of one aspect of the improved method:

> Therefore one aspect of the invention is an outer loop power control method for wireless communications systems which, based on a received data signal, coming from a base station or mobile unit, comprises the following phases:
>
> i. establishing a target block error rate ($BLER_{target}$)
>
> ii. estimating the ratio of desired signal to interference (SIR_{rec}) and of some parameters which characterize the fading in the channel (706) suffered by the received signal,
>
> iii. estimating fading margins, by means of the Newton-Raphson method, based on the fading parameters in the channel and on outage probabilities,
>
> iv. determining the state of the data blocks, based on checking the Cyclic Redundancy Code (CRC),
>
> v. establishing a target desired signal to interference ratio (SIR_{target}) for the outer loop, based on said state of the data blocks, the target block error rate ($BLER_{target}$) and the estimated fading margins associated with the outage probabilities considered.
>
> The target desired signal to interference ratio (SIR_{target}) which the proposed method of power control establishes, herein termed "Outage-Based OLPC," is calculated as the sum of two components, which are termed $SIR_{outage\text{-}tgt}$ and $SIR_{BLER\text{-}tgt}$, through a dynamic adjusting function which carries out a mapping between the

> quality criterion based on the target block error rate ($BLER_{target}$) and another quality criterion, this one based on the outage probabilities.

Id. at 5:47-6:6. The specification also identifies other ways of implementing the improved method, such as for example estimating fading margins in other ways besides the Newton-Raphson method. *See, e.g., id*. at 10:6-10 ("The first component ($SIR_{outage\text{-}tgt}$) is a function of some fading margins (M_1, M_2, . . . , M_N), calculated previously by means of the Newton-Raphson method or another applicable and associated with some outage probabilities (p_{o1}, p_{o2}, . . . , p_{oN}) considered."); *id.* at 14:8-15 ("The computation (708) or the estimation of the fading margins (M_1, M_2, . . . , M_N) corresponding to the outage probabilities (p_{o1}, p_{o2}, . . . , p_{oN}) which are considered as the input parameters (702) thereof, as well as corresponding to the fading parameters in the channel (706) given by the estimator (701) of the received desired signal to interference ratio (SIR_{rec}), can be made based on the method proposed in the aforementioned patent application ES 200202947."). *See also* TOT00190774-91 (functional specification for TOT OLPC); TOT00190643-48 ("Optimal SIR target determination for Outer-Loop Control in the W-CDMA System"); TOT00105794-811 ("'Outage-Based' Outer Loop Power Control (OLPC)").

87. The '376 specification describes the benefits of the improved method as including increasing the capacity of the cellular network:

> Thus, the required quality of service (QoS) is satisfied, with the minimum power level necessary, the power adapting quickly and dynamically to the propagation conditions of the data signal, for which reason, since it is an interference limited technology, it signifies the capacity of the system is also optimised.

Id. at 6:7-12.

88. The '376 specification also teaches as one embodiment of the invention implementing the improved method in a neural network:

> The dynamic adjustment function with which the target desired signal to interference ratio (SIR_{target}) is established as the sum of the two components mentioned: $SIR_{tgt} = SIR_{outage\text{-}tgt} + SIR_{BLER\text{-}tgt}$, consists preferentially of a neural network.
>
> Within the ambit of this description, a neural network is understood to be a tool to implement a parameterizable generic function, to which weighting and offsets are applied which represent the parameters ofthe function, which can be adjusted, which is known as training a neural network, to obtain a certain desired behaviour.

Id. at 6:13-23. *See also id.* at 6:24-7:56.

89. One exemplary neural network is depicted in Figure 5 of the '376 Patent, shown below:

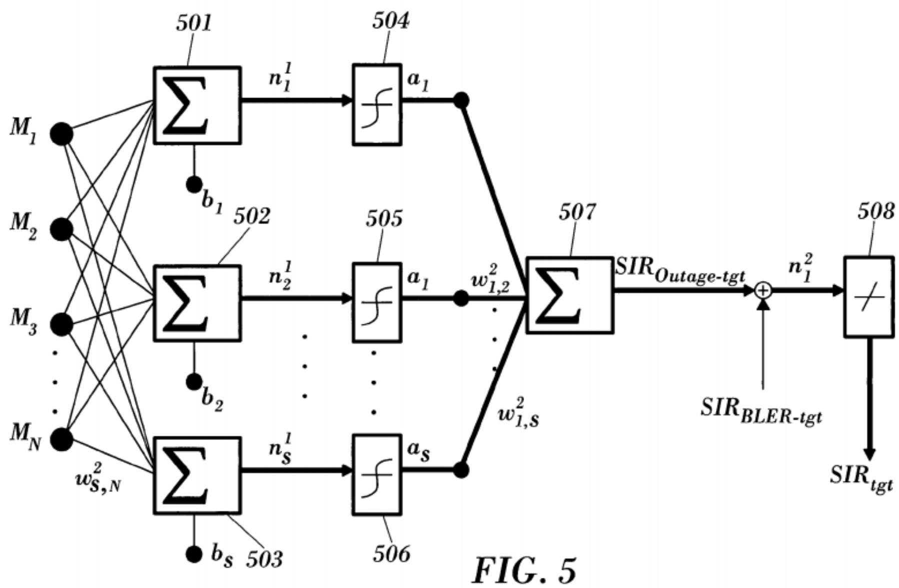


FIG. 5
500

Id., Fig. 5. *See also id.* at 8:62-65, 11:47-12:36.

90. In one preferred embodiment of the invention, the '376 specification describes the steps of the improved method as follows:

> The method of the invention, which is termed herein "Outage-Based OLPC" insofar as it constitutes an outer loop power control (OLPC) which guarantees a quality criterion in terms of a target block error rate ($BLER_{target}$) and is also able to adapt the power quickly to the conditions of the radiofrequency channel, considering another quality criterion based on the outage probability, is developed according to some steps which take place in the controller (201) and which are detailed below.

> The present invention proposes that the target desired signal to interference ratio (SIR_{target}) which is provided for the outer loop is given as the sum of two components: a first component ($SIR_{outage\text{-}tgt}$) and a second component ($SIR_{BLER\text{-}tgt}$), such that:
>
> $$SIR_{tgt} = SIR_{outage\text{-}tgt} + SIR_{BLER\text{-}tgt}$$
>
> The first component ($SIR_{outage\text{-}tgt}$) is a function of some fading margins ($M_1, M_2, \ldots, M_N$), calculated previously by means of the Newton-Raphson method or another applicable and associated with some outage probabilities (p_{o1}, $p_{o2}, \ldots, p_{oN}$) considered. Therefore, this component ($SIR_{outage\text{-}tgt}$) has a fast variational behaviour with permits it to adapt to changing propagation conditions, although said behaviour is not always ideal, that is, not all channel variations are taken into account by the aforementioned ($SIR_{outage\text{-}tgt}$) and in itself it does not guarantee the pre-established criterion of target block error rate ($BLER_{target}$), if it were not because it is supplemented with the other component ($SIR_{BLER\text{-}tgt}$).
>
> The second component ($SIR_{BLER\text{-}tgt}$) covers the non-ideal behaviours of the channel, assuring that the target block error rate ($BLER_{target}$) is indeed maintained for the service. This component ($SIR_{BLER\text{-}tgt}$) would remain constant in an ideal environment, but in practice, it will present small variations, it not being imperative that it respond instantaneously to changes in the channel. For this reason, it is necessary to maintain in this component ($SIR_{BLER\text{-}tgt}$) the characteristic step procedure of the known "BLER-based OLPC method (see again Sampath A. Kumar P S & Holtzman J M (1997), "On setting reverse link target SIR in a CDMA system". Proc. IEEE Vehicular Technology Conference, Phoenix, Ariz., pp 929-933.), which actually has the characteristics of a slow response but which is capable of assuring the specified target block error rate (BLERtarget) exactly.
>
> Returning now to the first component ($SIR_{outage\text{-}tgt}$), which is determined, as has already been commented, by a function of the fading margins ($M_1, M_2, \ldots, M_N$) associated with the different outage probabilities (p_{o1}, $p_{o2}, \ldots, p_{oN}$) considered, the fact that not only one outage probability and therefore only one associated fading margin are considered, is because it is not possible to maintain the outage probability constant for all propagation conditions, nor would the block error rate (BLER) be constant and, in consequence, the target of the outer loop would not be maintained. The previous discrepancy between outage probability and block error rate (BLER) is because there is no constant ratio between the two criteria, but rather it depends precisely on the radio conditions present at the time.

Id. at 9:56-10:44.

91. The specification then goes on to describe "several forms . . . for finding the function which based on the fading margins ($M_1, M_2, \ldots, M_N$) gives the first component ($SIR_{outage\text{-}}$

$_{tgt}$) as a result, so that the 'Outage-Based OLPC' method satisfies the quality criterion imposed by the target block error rate ($BLER_{target}$), complying with a minimum power consumption in the transmission." *Id.* at 10:45-50. One example involves a single fading margin as follows:

> One of the simplest alternative embodiments that can be proposed is a linear combination of the fading margins ($M_1, M_2, \ldots, M_N$), whereby the first component ($SIR_{outage\text{-}tgt}$) is a summation of said fading margins ($M_1, M_2, \ldots, M_N$) weighted or multiplied by some appropriate fading margin constants ($K_1, K_2, \ldots, K_N$), resulting in the target desired signal to interference ratio (SIR_{target}):
>
> $$SIR_{tgt}=SIR_{BLER\text{-}tgt}+k_1 \cdot M_1 + k_2 \cdot M_2 + \ldots + k_N \cdot M_N$$
>
> A particular case is the method which is described in the patent application ES200202947 mentioned as a precedent; indeed, if in the previous equation all the constants are cancelled except one and a single fading margin is taken:
>
> $K_1=1$
> $K_i=0 \forall i \neq 1$
> the result is:
>
> $$SIR_{target}=SIR_{outage}+k_1 \cdot M_1$$

Id. at 10:51–67.

92. Figure 7 in the '376 Patent "shows a block diagram with the input and output parameters of the outer loop power control method for mobile communications systems object of the invention, to which the name 'Outage-Based OLPC has been given.'" *Id.* at 9:1-4. Figure 7 is reproduced below:

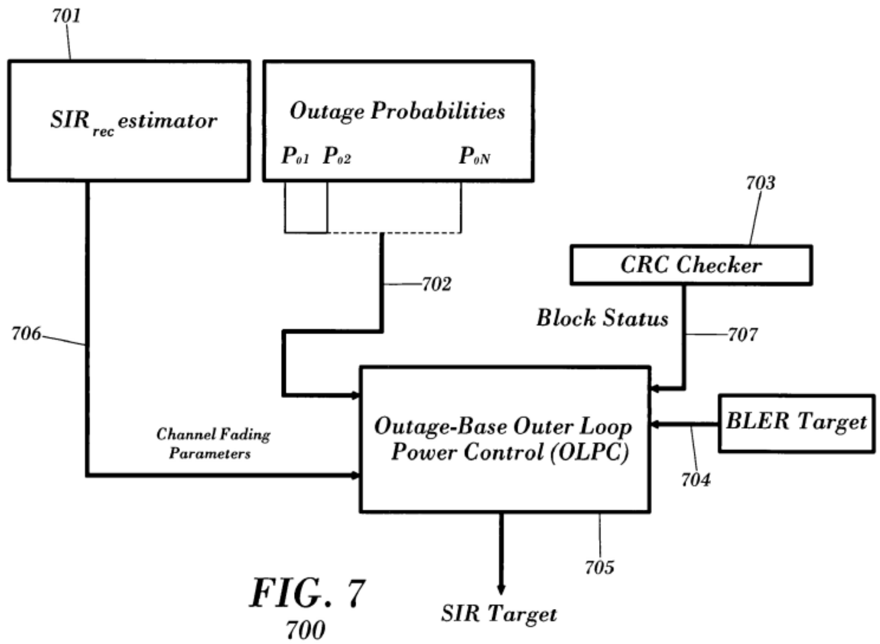


FIG. 7
700

93. The '376 specification provides the following description of the various components the Figure 7 block diagram:

> Firstly, an estimation (701) is made of the received desired signal to interference ratio (SIR_{rec}) by means of the corresponding hardware architecture . . . . Within this estimate (701), some fading parameters are included in the channel (706) which are considered opportune for characterizing the received signal (107, 108). For example, in the aforementioned patent application ES 200202947, the fading parameters in the channel (706) considered are: the standard deviation corresponding to the log-normal fading (σ_N) and the Rice factor (K) of the desired signal, as well as the standard deviation (σ_I) corresponding to the distribution which describes the variations of the interfering signals.
>
> The fading margins (M_1, M_2 , . . . , M_N) associated with the previous fading parameters in the channel (706) are also a function of the corresponding outage probabilities (p_{o1}, p_{o2}, . . . , p_{oN}) which are considered and, therefore, these outage probabilities (p_{o1}, p_{o2}, . . . , p_{oN}) constitute another of the inputs (702) necessary for the Outage-Based Outer Loop Power Control (OLPC) method object of the invention.
>
> Continuing with the blocks of FIG. 7, the decoded data of each frame involved in the communication pass to a checker of the CRC (703), which determines or indicates if the frame has been decoded correctly or, on the contrary, it contains errors, by checking the bits of the Cyclic Redundancy Code (CRC) added at the end of the data frame. For each frame received and decoded, the checker of the CRC (703) provides a status of the data blocks (707) which consists of a frame indicating

> whether the data frame is adequately decoded or, because it is not so, it has been erased. Notice that this is the known operating principle of the earlier BLER-based Outer Loop Power Control (OLPC) method, in which the target desired signal to interference ratio (SIR_{target})) is varied for the outer loop in correspondence with the result which said checker of the CRC (703) provides.
>
> The method object of this invention, herein named as "Outage-Based Outer Loop Power Control (OLPC)" takes place in the block (705) and which processes all the aforementioned inputs (702. 706,707), including the introduction (704) of the target block error rate ($BLER_{target}$), in the manner explained in the following paragraphs.

Id. at 13:27-14:3.

94. Figure 8 in the '376 Patent "shows a block diagram of the outer loop power control method for mobile communications systems object of the invention, illustrating the breaking down of the target desired signal to interference ratio (SIR_{target}) into the two components ($SIR_{outage\text{-}tgt}$, $SIR_{BLER\text{-}tgt}$) which are added, together with the appropriate input parameters." *Id.* at 9:5-10. Figure 8 is reproduced below:

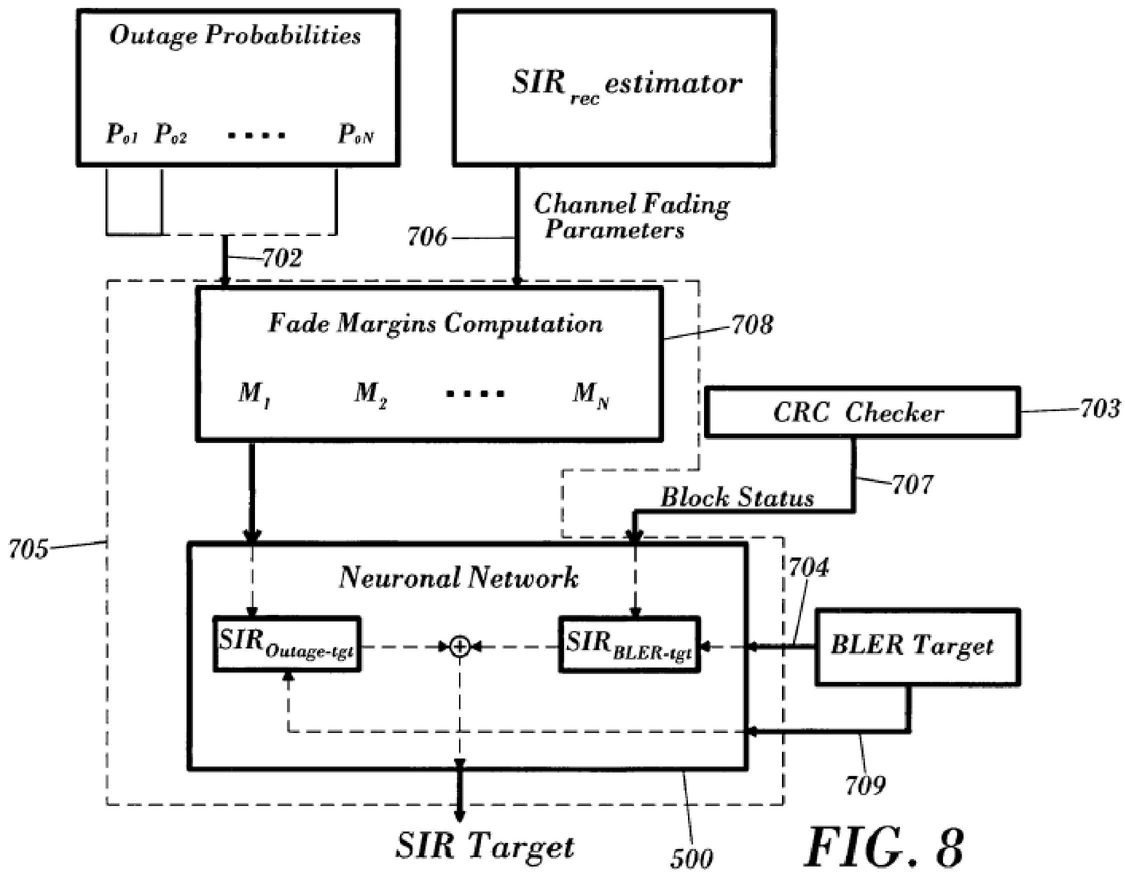


FIG. 8

95. The '376 specification also describes that "In FIG. 8 the steps are specified in more detail which take place in the block (705) of FIG. 7, that is, a preferred embodiment is shown of the operation of the Outage-Based Outer Loop Power Control (OLPC) method of the invention." *Id.* at 14:4-7. The specification then goes on to describe the various computations represented in Figure 8 as follows:

> The computation (708) or the estimation of the fading margins (M_1, M_2, . . . , M_N) corresponding to the outage probabilities (p_{o1}, p_{o2}, . . . , p_{oN}) which are considered as the input parameters (702) thereof, as well as corresponding to the fading parameters in the channel (706) given by the estimator (701) of the received desired signal to interference ratio (SIR_{rec}), can be made based on the method proposed in the aforementioned patent application ES 200202947. The aforementioned fading margins (M_1, M_2, . . . , M_N) constitute one of the inputs (710) of the neural network (500) and are used, together with the target block error rate ($BLER_{target}$), introduced by the input (709), to obtain the first component ($SOR_{outage\text{-}tgt}$) [sic] of the target desired signal to interference ratio (SIR_{target}). Moreover, with the reintroduction (704) of the target block error rate ($BLER_{target}$) and of the state of the data blocks

> (707) produced by the checker of CRC (703), the second component ($SIR_{BLER\text{-}tgt}$) is obtained. Finally, both components are added and the desired target desired signal to interference ratio (SIR_{target}) is obtained for the outer loop power control.

Id. at 14:8-27.

V. TECHNOLOGY OF THE ACCUSED PRODUCTS

96. The accused products in this case are various models of Apple's iPhone, iPad, and Watch products that include 3G cellular communications functionality. Some of these accused products include a modem (which I also refer to as a baseband processor in this report) sold by Qualcomm that provides some of the accused functionality, while others include a modem sold by Intel. For ease of reference, in this report I refer to the accused Apple products that include a Qualcomm modem as the "Apple/Qualcomm Accused Products," and the accused Apple products that include an Intel modem as the "Apple/Intel Accused Products."

97. Attached as Exhibit C to this report is a listing of all of the Apple/Qualcomm Accused Products by model name, model number, and internal product code. The exhibit also includes, for each accused product, an identification of the Qualcomm modem that is included in the product as well as the baseband project name associated with the product.

98. Attached as Exhibit D to this report is a listing of all of the Apple/Intel Accused Products by model name, model number, and internal product code. The exhibit also includes, for each accused product, an identification of the Intel modem that is included in the product as well as the baseband project name associated with the product.

99. The information in Exhibits C and D is based on information provided by Apple regarding the accused products, including for example the following responses to TOT's interrogatories: Apple's First Supplemental Responses to Plaintiff's First Set of Interrogatories (No. 1), at Exhibit A, dated June 2, 2023; Apple's Second Supplemental Response to Plaintiff's First Set of Interrogatories (No. 1), at Exhibit B, dated March 7, 2024; and Apple's Third

Supplemental Responses and Objections to Plaintiff's Second Set of Interrogatories (No. 18), dated April 2, 2024.

VI. INFRINGEMENT OF THE ASSERTED CLAIMS

A. The Apple/Qualcomm Accused Products Infringe the '865 Patent

100. I understand that TOT asserts claims 1, 2, 5, 6, 7, 8, 10, and 12 of the '865 Patent against the Apple/Qualcomm Accused Products. Claims 1 and 2 are method claims directed to an "outer loop power control method," while claims 5, 6, 7, 8, 10, and 12 are product claims directed to an "outer loop power control device" or a "mobile station." It is my opinion that the Apple/Qualcomm Accused Products perform each element of method claims 1 and 2 when powered on and in normal use, and the Apple/Qualcomm Accused Products satisfy all of the elements of product claims 5, 6, 7, 8, 10, and 12.

101. I understand that Apple and Qualcomm produced software and firmware source code for the Apple/Qualcomm Accused Products, including source code printouts APPLE_QUALCOMM_000001 – 307 (produced by Apple) and Q2TOTVAPPLE1302SC0000001 – 493 (produced by Qualcomm). These printouts are of portions of electronic source code files that were made available for inspection on review computers set up by Apple and Qualcomm. I was assisted by Dr. Atif Hashmi in the review of the source code on these computers and the collection of printouts from them.

102. My analysis included the review of source code for multiple builds of the software/firmware that is included with the Qualcomm modem in the Apple/Qualcomm Accused Products. Specifically, I reviewed source code produced by Apple for the baseband project name Mav17 at the path /Baseband_FW/Baseband-Mav17-3.31.00/, which I understand from Apple's interrogatory responses is used in the Qualcomm modem based iPhone 8 (A1863), iPhone 8 plus (A1864), and iPhone X (A1865) products. *See* Exhibit C. I also reviewed source code produced

by Qualcomm at the following paths: SW\MPSS.DI.2.1.4.R12-00002-M9625TAAAANAZM-1, SW\MPSS.HI.2.0.c3.1.3-00004-SDX55_MNRMTEFS_PACK-1.436915.12, SW\MPSS.HI.4.3.3.c2-00027-CHITWAN_MNRMTEFS_PACK-1.447841.34.457748.8, and SW\MPSS.HI.4.3.6.c1-00329-CHITWAN-MNRMTEFS_PACK-1.618325.2. I understand that, based on information provided by Qualcomm and Apple, the code at these paths corresponds to the following baseband project names and products:

Software Production Path	Build ID	Baseband Project Name	Products
SW\MPSS.DI.2.1.4.R12-00002-M9625TAAAANAZM-1	M9625AAATWNMZD 27508501	Mav10	iPhone SE iPad 5th Gen. Cellular Ver
SW\MPSS.HI.2.0.c3.1.3-00004-SDX55_MNRMTEFS_PACK-1.436915.12	SDX55.MN.1.0-00073-FBOOT.REFS.PROD-1.325180.1	Mav20	iPhone 12 mini iPhone 12 iPhone 12 Pro iPhone 12 Pro Max
SW\MPSS.HI.4.3.3.c2-00027-CHITWAN_MNRMTEFS_PACK-1.447841.34.457748.8	Chitwan.MN.1.0-00043-FBOOT.REFS.PROD-1.424309.2.425911.4	Mav21	iPhone 13 mini iPhone 13 iPhone 13 Pro iPhone 13 Pro Max iPad mini 6th Gen.
SW\MPSS.HI.4.3.6.c1-00329-CHITWAN-MNRMTEFS_PACK-1.618325.2	Olympic.MN.1.0.r1-00044-FBOOT.REFS.PROD-1.513587.17	Mav22	iPhone 14 iPhone 14 Plus iPhone 14 Pro iPhone 14 Pro Max

See Apple's Second Supplemental Response to Plaintiff's First Set of Interrogatories (No. 1), dated March 7, 2024, at Exhibit B, pages 1-3, 5, 13-14, 18-19; Jeff Schultz (Qualcomm) Declaration, dated June 28, 2024, at Exhibit A. I also understand that the four versions of code from Qualcomm that I reviewed are exemplary of the four major software builds ("M9625," "SDX55," "Chitwan," and "Olympic") that Qualcomm made available for inspection. *See* Jeff Schultz (Qualcomm) Declaration, dated June 28, 2024, at Exhibit A.

103. From my review, the relevant portions of the code for each of these builds related to OLPC are substantially identical across all versions. Given that the source code with respect to OLPC has not materially changed over time for these various versions of the code for Mav10, Mav 17, Mav20, Mav21, and Mav22, it is reasonable to conclude that the OLPC code is the same for purposes of infringement for all of the Apple/Qualcomm Accused Products. I provide a specific infringement analysis of Mav17, specifically the code from the path /Baseband_FW/Baseband-Mav17-3.31.00/, below, which as I discussed above is used in the Qualcomm modem based iPhone 8 (A1863), iPhone 8 plus (A1864), and iPhone X (A1865) products. While I cite to this version in my analysis, I have reviewed the other source code files for this functionality produced by Apple and Qualcomm, have determined that it operates in the same way for all relevant purposes, and thus it should be understood that my analysis below holds true for all of the Apple/Qualcomm Accused Products using any of the other source code versions.

104. In addition, I understand that the source code is included with the Qualcomm modems in the Apple/Qualcomm Accused Products, regardless of the type of network in which the product is used. *See* Apple's Second Supplemental Response to Plaintiff's First Set of Interrogatories (No. 1), dated March 7, 2024, at 7-8, Exhibit B. Thus, even if the Apple/Qualcomm Accused Products are used in a non-WCDMA network, the products still include the software/firmware functionality that is capable of infringing the patent claims as I discuss below.

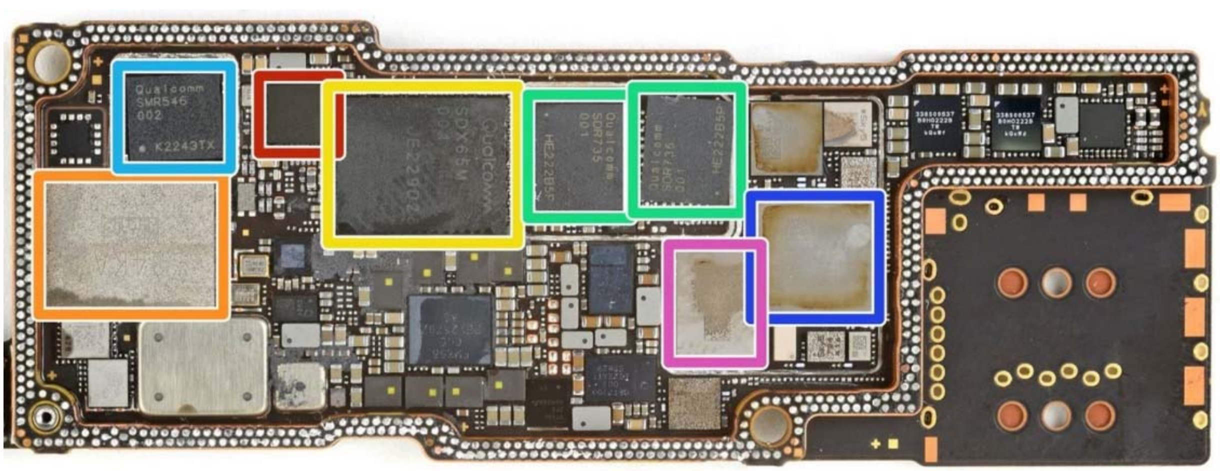
1. '865 Patent Claim 1

105. The Apple/Qualcomm Accused Products infringe each element of claim 1 of the '865 Patent as will be explained below.

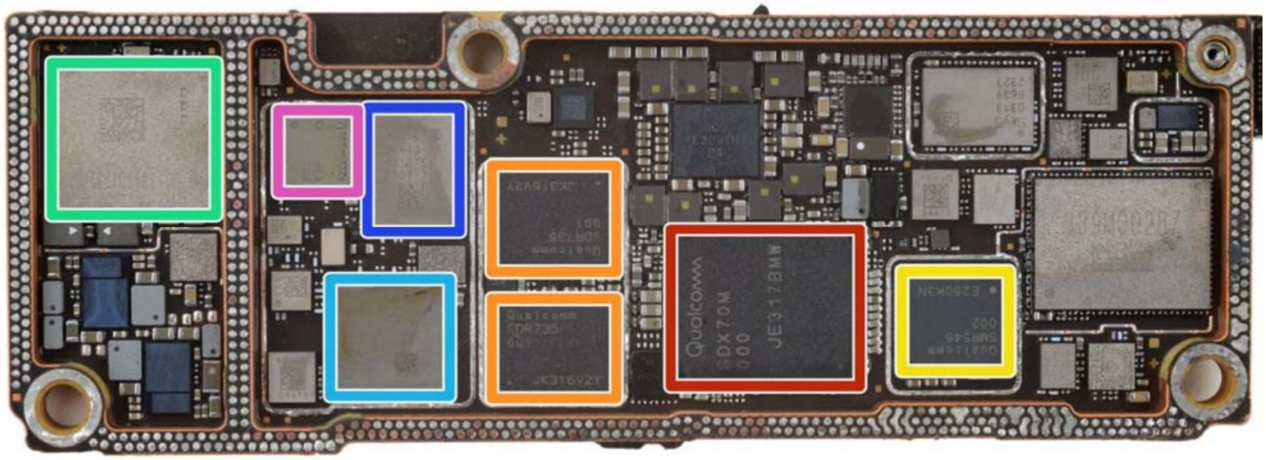
a) [1.pre] *Outer loop power control method for wireless communications systems, based on CDMA technology, the method comprising:*

106. The preamble of claim 1 recites: "Outer loop power control method for wireless communications systems, based on CDMA technology, the method comprising." I understand that the parties disagree as to whether the preamble of claim 1 is limiting. Whether or not the preamble is limiting, in my opinion the Apple/Qualcomm Accused Products satisfy the claim 1 preamble.

107. As listed in Exhibit C, each of the Apple/Qualcomm Accused Products includes a Qualcomm modem. Other evidence confirms which Qualcomm modems are included in which of the Apple/Qualcomm Accused Products. For example, an iFixit Teardown report, available at https://www.ifixit.com/Guide/iPhone+14+Pro+Max+Chip+ID/153224, shows that Qualcomm's SDX65M modem component can be found in the iPhone 14 Pro Max:



108. As another example, another iFixit Teardown report, available at https://www.ifixit.com/Guide/iPhone+15+Pro+Max+Chip+ID/165320, shows that Qualcomm's SDX70M modem component can be found in the iPhone 15 Pro Max.



109. Based on my analysis of the evidence, including source code for the software/firmware that is included with the Qualcomm modems that are in the Apple/Qualcomm Accused Products, the Apple/Qualcomm Accused Products practice an outer loop power control method for wireless communications systems, based on CDMA technology. *See, e.g.*, APPLE_QUALCOMM_000001-62, APPLE_QUALCOMM_000063-74, APPLE_QUALCOMM_0000075-99, APPLE_QUALCOMM_000100-116. I provide further details below regarding how the outer loop power control method is implemented in the source code for the Qualcomm modems in the Apple/Qualcomm Accused Products.

110. Moreover, the Apple/Qualcomm Accused Products comply with the 3G standards, and when operating on 3G operate on wireless communications systems based on CDMA technology:

- **Model A1863***
  FDD-LTE (Bands 1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 18, 19, 20, 25, 26, 28, 29, 30, 66)
  TD-LTE (Bands 34, 38, 39, 40, 41)
  TD-SCDMA 1900 (F), 2000 (A)
  CDMA EV-DO Rev. A (800, 1900, 2100 MHz)
  UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)
  GSM/EDGE (850, 900, 1800, 1900 MHz)

APL-TOTDDE_00693077. *See also* APL-TOTDDE_00690652 (iPhone 13 Pro Max Technical Specifications: "CDMA EV-DO Rev. A (800, 1900 MHz) … UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)"); APL-TOTDDE_00693112 (iPad (6th generation) - Technical Specifications).

> **WCDMA (Wideband Code Division Multiple Access)**
>
> UMTS standard for 3G digital mobile networks, using CDMA technology. It is the evolution path for GSM and EDGE to UMTS and offers increased voice capacity and theoretical peak data speeds of up to 2 Mbps. The 3GPP task group continues to work on the evolution of WCDMA toward 4G and has defined a series of evolutionary steps:

https://www.gartner.com/en/information-technology/glossary/wcdma-wideband-code-division-multiple-access#:~:text=Division%20Multiple%20Access)-,WCDMA%20(Wideband%20Code%20Division%20Multiple%20Access),of%20up%20to%202%20Mbps.

111. The 3G standards, with which the Apple/Qualcomm Accused Products are advertised to comply, provide for methods of outer loop power control. For example, the UMTS (also referred to as WCDMA) requirements for outer loop power control are described in the following 3G technical specifications:

14.9s Downlink power control

14.9.1 Generalities

This function is implemented in the UE in order to set the SIR target value on each CCTrCH used for the downlink power control. This SIR value shall be adjusted according to an autonomous function in the UE in order to achieve the same measured quality as the quality target set by UTRAN. The quality target is set as the transport channel BLER value for each transport channel as signalled by UTRAN.

When transport channel BLER is used the UE shall run a quality target control loop such that the quality requirement is met for each transport channel, which has been assigned a BLER target.

The UE shall set the SIR target when the physical channel has been set up or reconfigured. It shall not increase the SIR target value before the power control has converged on the current value. The UE may estimate whether the power control has converged on the current value, by comparing the averaged measured SIR to the SIR target value.

ETSI TS 125 331 V10.20.0 (2016-08) § 14.9.1 (TOT00000415-2340 at TOT00002240).

7.2.4.8 RF power control

This group of functions controls the level of the transmitted power in order to minimise interference and keep the quality of the connections. It consist of the following functions: UL Outer Loop Power Control, DL Outer Loop Power Control, UL Inner Loop Power Control, DL Inner Loop Power Control, UL Open Loop Power Control and DL Open Loop Power Control.

ETSI TS 125 401 V4.2.0 (2001-09) § 7.2.4.8 (TOT00000375-414 at TOT00000398).

Responding to a downlink TPC command, the UE shall change its uplink DPCH output power at the beginning of the first uplink pilot field after the TPC command reception. Responding to an uplink TPC command, the UTRAN access point shall change its DPCH output power at the beginning of the next downlink pilot field after the reception of the whole TPC command. Note that in soft handover, the TPC command is sent over one slot when DPC_MODE is 0 and over three slots when DPC_MODE is 1. Note also that the delay from the uplink TPC command reception to the power change timing is not specified for UTRAN. The UE shall decide and send TPC commands on the uplink based on the downlink SIR measurement. For the DPCH, the TPC command field on the uplink starts, when measured at the UE antenna, 512 chips after the end of the downlink pilot field. The UTRAN access point shall decide and send TPC commands based on the uplink SIR measurement. However, the SIR measurement periods are not specified either for UE nor UTRAN.

ETSI TS 125 214 V12.1.0 (2015-01) Annex B § B.1.

B.2 Example of implementation in the UE

The downlink inner-loop power control adjusts the network transmit power in order to keep the received downlink SIR at a given SIR target, SIR_{target}. A higher layer outer loop adjusts SIR_{target} independently for each connection.

The UE should estimate the received downlink DPCCH/DPDCH power of the connection to be power controlled. Simultaneously, the UE should estimate the received interference and calculate the signal-to-interference ratio, SIR_{est}. SIR_{est} can be calculated as RSCP/ISCP, where RSCP refers to the received signal code power on one code and ISCP refers to the non-orthogonal interference signal code power of the received signal on one code. Note that due to the specific SIR target offsets described in [5] that can be applied during compressed frames, the spreading factor shall not be considered in the calculation of SIR_{est}.

The obtained SIR estimate SIR_{est} is then used by the UE to generate TPC commands according to the following rule: if $SIR_{est} > SIR_{target}$ then the TPC command to transmit is "0", requesting a transmit power decrease, while if $SIR_{est} < SIR_{target}$ then the TPC command to transmit is "1", requesting a transmit power increase.

When the UE is in soft handover, the UE should estimate SIR_{est} from the downlink signals of all cells in the active set.

ETSI TS 125 214 V12.1.0 (2015-01) Annex B § B.2.

112. Other technical documentation produced in this case, including source code, device specifications, repair guides, processor specifications, and algorithm documentation, likewise support my opinion that the Apple/Qualcomm Accused Products meet the preamble of this claim. *See* Affidavit of Qualcomm Technologies, Inc., in Spanish proceeding No. 240-18-Ml, July 18, 2018, QCTOTVAPPLE01302_0008063 at 1-2 ("Below follows the details of the operation of the OLPC in Qualcomm's chipsets"), APL-TOTDDE_00721273 at 21 ("UMTS/HSPA+"), QCTOTVAPPLE01302_0002515 at 17, 292 ("WCDMA"), QCTOTVAPPLE01302_0005897 at 17, QCTOTVAPPLE01302_0004933.

113. Qualcomm's VP of Technology, Rajiv Nambiar, also confirmed in his deposition that all of Qualcomm's 3G chipsets practice an outer loop power control algorithm. *See* 5/17/24 Rajiv Nambiar Deposition (5/17/24) at 21:11-22:19. *See also* Luis Maestro (Nokia) Deposition (3/15/24) at 24:11-25:1 ("Q. Is OLPC part of the 3G standard? A. I believe some parts of the solution are standardized, but then it is up to the vendor and network equipment manufacturers to develop their own algorithms, and that is proprietary.").

114. I understand that defendants may rely on the claim construction argument that the preamble is limiting, to further argue that Accused Products do not infringe, because some of the code that TOT has identified as infringing is alleged to be part of the "inner loop" rather than the "outer loop." In the first instance, even if the preamble is limited to "outer loop," it is my opinion that the Accused Products literally infringe this claim. The functionality described herein that implements the claim elements is outer loop functionality. The software and firmware code described herein implements functions that both meet the claim elements, and are directed to the functioning of the CDMA power control "outer loop." For example, the code that sets the desired SIRtarget, and is present in the file dlolpc.c, does so in order to implement the requirements of the 3GPP standard relating to the use of a SIRtarget by the outer loop to maintain a quality objective.

115. In the alternative, if the Court determines that the preamble is limiting, it is my opinion that the Accused Products infringe under the doctrine of equivalents because, even if relevant portions of the infringing code were deemed exclusively part of the inner loop—which they are not—the differences are a matter of semantics and are insubstantial. Inner and outer loop are both part of a broader power control algorithm and are inextricable in CDMA. Thus, whether particular functions fall within one area of code or another they nonetheless are part of a cohesive system. Moreover, as will be described below, the infringing code performs the same function as an outer loop algorithm would, as its purpose is the same, for example to set a target SIR to pass to the inner loop for the transmission of TPC commands. *See* elements [1.b], [1.d] infra. As will be described in more detail below, the infringing code performs that functionality in the same way as an outer loop algorithm would, for example it determines the target SIR based on connection quality objectives, whether through directly setting target SIR or by setting a target SIR along with a flag indicating that it be adjusted by a set amount. *See* elements [1.b]-[1.e], infra. Finally, the

infringing code reaches the same result as an outer loop power control algorithm would, for example, the set SIRtarget is used by the power control algorithm to determine whether to send TPC Up or Down commands. *See* element [1.b]-[1.e], infra. Thus, in my opinion if the Court were to find that the preamble of claim 1 is limiting and it is found that the code identified as infringing below is part of the inner loop, the Accused Products nonetheless infringe under the doctrine of equivalents.

b) [1.a] *estimating a desired signal to interference ratio received (SIR_{rec}) based on a data signal (107, 108) received from a base station (102, 103) or mobile station (104)*

116. Element **[1.a]** in claim 1 recites "estimating a desired signal to interference ratio received (SIR_{rec}) based on a data signal (107, 108) received from a base station (102, 103) or mobile station (104)." In my opinion, the Apple/Qualcomm Accused Products perform this element.

117. The Apple/Qualcomm Accused Products comply with the 3G standard, which explains that the SIR_{rec} ratio is a computed value based on, in part, the received signal code power. For example, the UMTS specification states that user equipment "should estimate the received downlink DPCCH/DPDCH power of the connection to be power controlled" and the "SIR_{est} can be calculated as RSCP/ISCP, where RSCP refers to the received signal code power on one code and ISCP refers to the non-orthogonal interference signal code power of the received signal on one code." ETSI TS 125 214 V12.1.0 (2015-01) Annex B § B.2. The standard further explains that the base station sends a TPC (transmit power control) signal to the device, which is a data signal, that the device uses to estimate a desired SIR for setting its output power:

> Responding to a downlink TPC command, the UE shall change its uplink DPCH output power at the beginning of the first uplink pilot field after the TPC command reception. Responding to an uplink TPC command, the UTRAN access point shall change its DPCH output power at the beginning of the next downlink pilot field after the reception of the whole TPC command. Note that in soft handover, the TPC command is sent over one slot when DPC_MODE is 0 and over three slots when DPC_MODE is 1. Note also that the delay from the uplink TPC command reception to the power change timing is not specified for UTRAN. The UE shall decide and send TPC commands on the uplink based on the downlink SIR measurement. For the DPCH, the TPC command field on the uplink starts, when measured at the UE antenna, 512 chips after the end of the downlink pilot field. The UTRAN access point shall decide and send TPC commands based on the uplink SIR measurement. However, the SIR measurement periods are not specified either for UE nor UTRAN.

ETSI TS 125 214 V12.1.0 (2015-01) Annex B § B.1 ; *See also* ETSI TS 125 214 V12.1.0 (2015-01) Annex B § B.2:

118. Other 3G standard documents likewise state that devices implementing the 3G/WCDMA standards use data signals to estimate a SIR_{rec}:

9 Measurements provided by the physical layer

One of the key services provided by the physical layer is the measurement of various quantities, which are used to trigger or perform a multitude of functions. Both the UE and the UTRAN are required to perform a variety of measurements. The standard will not specify the method to perform these measurements or stipulate that the list of measurements provided in this clause must all be performed. While some of the measurements are critical to the functioning of the network and are mandatory for delivering the basic functionality (e.g., handover measurements, power control measurements), others may be used by the network operators in optimising the network (e.g., radio environment).

ETSI TS 125 302 V15.0.0 (2018-07) § 9.

9.2 UE Measurements

For definitions of the measurements, see [6] and [11].

9.2.12 Transport channel BLER

This measure is mandatory for UE.

Measurement	Transport channel BLER (BLock Error Rate)
Source	L1(UE)
Destination	RRC (RNC,UE)
Reporting Trigger	Periodic, on demand
Description	Estimation of the transport channel block error rate (BLER).

ETSI TS 125 302 V15.0.0 (2018-07) § 9.2.12.

5.2.2 SIR

Definition	Type 1: Signal to Interference Ratio, is defined as: (RSCP/ISCP)×SF. The measurement shall be performed on the DPCCH of a Radio Link Set. In compressed mode the SIR shall not be measured in the transmission gap. The reference point for the SIR measurements shall be the Rx antenna connector. If the radio link set contains more than one radio link, the reported value shall be the linear summation of the SIR from each radio link of the radio link set. If Rx diversity is used in the Node B for a cell, the SIR for a radio link shall be the linear summation of the SIR from each Rx antenna for that radio link. When cell portions are defined in the cell, the SIR measurement shall be possible in each cell portion. where: RSCP = Received Signal Code Power, unbiased measurement of the received power on one code. ISCP = Interference Signal Code Power, the interference on the received signal. SF=The spreading factor used on the DPCCH. Type 2: Signal to Interference Ratio, is defined as: (RSCP/ISCP)×SF. The measurement shall be performed on the PRACH control part. The reference point for the SIR measurements shall be the Rx antenna connector. When cell portions are defined in the cell, the SIR measurement shall be possible in each cell portion. where: RSCP = Received Signal Code Power, unbiased measurement of the received power on the code. ISCP = Interference Signal Code Power, the interference on the received signal. SF=The spreading factor used on the control part of the PRACH.

ETSI TS 125 215 V11.0.0 (2012-11) § 5.2.2.

119. A document describing Qualcomm's OLPC algorithm also confirms that the algorithm measures SIR from a data signal: "In general, the OLPC algorithm attempts to set an overall SIR target (Es/Nt) in a manner that the network-set BLER targets for all downlink transport channels are satisfied. If the UE **measures an SIR** lower than this target in a slot, the UE sends an UP (1) TPC command on the Uplink. Similarly, if the measured SIR is larger, the UE sends a DOWN (0)command." QCTOTVAPPLE01302_0008067 at 2 (emphasis added); *see also* Fig. 1.

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120. This is borne out by my analysis of the produced source code. The source code file /modem_proc/…/fw/…/src/wfw_tx_modulator.c is relevant to the Apple/Qualcomm Accused Products' OLPC algorithm and its measurement of SIRrec. APPLE_QUALCOMM_000075-99.[1]

121. wfw_tx_modulator.c contains the function wfw_tx_fpc_decision_proc which is used to compare actual measured signal and noise values (i.e. estimating a desired SIR based on the data signal) from the received data signal, and use those values to make a decision on whether to send a TPC up/down bits. APPLE_QUALCOMM_000087-89.[2] Function wfw_tx_prog_calc_tpc_bit_proc is used to calculate TPC bits for transmission based on calculated signal and noise values (i.e. SIRrec derived from the data signal), and can call wfw_tx_fpc_decision_proc. APPLE_QUALCOMM_000090-99.[3]

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122. Therefore, it is my opinion that the Apple/Qualcomm Accused Products perform claim element **[1.a]**.

c) **[1.b]** ***setting a desired signal to interference ratio target (SIR_{target}) that is close to a signal to interference ratio required (SIR_{rec}) during the normal mode of the outer loop***

123. Element **[1.b]** in claim 1 recites "setting a desired signal to interference ratio target (SIR_{target}) that is close to a signal to interference ratio required (SIR_{rec}) during the normal mode of the outer loop." I understand that the parties agree that the phrase "signal to interference ratio required (SIR_{rec})" in this element should be construed as "signal to interference ratio required

[1] *See also* Q2TOTAPPLE1302SC0000146-161 and Q2TOTAPPLE1302SC0000311-326 for the corresponding code in the wfw_tx_modulator.c file for the other versions I reviewed.

[2] *See also* Q2TOTAPPLE1302SC0000146-149, Q2TOTAPPLE1302SC0000311-314.

[3] *See also* Q2TOTAPPLE1302SC0000150-161, Q2TOTAPPLE1302SC0000315-326.

(SIR_{req})." Applying this construction, it is my opinion that the Apple/Qualcomm Accused Products perform this step.

124. I also understand that certain of the Defendants have argued that "SIR_{req}" means "theoretical minimum of the desired signal to interference ratio received (SIR_{rec}) that satisfies the target frame error rate (FER_{target})." Under any of the parties' proposed constructions, the Apple/Qualcomm Accused Products perform element **[1.b]**, for the reasons I discuss in more detail below.

125. As discussed above, the Apple/Qualcomm Accused Products comply with the 3G standard. The ETSI TS describes how 3G implements outer loop power control:

7.2.4.8.1 UL Outer Loop Power Control

The UL Outer Loop Power Control located in the SRNC [TDD – except for uplink shared channels where it is located in the CRNC] sets the target quality value for the UL Inner Loop Power Control which is located in Node B for FDD and 1.28 Mcps TDD and is located in the UE for 3.84 Mcps TDD. It receives input from quality estimates of the transport channel. The UL outer loop power control is mainly used for a long-term quality control of the radio channel.

In FDD and 1.28 Mcps TDD this function is located in the UTRAN, in 3.84 Mcps TDD the function is performed in UTRAN and the target quality value is sent to the UE by the SRNC or the CRNC, respectively.

In FDD and 1.28 Mcps TDD, if the connection involves both a SRNS and a DRNS the function UL Outer Loop Power Control (located in the SRNC [1.28 Mcps TDD – or in the CRNC, respectively]) sets the target quality for the UL Inner Loop Power Control function (located in Node B).

7.2.4.8.2 DL Outer Loop Power Control

The DL Outer Loop Power Control sets the target quality value for the DL inner loop power control. It receives input from quality estimates of the transport channel, measured in the UE. The DL outer loop power control is mainly used for a long-term quality control of the radio channel.

This function is located mainly in the UE, but some control parameters are set by the UTRAN.

The SRNC, regularly (or under some algorithms), sends the target down link power range based on the measurement report from UE.

ETSI TS 125 401 V4.2.0 (2001-09) at 23.

126. As the document notes, OLPC "sets the target quality value for the UL [uplink] Inner Loop Power Control," that "is mainly used for long-term quality control of the radio channel." Likewise, OLPC "sets the target quality value for the DL [downlink] inner loop power

control." ETSI TS 125 401 V4.2.0 (2001-09) at 23; *see also* ETSI TS 125 301 V13.0.0 (2016-01) at 33. The target quality value discussed in these references is the SIR_{target} of the claim. SIR_{target} is set to maintain required call quality, which is measured by a Block Error Rate (BLER) set by the network:

14.9s Downlink power control

14.9.1 Generalities

This function is implemented in the UE in order to set the SIR target value on each CCTrCH used for the downlink power control. This SIR value shall be adjusted according to an autonomous function in the UE in order to achieve the same measured quality as the quality target set by UTRAN. The quality target is set as the transport channel BLER value for each transport channel as signalled by UTRAN.

When transport channel BLER is used the UE shall run a quality target control loop such that the quality requirement is met for each transport channel, which has been assigned a BLER target.

The UE shall set the SIR target when the physical channel has been set up or reconfigured. It shall not increase the SIR target value before the power control has converged on the current value. The UE may estimate whether the power control has converged on the current value, by comparing the averaged measured SIR to the SIR target value.

ETSI TS 125 331 V10.20.0 (2016-08) at 1825.

127. This is also described in Holma and Toskala's *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, which notes that OLPC "sets the target for fast power control so that the required quality is provided." Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2002) at 232; *see also id.* at 239 ("[t]he outer loop power control is needed to keep the quality of communication at the required level by setting the target for the fast power control.").

128. Likewise, a document describing Qualcomm's OLPC algorithm confirms that the algorithm sets and updates the Target SIR (i.e. SIR_{target}) to get a SIR close to the overall target (i.e. SIR_{rec}): "In general, the OLPC algorithm attempts to set an overall SIR target (Es/Nt) in a manner that the network-set BLER targets for all downlink transport channels are satisfied. If the UE measures an SIR lower than this target in a slot, the UE sends an UP (1) TPC command on the

Uplink. Similarly, if the measured SIR is larger, the UE sends a DOWN (0)command." QCTOTVAPPLE01302_0008067 at 2; *see also* Fig. 1:

$$\text{DL TPC} = \begin{cases} 1, \text{Measured SIR} < \text{Target SIR} \\ 0, \text{Measured SIR} >= \text{Target SIR} \end{cases} \qquad \text{Target SIR} \begin{cases} \text{increased on CRC Error} \\ \text{decreased on CRC Pass} \end{cases}$$

129. I understand that a Qualcomm employee provided an affidavit in a separate litigation describing Qualcomm's OLPC algorithm that comports with this operation:

> Below follows the details of the operation of the OLPC in Qualcomm's chipsets
> …
> (a) At the end of each downlink TTI (Transmission Time Interval), the Qualcomm algorithm **determines whether the transport block(s) received in that TTI were received correctly or in error, and increases the SIRT value in case of error and decreases SIRT if the transport block(s) were received without errors**.
> …
> (g) When the Qualcomm software detects the end of the windup condition, it decreases the SIRT (signal-to-interference target) used for OLPC (outer loop power control) by the same fixed windup offset amount.
>
> (h) After decreasing the SIRT by the same fixed windup offset amount, t**he SIRT is allowed to change in accordance with the CRC check(s) performed on the subsequent downlink TTIs.**

QCTOTVAPPLE01302_0008063 at 1-2 (emphasis added). Specifically, the affidavit references setting a SIRT (i.e. SIR_{target}) that is intended to be close to a desired SIR based on received errors.

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130. My review of the produced source code confirms that the Apple/Qualcomm Accused Products perform this step. The source code file

/modem_proc/wcdma/l1/offline/src/dlolpc.c contains the functions for OLPC that calculate and set the SIR_{target}. *See* APPLE_QUALCOMM_000001-62.[4]

131. The function named dl_olpc_fdpch_compute_sir_target_from_outage gets statistics on slot outage to calculate and set a new target SIR (i.e. SIR_{target}) that is close to the required SIR based on outage statistics (i.e. the SIRrec). APPLE_QUALCOMM_000055-57.[5]

132. The function dl_olpc_update_sir_target (APPLE_QUALCOMM_00041-43)[6] makes update to a SIR_{target} (i.e. modifying SIR_{target} to be close to SIR_{rec}) by calling function dl_olpc_update_acq_mode_target or dl_olpc_update_trk_mode_target to update the target. APPLE_QUALCOMM_000021-23.[7] Once it has the target, it calls the function dl_set_olpc_target_val, and dl_set_olpc_target_val_windup depending on the value of a windup/unwinding detection flag, to set a new target SIR to the DSP (inner loop). APPLE_QUALCOMM_000044-46.[8]

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133. Even under Defendants' proposed construction of SIR_{req} as a "theoretical minimum of the desired signal to interference ratio received (SIR_{rec}) that satisfies the target frame error rate (FER_{target})," the Apple/Qualcomm Accused Products perform this element. As discussed above,

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[4] *See also* Q2TOTAPPLE1302SC0000001-80, Q2TOTAPPLE1302SC0000106-131, Q2TOTAPPLE1302SC0000177-223, Q2TOTAPPLE1302SC0000224-296, and Q2TOTAPPLE1302SC0000342-414 for the corresponding code in the dlolpc.c file for the other versions I reviewed.

[5] *See also* Q2TOTAPPLE1302SC0000078-80, Q2TOTAPPLE1302SC0000221-223, Q2TOTAPPLE1302SC0000294-296, Q2TOTAPPLE1302SC0000412-414.

[6] *See also* Q2TOTAPPLE1302SC0000060-62, Q2TOTAPPLE1302SC0000201-203, Q2TOTAPPLE1302SC0000274-276, Q2TOTAPPLE1302SC0000392-394.

[7] *See also* Q2TOTAPPLE1302SC0000038-41, Q2TOTAPPLE1302SC0000177-180, Q2TOTAPPLE1302SC0000250-253, Q2TOTAPPLE1302SC0000368-371.

[8] *See also* Q2TOTAPPLE1302SC0000062-64, Q2TOTAPPLE1302SC0000203-206, Q2TOTAPPLE1302SC0000276-279, Q2TOTAPPLE1302SC0000394-397.

the Apple/Qualcomm Accused Products calculate a SIR_{req} as a required SIR based on outage statistics – in other words a desired SIR that minimizes outages. This calculated SIR_{req} is a theoretical minimum of the desired SIR as required by the claims. A frame error rate (FER) is a ratio of data received with errors to total data received that determines the quality of a signal connection. Therefore, where the Apple/Qualcomm Accused Products calculate a SIR_{req} to minimize outages (e.g. maintain signal connection quality), the SIR_{req} is implicitly designed to satisfy a frame error rate.

134. Therefore, it is my opinion that the Apple/Qualcomm Accused Products perform claim element **[1.b]**.

d) [1.c] *detecting a start (402) of the outer loop wind-up*

135. Element **[1.c]** in claim 1 recites "detecting a start (402) of the outer loop wind-up." It is my opinion that the Apple/Qualcomm Accused Products perform this step.

136. As an initial matter, I understand that the parties disagree on the meaning of the term "outer loop wind-up." I understand that TOT believes that outer loop wind-up should have its plain and ordinary meaning, which is "an outer loop condition wherein the signal to interference ratio received (SIR_{rec}) does not follow the desired signal to interference ratio target (SIR_{target}), for reasons such as worsening of channel conditions or saturation of the transmitter." I understand that Defendants have proposed that outer loop wind-up means "outer loop condition or mode that would dictate increases to the signal to interference ratio target (SIR_{target}) that cannot be followed by the signal to interference ratio received (SIR_{rec}) because of sustained worsening of the channel's conditions or sustained transmission of the transmitter at the maximum power available for the connection." Whichever construction is deemed appropriate, it does not affect my opinion that the Apple/Qualcomm Accused Products perform this claim element.

137. As discussed above, the Apple/Qualcomm Accused Products comply with the 3G standard. The ETSI TS mandates that 3G-compliant devices detect a start of outer loop wind-up and limit SIR_{target} when a windup condition is detected:

> 7.8.1.1 Definition and applicability
>
> Power control in the downlink is the ability of the UE receiver to converge to required link quality set by the network while using as low power as possible in downlink. If a BLER target has been assigned to a DCCH (See clause C.3), then it has to be such that outer loop is based on DTCH and not on DCCH. The requirements and this test apply to all types of UTRA for the FDD UE for Release 5 and earlier releases.

ETSI TS 134 121-1 V13.0.0 (2016-08) at 647.

> 7.8.3 Power control in the downlink, wind up effects (Release 5 and earlier)
>
> 7.8.3.1 Definition and applicability
>
> This requirement verifies that, after the downlink maximum power is limited in the UTRAN and it has been released again, the downlink power control in the UE does not have a wind up effect, i.e. the required DL power has increased during time period the DL power was limited. The requirements and this test apply to all types of UTRA for the FDD UE for Release 5 and earlier releases.

Id. at 663.

> 7.8.3A Power control in the downlink, wind up effects (Release 6 and later)
>
> 7.8.3A.1 Definition and applicability
>
> This requirement verifies that, after the downlink maximum power is limited in the UTRAN and it has been released again, the downlink power control in the UE does not have a wind up effect, i.e. the required DL power has increased during time period the DL power was limited. The requirements and this test apply to Release 6 and later release for all types of UTRA for the FDD UE.
>
> 7.8.3A.2 Minimum requirements
>
> This test is run in three stages where stage 1 is for convergence of the power control loop. In stage two the maximum downlink power for the dedicated channel is limited not to be higher than the parameter specified in table 7.8.3A.1. All parameters used in the three stages are specified in table 7.8.3A.1. The downlink $\frac{DPCH\_E_c}{I_{or}}$ power ratio measured values, which are averaged over one slot, during stage 3 shall be lower than the value specified in table 7.8.3A.2 more than 90 % of the time. Power control of the UE is ON during the test.

Id. at 665; *see also* ETSI TS 125 331 V10.20.0 (2016-08) at 1825 ("[The UE] shall not increase the SIR target value before the power control has converged on the current value. The UE may estimate whether the power control has converged on the current value, by comparing the averaged measured SIR to the SIR target value.").

138. Again, a Qualcomm employee provided an affidavit in a separate litigation that describes the OLPC algorithm that comports with this operation:

> Below follows the details of the operation of the OLPC in Qualcomm's chipsets
> …
>
> (b) The Qualcomm algorithm **detects windup by detecting three consecutive frames received in poor quality**.
>
> (c) When the Qualcomm software detects a windup condition, it increases the SIRT (signal-to-interference target) used for OLPC (outer loop power control) by a fixed windup offset amount, and will not modify the SIRT further until the end of the windup condition is detected.
>
> (d) In the event that windup is detected at a downlink TTI boundary, the SIRT will first be altered based upon whether the transport block(s) received in that downlink TTI were received correctly or in error. Then the fixed windup offset amount will be added.
>
> (e) After adding the fixed windup offset amount, the Qualcomm algorithm prevents the SIRT from changing further until the end of the windup condition is detected.

QCTOTVAPPLE01302_0008063 at 1-2 (emphasis added).

139. Specifically, the affidavit references detecting windup "by detecting three consecutive frames received in poor quality," in other words detecting a start of the outer loop wind-up.

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140. Review of the Qualcomm source code confirms that the Apple/Qualcomm Accused Devices perform the step of detecting a start of outer loop wind-up as described. Again, the file

/modem_proc/wcdma/l1/offline/src/dlolpc.c contains the functions for detecting outer loop wind-up. *See* APPLE_QUALCOMM_000001-62.[9]

141. Specifically, this functionality is performed by the function dl_olpc_check_for_windup. APPLE_QUALCOMM_000024-26.[10] This function counts the number of up commands, and when they exceed the number set in the global variable DL_THRESH_UPS the function sets the variables "windup_detected = TRUE" and dl_olpc_change_sirt_on_windup_detection = 1", which indicates to the code that outer loop wind-up has been detected. APPLE_QUALCOMM_000026 at lines 2227-2254.[11] windup_detected is a global variable set at APPLE_QUALCOMM_000010 that can be checked by other functions of the OLPC algorithm, and indicates wind-up as confirmed by the comments: "This variable is set to TRUE or FALSE depending on whether UE detects Wind-Up condition or not in the DL power control." APPLE_QUALCOMM_000010 at lines 686-694.[12] The function dl_olpc_check_for_windup is called by the maintenance event handler function in the file wl1dec.c. APPLE_QUALCOMM_000102 at line 5061. This function is called every 10 milliseconds to handle tasks that must be performed periodically on frame decode events. *Id.* It is called before the function dl_olpc_update_sir_target. *Id.* at line 5104._

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[9] *See also* Q2TOTAPPLE1302SC0000001-80, Q2TOTAPPLE1302SC0000106-131, Q2TOTAPPLE1302SC0000177-223, Q2TOTAPPLE1302SC0000224-296, and Q2TOTAPPLE1302SC0000342-414 for the corresponding code in the dlolpc.c file for the other versions I reviewed.

[10] *See also* Q2TOTAPPLE1302SC0000041-44, Q2TOTAPPLE1302SC0000180-183, Q2TOTAPPLE1302SC0000253-256, Q2TOTAPPLE1302SC0000371-374.

[11] *See also* Q2TOTAPPLE1302SC0000043-44 at lines 2075-2102, Q2TOTAPPLE1302SC0000182-183 at lines 2231-2258, Q2TOTAPPLE1302SC0000255-256 at lines 2231-2258, Q2TOTAPPLE1302SC0000373-374 at lines 2231-2258.

[12] *See also* Q2TOTAPPLE1302SC0000024 at lines 589-597, Q2TOTAPPLE1302SC0000116 at lines 690-698, Q2TOTAPPLE1302SC0000234 at lines 690-698, Q2TOTAPPLE1302SC0000352 at lines 690-698.

142. As a result, the Apple/Qualcomm Accused Products perform this claim limitation under either the plain and ordinary meaning of "outer loop wind-up" which is "an outer loop condition wherein the signal to interference ratio received (SIR_{rec}) does not follow the desired signal to interference ratio target (SIR_{target}), for reasons such as worsening of channel conditions or saturation of the transmitter," or under Defendants' proposed construction which is "outer loop condition or mode that would dictate increases to the signal to interference ratio target (SIR_{target}) that cannot be followed by the signal to interference ratio received (SIR_{rec}) because of sustained worsening of the channel's conditions or sustained transmission of the transmitter at the maximum power available for the connection." As shown above, when conditions deteriorate to the extent that increasing SIR_{target} does not affect SIR_{rec} and the number of "up" commands are met, the Apple/Qualcomm Accused Products enter wind-up mode. In other words, SIR_{rec} is not following the SIR_{target}, as in TOT's proposed construction. Or, as in Defendants' proposed construction, the OLPC algorithm is determining that increases to the signal to interference ratio target (SIR_{target}) cannot be followed, e.g. because too many "ups" have occurred with no meaningful improvement in SIR_{rec}. Moreover, because the code only detects wind-up after a set number of "up" commands, it is my opinion that they would be triggered by "sustained worsening of the channel's conditions or sustained transmission of the transmitter at the maximum power available for the connection." As a result, it is my opinion that the Apple/Qualcomm Accused Products perform this claim limitation under either construction.

143. Therefore, it is my opinion that the Apple/Qualcomm Accused Products perform claim element **[1.c]**.

e) [1.d] *setting a specific desired signal to interference ratio target (SIR_{target}) during the outer loop wind-up, and*

144. Element **[1.d]** in claim 1 recites "setting a specific desired signal to interference ratio target (SIR_{target}) during the outer loop wind-up." As I discussed above with respect to element **[1.c]**, I understand that the parties dispute the proper construction of "outer loop wind-up." Under any of the parties' proposed constructions, it is my opinion that the Apple/Qualcomm Accused Products perform the step in element **[1.d]** of "setting a specific desired signal to interference ratio target (SIR_{target}) during the outer loop wind-up."

145. As discussed above, the Apple/Qualcomm Accused Products comply with the 3G standard for WCDMA. Documents explaining WCDMA and 3G standards demonstrate the requirement that compliant devices set a specific SIR_{target} during outer loop wind-up. For example, Holma and Toskala note that setting a desired SIR_{target} during wind-up is a requirement of the 3GPP standard:

> The outer loop problems from limited power control dynamics can be avoided by setting tight limits for the E_b/N_0 target or by an intelligent outer loop power control algorithm. Such an algorithm would not increase the E_b/N_0 target if the increase did not improve the quality. The 3GPP specifications include this requirement for the UE in [2].

Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2002) at 244.

146. Holma and Toskala describe that the SIR_{target} is set to a desired level. *See id.* at 239 ("[t]he outer loop power control is needed to keep the quality of communication at the required level by setting the target for the fast power control."). When the UE is already at maximum or minimum value, then the SIR_{target} is not increased but is instead set to an optimal value.

9.2.2.5 Limited Power Control Dynamics

At the edge of the coverage area the UE may hit its maximum transmission power. In that case the received BLER can be higher than desired. If we apply directly the outer loop algorithm of Figure 9.10, the uplink SIR target would be increased. The increase of the SIR target does not improve the uplink quality if the Node B is already sending only power-up commands to the UE. In that case the E_b/N_0 target might become unnecessarily high. When the UE returns closer to the Node B, the quality of the uplink connection is unnecessarily high before the outer loop lowers the E_b/N_0 target back to the optimal value. The situation in which the UE hits its maximum transmission power is shown in Figure 9.14. In this example,

The same problem could also occur if the UE hits its minimum transmission power. In that case, the E_b/N_0 target would become unnecessarily low. The same problems can be observed also in the downlink if the power of the downlink connection is using its maximum or minimum value.

Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2002) at 243; *see also id.* at 240 (Figure 9.10).

147. In addition, the ETSI TS mandates that the downlink power control sets power to a target, which corresponds to the SIR_{target}:

8.8 Power control in downlink

Power control in the downlink is the ability of the UE receiver to converge to required link quality set by the network while using as low power as possible in downlink . If a BLER target has been assigned to a DCCH (See Annex A.3), then it has to be such that outer loop is based on DTCH and not on DCCH.

The requirements in this subclause were derived with the assumption that the UTRAN responds immediately to the uplink TPC commands by adjusting the power of the first pilot field of the DL DPCCH that commences after end of the received TPC command.

ETSI TS 125 101 V10.1.0 (2011-05) § 8.8.

148. Again, a Qualcomm employee provided an affidavit that describes how the OLPC algorithm meets this element:

> Below follows the details of the operation of the OLPC in Qualcomm's chipsets
>
> …
>
> (b) The Qualcomm algorithm detects windup by detecting three consecutive frames received in poor quality.

> (c) **When the Qualcomm software detects a windup condition, it increases the SIRT (signal-to-interference target) used for OLPC (outer loop power control) by a fixed windup offset amount, and <u>will not modify the SIRT further</u> until the end of the windup condition is detected.**
>
> (d) In the event that windup is detected at a downlink TTI boundary, the SIRT will first be altered based upon whether the transport block(s) received in that downlink TTI were received correctly or in error. Then the fixed windup offset amount will be added.
>
> (e) After adding the fixed windup offset amount, the Qualcomm algorithm prevents the SIRT from changing further until the end of the windup condition is detected.

QCTOTVAPPLE01302_0008063 at 1-2 (emphasis added) ; *see also* APL-TOTDDE_00737380 at APL-TOTDDE_00737481 ("Upon Upon Normal -> Windup transition, Bump up SIR Tgt by 'WindupSirTgtAdjustment' (3 . . . 5dB).").

149. As noted above, the Qualcomm affidavit states that when the algorithm "detects a windup condition" (i.e. outer loop wind-up is detected), during the outer loop wind-up "it increases the SIRT (signal-to-interference target) used for OLPC (outer loop power control) by a fixed windup offset amount, and will not modify the SIRT further" (i.e. sets a specific desired SIR_{target}.)

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150. The source code of the Apple/Qualcomm Accused Products demonstrates that this claim element is met. Again, this functionality exists /modem_proc/wcdma/l1/offline/src/dlolpc.c. APPLE_QUALCOMM_000001-62.[13]

151. The function dl_olpc_update_sir_target adds the fixed windup offset amount (in this case 4dB) to the SIRT (i.e. SIR_{target}) and then calls function dl_olpc_set_target_val_windup. APPLE_QUALCOMM_000042-46.[14] That function sets the SIRT with the increased value (i.e

[13] *See also* Q2TOTAPPLE1302SC0000001-80, Q2TOTAPPLE1302SC0000106-131, Q2TOTAPPLE1302SC0000177-223, Q2TOTAPPLE1302SC0000224-296, and Q2TOTAPPLE1302SC0000342-414 for the corresponding code in the dlolpc.c file for the other versions I reviewed.

[14] *See also* Q2TOTAPPLE1302SC0000060-65, Q2TOTAPPLE1302SC0000201-206, Q2TOTAPPLE1302SC0000274-279, Q2TOTAPPLE1302SC0000392-397.

setting a specific desired signal to interference ratio target). *See, e.g.,* APPLE_QUALCOMM_000043 at lines 3522-3525 ("sirt_plus_delta_q25 += DL_OLPC_DB_TO_Q25(4);" with comment "sirt raised by 4 dB due to windup detection").[15] *See also* QCTOTVAPPLE01302_0011211 at _0011276 ("SIRT + WindupSirTgtAdjustment [Set to 4dB] used for UP/DOWN generation in ILPC").

152. As the Qualcomm employee stated above, SIRT is not modified further while in the windup state. For example, function dl_olpc_update_trch_sir_tgt checks if windup is detected and, if so, freezes the OLPC algorithm from further adjustment to SIRtarget. APPLE_QUALCOMM_000034-39 at lines 3074-3081.[16] Thus, it sets a specific desired SIRtarget.

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153. Based on this evidence, it is my opinion that the Apple/Qualcomm Accused Products perform claim element **[1.d]**.

f) **[1.e]** ***detecting a start (403) of the outer loop unwinding***

154. Element **[1.e]** in claim 1 recites "detecting a start (403) of the outer loop unwinding." It is my opinion that the Apple/Qualcomm Accused Products perform this step. I understand that the parties disagree as to the construction of the term "outer loop unwinding." I understand that TOT has proposed that this term has its plain and ordinary meaning, which is "exiting or recovering from outer loop wind-up." I also understand that some of the Defendants

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[15] *See also* Q2TOTAPPLE1302SC0000062 at lines 3261-3264, Q2TOTAPPLE1302SC0000203 at lines 3526-3529, Q2TOTAPPLE1302SC0000276 at lines 3526-3529, Q2TOTAPPLE1302SC0000394 at lines 3526-3529.

[16] *See also* Q2TOTAPPLE1302SC0000051-57 at lines 2829-2836, Q2TOTAPPLE1302SC0000191-198 at lines 3078-3085, Q2TOTAPPLE1302SC0000264-271 at lines3078-3085, Q2TOTAPPLE1302SC0000382-389 at lines 3078-3085.

have proposed that this term means "outer loop condition or mode involving the process of lowering the desired signal to interference ratio target (SIR_{target}) set during the outer loop windup." Whichever construction is deemed appropriate, it does not affect my opinion that the Apple/Qualcomm Accused Products perform this claim element.

155. Qualcomm's employee affidavit explains that the Apple/Qualcomm Accused Products' OLPC algorithm performs this element:

> (e) After adding the fixed windup offset amount, the Qualcomm algorithm prevents the SIRT from changing further until the end of the windup condition is detected.
>
> (f) **The Qualcomm algorithm detects the end of windup by evaluating three consecutive frames**.
>
> (g) When the Qualcomm software detects the end of the windup condition, it decreases the SIRT (signal-to-interference target) used for OLPC (outer loop power control) by the same fixed windup offset amount.

QCTOTVAPPLE01302_0008063 at 1-2 (emphasis added).

156. Specifically, the Apple/Qualcomm OLPC algorithm detects the end of windup by evaluating three consecutive frames (i.e. detecting a start of the outer loop unwinding).

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157. /modem_proc/wcdma/l1/offline/src/dlolpc.c contains the functions in the code for detecting the start of outer loop unwinding. APPLE_QUALCOMM_000001-62.[17]

[17] *See also* Q2TOTAPPLE1302SC0000001-80, Q2TOTAPPLE1302SC0000106-131, Q2TOTAPPLE1302SC0000177-223, Q2TOTAPPLE1302SC0000224-296, and Q2TOTAPPLE1302SC0000342-414 for the corresponding code in the dlolpc.c file for the other versions I reviewed.

158. As above for step [1.c], this functionality is performed by the function dl_olpc_check_for_windup. APPLE_QUALCOMM_000024-26.[18] This function counts the number of up commands, and when in windup but the number of ups are less than the number set in the global variable DL_THRESH_UPS minus 10, the function sets the variables "windup_detected = FALSE" and dl_olpc_change_sirt_on_windup_detection = 0", which indicates to the code that outer loop unwinding has been detected. APPLE_QUALCOMM_000026 at lines 2247-2254.[19] windup_detected is a global variable set at APPLE_QUALCOMM_000010 that can be checked by other functions of the OLPC algorithm, and indicates wind-up as confirmed by the comments: "This variable is set to TRUE or FALSE depending on whether UE detects Wind-Up condition or not in the DL power control." APPLE_QUALCOMM_000010 at lines 686-694.[20]

159. When, windup_detected is set to FALSE and dl_olpc_change_sirt_on_windup_detection is set to zero, this denotes that the Apple/Qualcomm Accused Product's OLPC algorithm has detected a start of the outer loop unwinding.

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160. Thus, the code shows that the Apple/Qualcomm Accused Products perform the step of detecting the start of the outer loop unwinding, and that they perform this step under either TOT or Defendants' constructions. TOT's construction of plain and ordinary meaning (exiting or

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[18] *See also* Q2TOTAPPLE1302SC0000041-44, Q2TOTAPPLE1302SC0000180-183, Q2TOTAPPLE1302SC0000253-256, Q2TOTAPPLE1302SC0000371-374.

[19] *See also* Q2TOTAPPLE1302SC0000043-44 at lines 2075-2102, Q2TOTAPPLE1302SC0000182-183 at lines 2231-2258, Q2TOTAPPLE1302SC0000255-256 at lines 2231-2258, Q2TOTAPPLE1302SC0000373-374 at lines 2231-2258.

[20] *See also* Q2TOTAPPLE1302SC0000024 at lines 589-597, Q2TOTAPPLE1302SC0000116 at lines 690-698, Q2TOTAPPLE1302SC0000234 at lines 690-698, Q2TOTAPPLE1302SC0000352 at lines 690-698.

recovering from outer loop wind-up) is met, because the OLPC algorithm checks the number of TPC "up" commands, and if they are less than the set threshold, then that means that the system is exiting or recovering from outer loop wind-up, as the delta between the received SIR and SIR_{target} is lowering from an overly elevated state, meaning conditions have improved. It also meets Defendants' construction of "outer loop condition or mode involving the process of lowering the desired signal to interference ratio target (SIR_{target}) set during the outer loop windup," as the detected number of "up" commands indicate lowering the SIR_{target} that had previously been frozen.

161. Based on this evidence, it is my opinion that the Apple/Qualcomm Accused Products perform claim element **[1.e]**.

g) **[1.f]** ***wherein the desired signal to interference ratio target (SlRtarget) is modified at the start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up.***

162. Element **[1.f]** in claim 1 recites "wherein the desired signal to interference ratio target (SlR_{target}) is modified at the start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up." In my opinion, the Apple/Qualcomm Accused Products perform this step.

163. I understand that the parties disagree as to the construction of the term "wherein the desired signal to interference ratio target (SIR_{target}) is modified at the start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up." I understand that TOT proposes the plain and ordinary meaning of the term, which is "wherein the desired signal to interference ratio target (SIR_{target}) is modified at the start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up." I understand that Defendants propose "wherein the desired signal to interference ratio target (SIR_{target}) is modified at the start (403) of the outer loop

unwinding to the last specific historical value of the SIR_{target} that was previously set for the outer loop power control in normal mode just prior to the start of the outer loop wind up." I further understand that Defendants claim that "[p]atentee disclaimed methods that modify the desired signal to interference ratio target (SIR_{target}) where SIR_{target} converges over some time period to the required SIR, and limited the claim to a modification of SIR_{target} that essentially eliminates the convergence period altogether." I disagree with Defendants' proposal, but in any case, the Apple/Qualcomm Accused Products perform this step under either construction.

164. Qualcomm's employee affidavit explains that the Apple/Qualcomm Accused Products' OLPC algorithm performs this element:

> (e) After adding the fixed windup offset amount, the Qualcomm algorithm prevents the SIRT from changing further until the end of the windup condition is detected.
>
> (f) The Qualcomm algorithm detects the end of windup by evaluating three consecutive frames.
>
> (g) **When the Qualcomm software detects the end of the windup condition, it decreases the SIRT (signal-to-interference target) used for OLPC (outer loop power control) by the same fixed windup offset amount**.
>
> (h) After decreasing the SIRT by the same fixed windup offset amount, the SIRT is allowed to change in accordance with the CRC check(s) performed on the subsequent downlink TTIs).

QCTOTVAPPLE01302_0008063 at 1-2 (emphasis added); *see also* APL-TOTDDE_00737380 at APL-TOTDDE_00737481 ("Upon Windup -> Normal transition , , , Revert SR Tgt down by the adjustment.").

165. As noted for claim element **[1.d]**, when windup is detected the Apple/Qualcomm OLPC algorithm raises the SIRT by 4 dB and then freezes it. As the Qualcomm employee affidavit states, when unwinding occurs, the Apple/Qualcomm OLPC algorithm decreases SIRT by that same amount. In other words, if SIRT = X at the start of windup, the algorithm sets it to X+4.

Then at unwinding, the OLPC algorithm subtracts that 4 such that SIRT becomes X again. As a result, the SIRT is modified, at the start of unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up.

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166. The function dl_olpc_update_sir_target in /modem_proc/wcdma/l1/offline/src/dlolpc.c performs this functionality. APPLE_QUALCOMM_000041-43.[21] That function removes the 4 dB from the SIRtarget by setting it to zero and then calls dl_set_olpc_target_val_windup (APPLE_QUALCOMM_000045-46)[22] to send that value to the firmware (see lines 3688-3699). APPLE_QUALCOMM_000043 (commented as "sirt lowered by 4 dB due to exit of windup").[23] This has the effect, as seen in wfw_tx_modulator.c function wfw_tx_fpc_decision_proc lines 9525-9596, of returning the system to the previously frozen value of SIRtarget, which is then used to make decisions on whether to send a TPC up/down bits. APPLE_QUALCOMM_000087-89.[24] For example, when fpcTargetEbNtWindUp retrieved from the software is zero, the code at lines 9557-9574 is no longer called and the un-offset target is used for the decision instead—subtracting the 4 dB offset. *Id.*

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[21] *See also* Q2TOTAPPLE1302SC0000060-62, Q2TOTAPPLE1302SC0000201-203, Q2TOTAPPLE1302SC0000274-276, Q2TOTAPPLE1302SC0000392-394.

[22] *See also* Q2TOTAPPLE1302SC0000064-65, Q2TOTAPPLE1302SC0000205-206, Q2TOTAPPLE1302SC0000278-279, Q2TOTAPPLE1302SC0000396-397.

[23] *See also* Q2TOTAPPLE1302SC0000062, Q2TOTAPPLE1302SC0000203, Q2TOTAPPLE1302SC0000276, Q2TOTAPPLE1302SC0000394.

[24] *See also* Q2TOTAPPLE1302SC0000146-149, Q2TOTAPPLE1302SC0000311-314.

167. The functions that had been frozen during at start of windup are allowed to continue. *See* APPLE_QUALCOMM_000034-39 at lines 3074-3081.[25]

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168. This functionality meets both proposed constructions. First, with regard to TOT's proposal of plain and ordinary meaning, which is "wherein the desired signal to interference ratio target (SIR_{target}) is modified at the start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up," the algorithm described above meets that definition. Specifically, as described above, the OLPC algorithm of the Apple/Qualcomm Accused Products removes the 4 dB from SIR_{target} that was added when wind-up was detected. Thus, the Apple/Qualcomm Accused Products match the SIR_{target} to the value at the beginning of windup, because, as discussed, 4 dB is added at wind-up detection and 4 dB is removed at wind-down. Since the net change is zero the SIR_{target} will be set to the value before wind-up.

169. With respect to Defendants' proposal that the claim term means "wherein the desired signal to interference ratio target (SIR_{target}) is modified at the start (403) of the outer loop unwinding to the last specific historical value of the SIR_{target} that was previously set for the outer loop power control in normal mode just prior to the start of the outer loop wind up," and that "[p]atentee disclaimed methods that modify the desired signal to interference ratio target (SIR_{target}) where SIRtarget converges over some time period to the required SIR, and limited the claim to a modification of SIR_{target} that essentially eliminates the convergence period altogether," even under this proposed construction, the Apple/Qualcomm Accused Products perform this step. As

[25] *See also* Q2TOTAPPLE1302SC0000051-57 at lines 2829-2836, Q2TOTAPPLE1302SC0000191-198 at lines 3078-3085, Q2TOTAPPLE1302SC0000264-271 at lines3078-3085, Q2TOTAPPLE1302SC0000382-389 at lines 3078-3085.

described above, the Apple/Qualcomm Accused Products match the SIR_{target} to the value at the beginning of windup, because, as discussed, 4 dB is added at wind-up detection and 4 dB is removed at unwinding. As such, the modified value will be the last specific historical value of the SIR_{target} as when wind-up was detected, which essentially eliminates the convergence period.

170. Tests performed on a sample Apple/Qualcomm Accused Product as well as other smartphones that include Qualcomm modems further confirm that the Apple/Qualcomm Accused Products perform claim element **[1.f]**. Specifically, at my direction, Ocean Tomo and Claude Royer Consultant Inc. ("CRC-I") conducted experimental testing of three phones having Qualcomm baseband processors accused of infringing the '865 Patent – the iPhone 13, Samsung Galaxy S8, and LG K40.[26] The tests were designed to show how the transmit power of each phone reacted to a simulated windup condition at the instant that the condition alleviated, *i.e.*, the start of unwinding. Each phone was tested while simulating its operation on a WCDMA network and, by comparison, operation on a cdma2000 network.[27]

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171. Based on my review of source code, I understand that Qualcomm's cdma2000 implementation operates in a different manner than described above. The file /modem_proc/1x/mux/src/ffpc.c includes functions relevant to outer loop forward power control for cdma2000. APPLE_QUALCOMM_000162-182. For example, function ffpc_update_setpt

[26] The iPhone 13 includes a Qualcomm SDX60M modem (*see* Exhibit C at 2); the Samsung Galaxy S8 includes a Qualcomm MSM8998 chipset, which includes a Qualcomm processor and modem (*see* Exhibit G at 12); the LG K40 includes a Qualcomm Snapdragon SDM450 chipset, which includes a Qualcomm processor and a modem (*see* LG K40 Features and Specs on LG website, available at https://www.lg.com/us/cell-phones/lg-lmx420qn-unlocked-k40).

[27] In the LG phone testing, a different LG phone was used for the cdma2000 testing, as the LG K40 test phone was unable to connect to the test equipment in cdma2000 mode.

has functionality to freeze the target power control setpoints based on a detected number of up commands. APPLE_QUALCOMM_000169-170; *see also id.*, at 180-182.

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172. In the WCDMA case, the phones dramatically and suddenly reduced their usage of power at the unwinding to a level matching the power level just prior to the test's emulation of windup. In contrast, in the cdma2000 case, the phones slowly and gradually reduced their power levels over a period of roughly one minute, similar to how outer loop power control would operate in normal mode at the time of the patent application. *See* Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2002) at 239-243. For example, the results of the testing of the iPhone 13 while simulating operation on a WCDMA network are shown below:

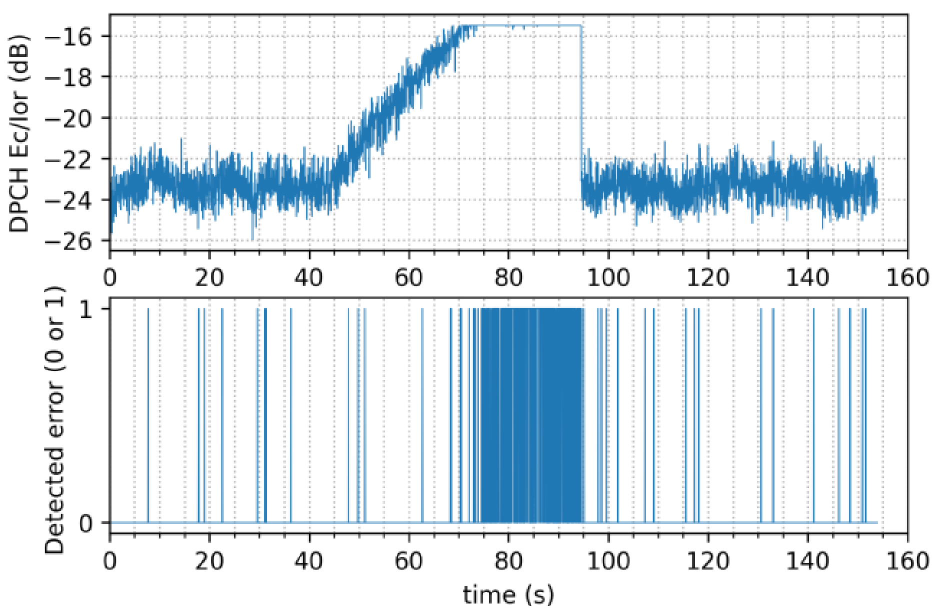


Figure 3: Ec/Ior and BLER versus time collected from the Keysight wireless communications test set (E5515C/8960).

173. The top graph in the figure above shows DPCH Ec/Ior measurements from E5515C/8960 test equipment. The DPCH Ec/Ior reported by the E5515C/8960 corresponds to the

ratio of dedicated physical channel power transmitted to the UE (the phone) over the total power transmitted by the emulated Node B. As per inner loop power control requirements, the Node B continuously receives transmit power control (TPC) commands from the UE. As a result, the Node B adjusts the dedicated power transmitted to the UE upward when it receives an "up" command, and downward, when it receives a "down" command. The UE sends an "up" command when the SIR it measures is below the SIR target, in order to obtain more dedicated power from the Node B. Conversely, the UE sends a "down" command when the SIR it measures is above the SIR target, in order to obtain less dedicated power from the Node B. The DPCH Ec/Ior thus varies instantly according to these "up" or "down" commands, but will average to a value equal to the current SIR target of the UE set by the outer loop power control. Accordingly, the DPCH Ec/Ior reported by the test set in the described environment (shield box, controlled attenuation, noise and interference) can be used to assess the SIR target used by the test device.

174. By comparison, the results of the testing of the iPhone 13 while simulating operation on a cdma2000 network are shown below:

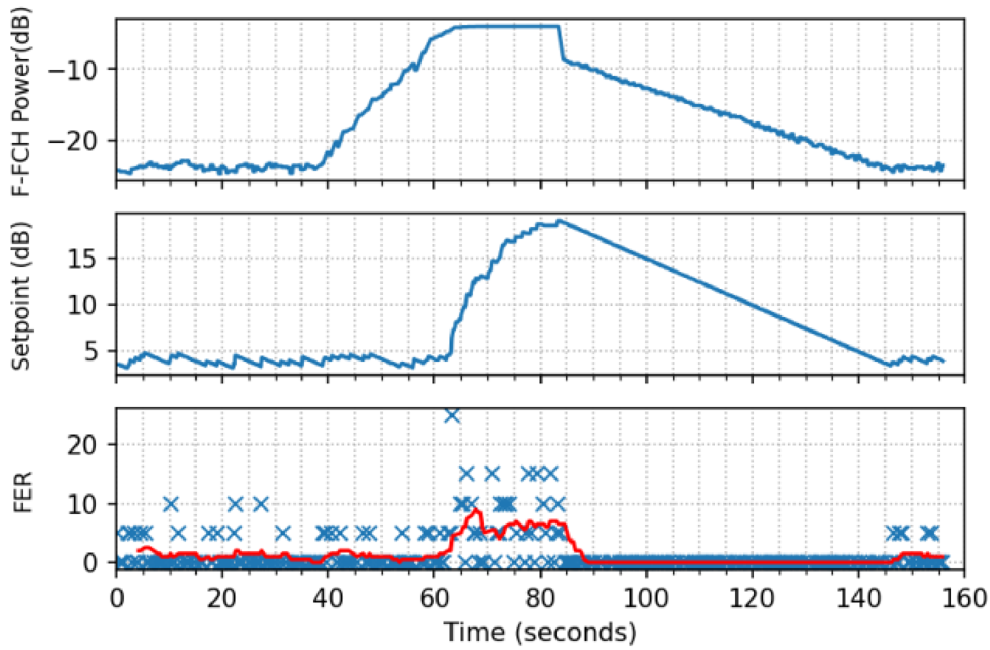


Figure 4: F-FCH power and FER versus time collected from the Keysight wireless communications test set (E5515C/8960). The blue crosses are the measured values, the red line represents an average of the measured value calculated for the benefit of the analysis.

175. These test results are consistent with the other evidence I have discussed above regarding how the OLPC algorithm operates in the Apple/Qualcomm Accused Products.

176. Further details regarding the procedures and results of this testing are provided in the test summaries attached as Exhibit F (iPhone 13), Exhibit G (Samsung Galaxy S8), and Exhibit H (LG K40).

177. Based on all of the evidence discussed above, it is my opinion that the Apple/Qualcomm Accused Products perform claim element **[1.f]**. And because the Apple/Qualcomm Accused Products perform each element of claim 1 of the '865 Patent, it is my opinion that the Apple/Qualcomm Accused Products infringe claim 1.

2. '865 Patent Claim 2: ***Outer loop power control method for wireless communications systems, according to claim 1, wherein at the start (403) of the outer loop unwinding the desired signal to interference ratio***

target (SIR_{target}) is set to a value suitably close to the original value (401) set just before the start moment (402) of the outer loop wind-up.

178. In my opinion, the Apple/Qualcomm Accused Products infringe claim 2 of the '865 Patent, which recites: "Outer loop power control method for wireless communications systems, according to claim 1, wherein at the start (403) of the outer loop unwinding the desired signal to interference ratio target (SIR_{target}) is set to a value suitably close to the original value (401) set just before the start moment (402) of the outer loop wind-up." Claim 2 therefore depends on claim 1.

179. As discussed above, it is my opinion that the Apple/Qualcomm Accused Products perform all elements of claim 1. And the Apple/Qualcomm Accused Products perform the further element of an outer loop power control method wherein at the start of the outer loop unwinding the desired signal to interference ratio target (SIR_{target}) is set to a value suitably close to the original value set just before the start moment of the outer loop wind-up.

180. As discussed above in my analysis for claim **[1.d]** and **[1.f]**, when windup occurs, the OLPC algorithm increases SIRT by 4 dB and then freezes it. Windup is detected after only three frames, such that the frozen value is close to the value just before wind-up. When winddown occurs, the OLPC algorithm decreases SIRT by 4 dB to be that value. As a result, the SIRT is modified, at the start of unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up which is suitably close to the original value. Therefore the Apple/Qualcomm Accused Products perform all of the elements of claim 2.

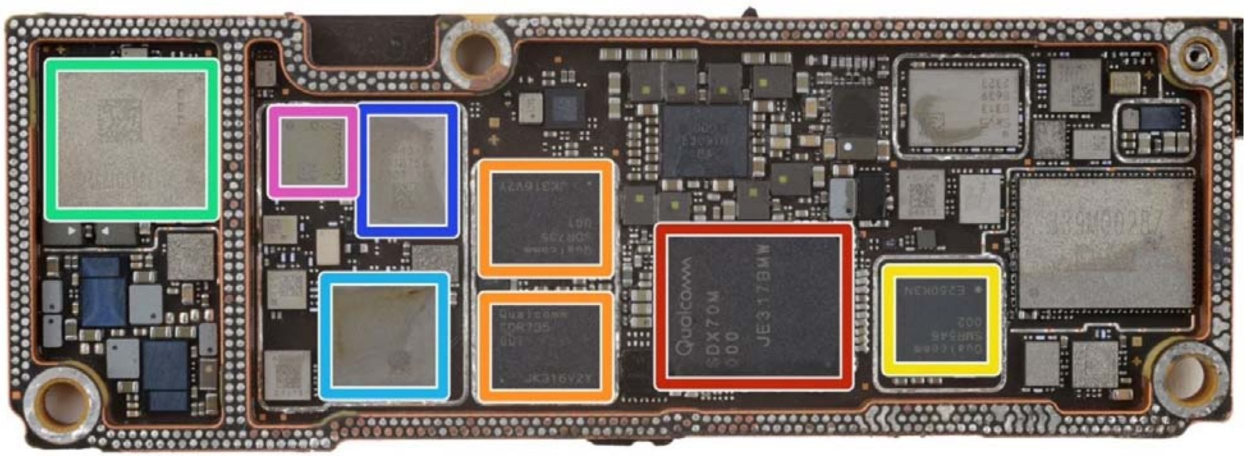
3. '865 Patent Claim 5

181. The Apple/Qualcomm Accused Products infringe each element of claim 5 of the '865 Patent as will be explained below.

a) [5.pre] *An outer loop power control device for wireless communications systems, comprising at least one programmable*

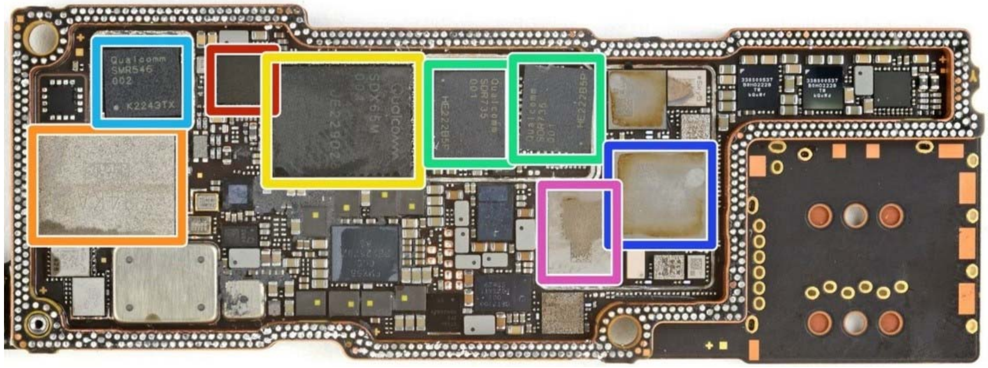
electronic device, the programmable electronic device operable to perform the steps of:

182. In my opinion, the Apple/Qualcomm Accused Products meet the preamble of claim 5, to the extent the preamble is found to be limiting. Each of the Apple/Qualcomm Accused Products include a Qualcomm Modem/Baseband Processor (e.g. Qualcomm SDX70M Snapdragon X70 modem) which is an outer loop power control device for wireless communications systems, comprising at least one programmable electronic device. For example, the iPhone 15 Pro Max includes Qualcomm SDX70M Snapdragon X70 modem which perform the remaining elements of the claim, highlighted in red:



iFixit Teardown report, *available at* https://www.ifixit.com/Guide/iPhone+15+Pro+Max+Chip+ID/165320.

183. Likewise, the iPhone 14 Pro Max includes a Qualcomm SDX65M X65 5G modem highlighted in yellow, below:



iFixit Teardown report, *available at* https://www.ifixit.com/Guide/iPhone+14+Pro+Max+Chip+ID.

184. Exhibit C provides further details regarding the specific Qualcomm Modem/Baseband Processor that is included in each of the Apple/Qualcomm Accused Products.

185. The Apple/Qualcomm Accused Products further satisfy the preamble for the same reasons as I discussed for claim element **[1.pre]**, above.

b) **[5.a]** ***estimating a desired signal to interference ratio received (SIRrec)based on a data signal (107, 108) received from a base station (102, 103) or mobile station (104)***

186. Element **[5.a]** in claim 5 is identical to claim element **[1.a]**, above, as performed by the outer loop power control device of element **[5.pre]**. The Apple/Qualcomm Accused Products perform this claim element for the same reasons as I discussed for claim elements **[1.a]** and **[5.pre]**, above. As such, I incorporate by reference my analysis for those elements.

c) **[5.b]** ***setting a desired signal to interference ratio target (SIRtarget) that is close to a signal to a signal to interference ratio required (SIRrec) during the normal mode of the outer loop***

187. Element **[5.b]** in claim 5 is identical to claim element **[1.b]**, above, as performed by the outer loop power control device of element **[5.pre]**. The Apple/Qualcomm Accused Products perform this claim element for the same reasons as I discussed for claim elements **[1.b]** and **[5.pre]**, above. As such, I incorporate by reference my analysis for those elements.

d) [5.c] *detecting a start (402) of the outer loop wind-up*

188. Element **[5.c]** in claim 5 is identical to claim element **[1.c]**, above, as performed by the outer loop power control device of element **[5.pre]**. The Apple/Qualcomm Accused Products perform this claim element for the same reasons as I discussed for claim elements **[1.c]** and **[5.pre]**, above. As such, I incorporate by reference my analysis for those elements.

e) [5.d] *setting a particular desired signal to interference ratio target (SIRtarget) during the outer loop wind-up, and*

189. Element **[5.d]** in claim 5 is identical to claim element **[1.d]**, above, as performed by the outer loop power control device of element **[5.pre]**. The Apple/Qualcomm Accused Products perform this claim element for the same reasons as I discussed for claim elements **[1.d]** and **[5.pre]**, above. As such, I incorporate by reference my analysis for those elements.

f) [5.e] *detecting a start (403) of the outer loop unwinding*

190. Element **[5.e]** in claim 5 is identical to claim element **[1.e]**, above, as performed by the outer loop power control device of element **[5.pre]**. The Apple/Qualcomm Accused Products perform this claim element for the same reasons as I discussed for claim elements **[1.e]** and **[5.pre]**, above. As such, I incorporate by reference my analysis for those elements.

g) [5.f] *wherein the desired signal to interference target (SIRtarget)is modified at the start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up.*

191. Element **[5.f]** in claim 5 is identical to claim element **[1.f]**, above, as performed by the outer loop power control device of element **[5.pre]**. The Apple/Qualcomm Accused Products perform this claim element for the same reasons as I discussed for claim elements **[1.f]** and **[5.pre]**, above. As such, I incorporate by reference my analysis for those elements.

4. ’865 Patent Claim 6: *Outer loop power control device for wireless communications systems, according to claim 5, wherein the programmable electronic device is chosen from among a general purpose processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC) and a programmable card (FPGA) or any combination of these.*

192. In my opinion, the Apple/Qualcomm Accused Products meet the elements of claim 6, which recites: "Outer loop power control device for wireless communications systems, according to claim 5, wherein the programmable electronic device is chosen from among a general purpose processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC) and a programmable card (FPGA) or any combination of these." Claim 6 therefore depends on claim 5.

193. As described above, the Apple/Qualcomm Accused Products meet the limitations of claim 5. Moreover, the devices described in claim 5 above include processors, DSPs, ASICs and/or FPGAs. For example, the MDM9655 modem is an ASIC that includes DSP processing blocks. *See, e.g.*, QCTOTVAPPLE01302_0002515 at 33.

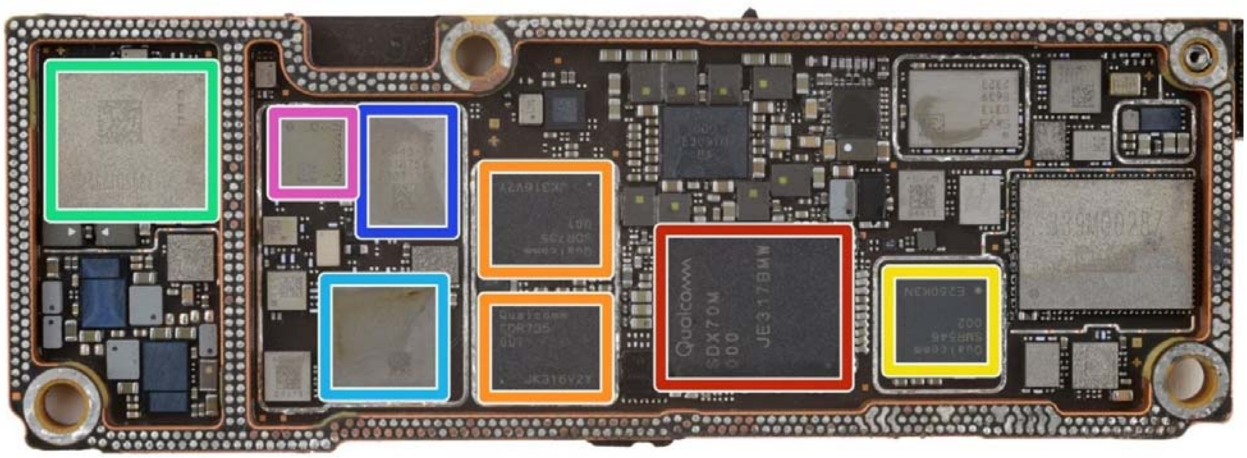
194. The Apple/Qualcomm Accused Products therefore meet all of the limitations of claim 6.

5. ’865 Patent Claim 7: *Outer loop power control device for wireless communications systems, according to claim 5, further comprising a radio receiver (203) able to receive a data signal (107, 108) from a base station (102, 103) or from a mobile station (104) of the wireless communication system.*

195. In my opinion, the Apple/Qualcomm Accused Products meet the elements of claim 7, which recites: "Outer loop power control device for wireless communications systems, according to claim 5, further comprising a radio receiver (203) able to receive a data signal (107, 108) from a base station (102, 103) or from a mobile station (104) of the wireless communication system." Claim 7 therefore depends on claim 5.

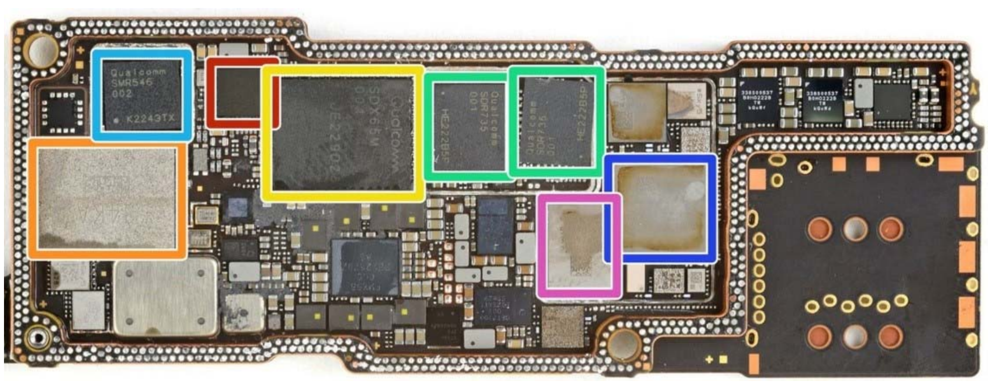
196. As described above, the Apple/Qualcomm Accused Products meet the limitations of claim 5. Moreover, the devices described in claim 5 above include radio receivers able to receive data signals from a base station or a mobile station of the wireless communication system.

197. For example, the iPhone 15 Pro Max includes a Qualcomm SDR735 RF transceiver and Qualcomm SMR546 RF transceiver highlighted in orange and yellow, respectively:



iFixit Teardown report, *available at* https://www.ifixit.com/Guide/iPhone+15+Pro+Max+Chip+ID/165320.

198. Likewise, the iPhone 14 Pro Max includes a Qualcomm SDR735 RF transceiver and Qualcomm SMR546 RF transceiver highlighted in green and light blue, respectively, below:



iFixit Teardown report, *available at* https://www.ifixit.com/Guide/iPhone+14+Pro+Max+Chip+ID.

199. The Technical Specifications produced by Apple also confirm that the Apple/Qualcomm Accused Products are capable of transmitting data signals to and receiving data

signals from base stations in a cellular network – functionality that requires a radiofrequency transmitter and receiver or transceiver. *See., e.g.*, APL-TOTDDE00690592-98 (iPhone SE Technical Specifications) at APL-TOTDDE00690593:

Cellular and Wireless

- **Model A1662**
  - LTE (Bands 1, 2, 3, 4, 5, 8, 12, 13, 17, 18, 19, 20, 25, 26, 29)
  - CDMA EV-DO Rev. A (800, 1700/2100, 1900, 2100 MHz)
  - UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)
  - GSM/EDGE (850, 900, 1800, 1900 MHz)
- **Model A1723**
  - LTE (Bands 1, 2, 3, 4, 5, 7, 8, 12, 17, 18, 19, 20, 25, 26, 28)
  - TD-LTE (Bands 38, 39, 40, 41)
  - TD-SCDMA 1900 (F), 2000 (A)
  - CDMA EV-DO Rev. A (800, 1700/2100, 1900, 2100 MHz)
  - UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)
  - GSM/EDGE (850, 900, 1800, 1900 MHz)

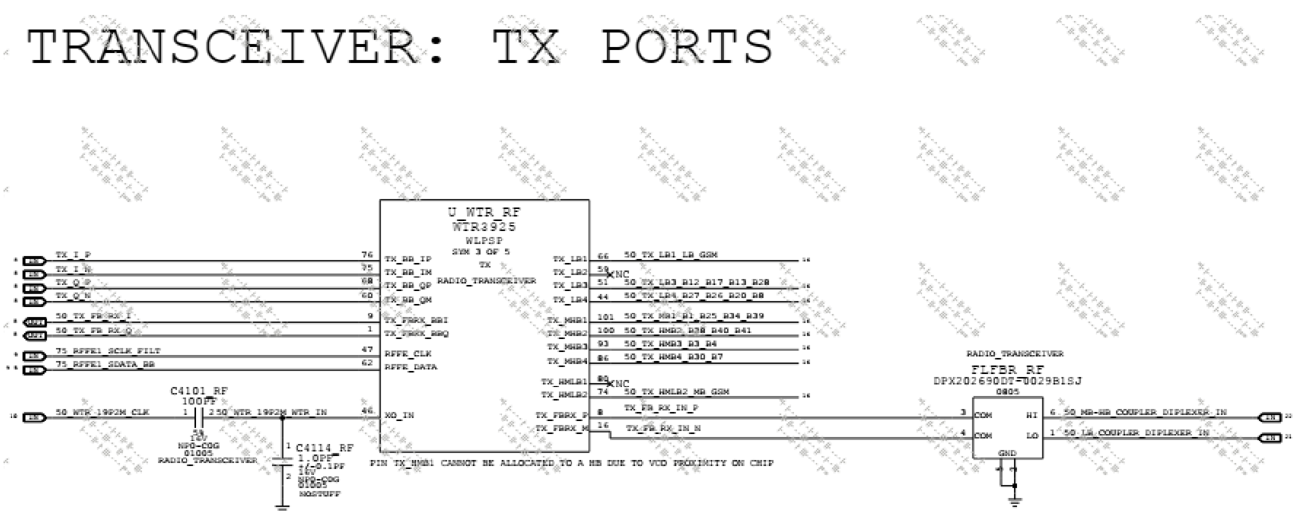
See also APL-TOTDDE_00692725-32; APL-TOTDDE_00690599-605; APL-TOTDDE_00693077-84; APL-TOTDDE_00693085-92; APL-TOTDDE_00693069-76; APL-TOTDDE_00693183-84; APL-TOTDDE_00693181-82; APL-TOTDDE_00690632-41; APL-TOTDDE_00690662-71; APL-TOTDDE_00690642-51; APL-TOTDDE_00690652-61; APL-TOTDDE_00692431; APL-TOTDDE_00692432; APL-TOTDDE_00690672-80; APL-TOTDDE_00692027; APL-TOTDDE_00693151-57; APL-TOTDDE_00692018; APL-TOTDDE_00690621-28; APL-TOTDDE_00693144-50; APL-TOTDDE_00688425-27; APL-TOTDDE_00690629-31.

200. The Schematics and Bills of Materials listed in Exhibit E also show that the Apple/Qualcomm Accused Products include RF transceiver components and RF Front End components that are capable of receiving radio data signals from a base station. *See, e.g.*, APL-

TOTDDE00000355-413 (schematics for "N71," which is the product code for iPhone 6s) at APL-TOTDDE00000355:

PAGE	CSA	CONTENTS
31	46	I/O:DOCK FLEX B2B
32	47	I/O:BUTTON FLEX B2B
33	49	BASEBAND:RADIO SYMBOL
34	1	page1
35	2	ELNA & UAT ANT FEED
36	3	FE: ANT CONNECTORS AND UAT TUNER
37	4	WLAN LAT 2.4GHZ BAW BPF
38	30	DEBUG CONN & TEST POINTS
39	31	CELLULAR BASEBAND: POWER1
40	32	CELLULAR BASEBAND: POWER2
41	33	CELLULAR BASEBAND: CONTROL AND INTERFACES
42	34	CELLULAR BASEBAND: GPIOS
43	35	CELLULAR PMU: CONTROL AND CLOCKS
44	36	CELLULAR PMU: SWITCHERS AND LDOS
45	37	CELLULAR PMU: ET MODULATOR
46	38	CELLULAR TRANSCEIVER: POWER
47	39	CELLULAR TRANSCEIVER: PRX PORTS
48	40	CELLULAR TRANSCEIVER: DRX/GPS PORTS
49	41	CELLULAR TRANSCEIVER: TX PORTS

See also id. at APL-TOTDDE00000403:



201. The Apple/Qualcomm Accused Products therefore meet the limitations of claim 7.

6. '865 Patent Claim 8: ***Outer loop power control device for wireless communications systems, according to claim 5, further comprising a radio transmitter (202) able to send the power control information to a***

base station (102, 103) or to a mobile station (104) of the wireless communication system.

202. In my opinion, the Apple/Qualcomm Accused Products meet the elements of claim 8, which recites: "Outer loop power control device for wireless communications systems, according to claim 5, further comprising a radio transmitter (202) able to send the power control information to a base station (102, 103) or to a mobile station (104) of the wireless communication system." Claim 8 therefore depends on claim 5.

203. As I described above, the Apple/Qualcomm Accused Products meet the limitations of claim 5 and include radio transceivers as described in claim 7. The radio transceivers of the Apple/Qualcomm Accused Products are also able to send power control information to a base station of the wireless communication system, as I discussed above with respect to claim 1.

204. The Apple/Qualcomm Accused Products therefore meet all of the limitations of claim 8.

7. '865 Patent Claim 10: *Outer loop power control device in a wireless communication system, according to claim 5, wherein the outer loop power control device is incorporated in a mobile station for wireless communications systems.*

205. In my opinion, the Apple/Qualcomm Accused Products meet the elements of claim 10, which recites "Outer loop power control device in a wireless communication system, according to claim 5, wherein the outer loop power control device is incorporated in a mobile station for wireless communications systems." Claim 10 therefore depends on claim 5.

206. As described above, the Apple/Qualcomm Accused Products meet the limitations of claim 5. The baseband processors of the Apple/Qualcomm Accused Products (i.e. the outer loop power control device) are incorporated into a mobile station for wireless communications systems (i.e. a mobile phone).

207. For example, the Qualcomm SDX60M (X60) modem baseband processor is incorporated in the Apple iPhone 13 Pro Max:

APL-TOTDDE_00690652-61 at APL-TOTDDE_00690652. *See also* Exhibit C (identifying the Qualcomm baseband processors that are incorporated into the Apple/Qualcomm Accused Products).

208. The Apple/Qualcomm Accused Products therefore meet the limitations of claim 10.

8. '865 Patent Claim 12: *Mobile station for wireless communications systems including the outer loop power control device according to claim 5.*

209. Claim 12 of the '865 Patent recites: "Mobile station for wireless communications systems including the outer loop power control device according to claim 5." In my opinion, the Apple/Qualcomm Accused Products meet all of the elements of claim 12 for the same reasons that

they meet all of the elements of claims 5 and 10 as described above. As such I incorporate my analysis of those claims by reference.

B. The Apple/Intel Accused Products Infringe the '865 Patent

210. I understand that TOT asserts claims 1, 2, 3, 5, 6, 7, 8, 10, and 12 of the '865 Patent against the Apple/Intel Accused Products. Claims 1 and 2 are method claims directed to an "outer loop power control method," while claims 5, 6, 7, 8, 10, and 12 are product claims directed to an "outer loop power control device" or a "mobile station." It is my opinion that the Apple/Intel Accused Products perform each element of method claims 1 and 2 when powered on and in normal use, and the Apple/Intel Accused Products satisfy all of the elements of product claims 5, 6, 7, 8, 10, and 12.

211. I understand that Apple produced software and firmware source code for the Apple/Intel Accused Products, including source code printouts APPLE_INTEL_000001 – 178. I have reviewed the code that Apple produced.

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212. I have reviewed source code for project names ICE16, ICE17, ICE19, and IBIS. From my review, the relevant portions of the code from each of these products related to OLPC are substantially identical across all of these versions. In addition, I understand that Apple's Rule 30(b)(6) witness Afzal Ahmad has confirmed that there are no material differences with respect to how the OLPC algorithm works as between the ICE16, ICE17, ICE 18, ICE19, and IBIS code versions. *See* Afzal Ahmad Deposition (3/19/2024) at 39:18-40:8; 116:7-122:3. I provide a specific infringement analysis of ICE19, specifically the code from the path /Baseband_FW/Baseband-ICE19-FW-1.05.05/, below, which I understand is used in the Intel XMM7660 modem based iPhone 11 (A2111), iPhone 11 Pro (A2160), and iPhone 11 Pro Max (A2160) products, as well as the iPhone SE (2020) (A2275), and the iPad Air (4th Gen) (2020)

(A2324, A2072), iPad Pro 11 (2020) (A2068, A2230), and iPad Pro 12.9 (4th Gen) (2020) (A2069, A2232). While I cite to this version in my analysis, I have reviewed the other source code files for this functionality produced by Apple, have determined that it operates in the same way for all relevant purposes, and thus it should be understood that my analysis below holds true for any Apple/Intel Accused Products using any of the other ICE and IBIS source code versions.

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1. '865 Patent Claim 1

213. The Apple/Intel Accused Products infringe each element of claim 1 of the '865 Patent as will be explained below.

a) [1.pre] *Outer loop power control method for wireless communications systems, based on CDMA technology, the method comprising:*

214. I understand that the parties disagree as to whether the preamble of claim 1 is limiting. Whether or not the preamble is limiting, in my opinion the Apple/Intel Accused Products satisfy the claim 1 preamble. As will be discussed below, the Apple/Intel Accused Products include an outer loop power control method. *See, e.g.,* APPLE_INTEL_000003-006.

215. Moreover, the Apple/Intel Accused Products comply with the 3G standard, and when operating on 3G operate on wireless communications systems based on CDMA technology:

- **Model A1863***
  FDD-LTE (Bands 1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 18, 19, 20, 25, 26, 28, 29, 30, 66)
  TD-LTE (Bands 34, 38, 39, 40, 41)
  TD-SCDMA 1900 (F), 2000 (A)
  CDMA EV-DO Rev. A (800, 1900, 2100 MHz)
  UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)
  GSM/EDGE (850, 900, 1800, 1900 MHz)

APL-TOTDDE_00693077. *See also* APL-TOTDDE_00690652 (iPhone 13 Pro Max Technical Specifications: "CDMA EV-DO Rev. A (800, 1900 MHz) … UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)"); APL-TOTDDE_00693112 (iPad (6th generation) - Technical Specifications).

WCDMA (Wideband Code Division Multiple Access)

UMTS standard for 3G digital mobile networks, using CDMA technology. It is the evolution path for GSM and EDGE to UMTS and offers increased voice capacity and theoretical peak data speeds of up to 2 Mbps. The 3GPP task group continues to work on the evolution of WCDMA toward 4G and has defined a series of evolutionary steps:

https://www.gartner.com/en/information-technology/glossary/wcdma-wideband-code-division-multiple-access#:~:text=Division%20Multiple%20Access)-,WCDMA%20(Wideband%20Code%20Division%20Multiple%20Access),of%20up%20to%202%20Mbps.

216. An Intel Specification makes clear that the Apple/Intel Accused Products perform Outer Loop Power control in the context of a WCDMA system:

1 Introduction

A WCDMA system is very sensitive in terms of power budget. If one of the physical channels currently transmitted by the node B is using too much power the other channels may get interfered. This interference can cause that the complete cell or some of the physical channels can not be correctly received by UEs. The power budget for all common control channels is configured such that the interference is kept on a minimum level. Dedicated channels are individually assigned to UEs and therefore a power control method is defined by the 3GPP standard. This power control algorithm is used to maintain a defined quality of service by using as low power as possible. For the UE an algorithm to control the uplink power of the UE and one to control the downlink power of the node B is defined. For uplink power control an inner loop power control is defined which receives commands from the node B and increases or decreases its uplink power accordingly. For the control of the downlink power of the node B an outer loop power control loop and an inner loop power control are defined. The outer loop power control loop controls the SIR of the dedicated channel signal received by the UE whereas the inner loop power control loop tries to converge the current SIR to the SIR requested by OLPC by sending power control commands to the node B on which the node B would increase or decrease the power of the dedicated channel.

1.1 Scope

This document only gives details of the functionality and implementation of outer loop power control running on the UE side and where needed for better understanding details of the corresponding inner loop power control functionality are also given.

1.2 Purpose

The purpose of this document is to give a detailed explanation and description of the outer loop power control loop implementation running within the COMNEON UMTS layer 1 protocol stack.

APL-TOTDDE_00693407 at 693413. This document was described by an Apple engineer as giving "the very high level view what the [OLPC] feature is all about." Afzal Ahmad Deposition (3/192024) at 44:21-46:8; *see also id.* at 49:7-53:13.

217. Other technical documentation produced in this case, including source code, device specifications, repair guides, processor specifications, and algorithm documentation, likewise support my opinion that the Apple/Intel Accused Products meet the preamble of this claim. *See* APL-TOTDDE_00688367, APL-TOTDDE_00693407, QCTOTVAPPLE01302_00705129, QCTOTVAPPLE01302_00695540, APL-TOTDDE_00688354, APL-TOTDDE_00688357, APL-TOTDDE_00688365, APL-TOTDDE_00688373, APL-TOTDDE_00688381, APL-TOTDDE_00688388, APL-TOTDDE_00688414, APL-TOTDDE_00688421, APL-

TOTDDE_00688425, APL-TOTDDE_00688436, APL-TOTDDE_00688444, APL-TOTDDE_00690586, APL-TOTDDE_00690589, APL-TOTDDE_00690592, APL-TOTDDE_00690599, APL-TOTDDE_00690606, APL-TOTDDE_00690614, APL-TOTDDE_00690621, APL-TOTDDE_00690629, APL-TOTDDE_00690632, APL-TOTDDE_00690642, APL-TOTDDE_00690652, APL-TOTDDE_00690662, APL-TOTDDE_00690672, APL-TOTDDE_00690681, APL-TOTDDE_00692016, APL-TOTDDE_00692018, APL-TOTDDE_00692027, APL-TOTDDE_00692431, APL-TOTDDE_00692432, APL-TOTDDE_00692725, APL-TOTDDE_00693069, APL-TOTDDE_00693077, APL-TOTDDE_00693085, APL-TOTDDE_00693119, APL-TOTDDE_00693126, APL-TOTDDE_00693134, APL-TOTDDE_00693144, APL-TOTDDE_00693151, APL-TOTDDE_00693178, APL-TOTDDE_00693181, and APL-TOTDDE_00693183, Afzal Ahmad Deposition (3/19/2024) at 13:12-14:21.

b) [1.a] *estimating a desired signal to interference ratio received (SIR_{rec}) based on a data signal (107, 108) received from a base station (102, 103) or mobile station (104)*

218. In my opinion, the Apple/Intel Accused Products perform claim element **[1.a]**, which recites "estimating a desired signal to interference ratio received (SIR_{rec}) based on a data signal (107, 108) received from a base station (102, 103) or mobile station (104)."

219. The Apple/Intel Accused Products comply with the 3G standard, which explains that the SIR_{rec} ratio is a computed value based on, in part, the received signal code power. For example, the UMTS specification states that user equipment "should estimate the received downlink DPCCH/DPDCH power of the connection to be power controlled" and the "SIR_{est} can be calculated as RSCP/ISCP, where RSCP refers to the received signal code power on one code and ISCP refers to the non-orthogonal interference signal code power of the received signal on one

code." ETSI TS 125 214 V12.1.0 (2015-01) Annex B § B.2. The standard further explains that the base station sends a TPC (transmit power control) signal to the device, which is a data signal, that the device uses to estimate a desired SIR for setting its output power:

> Responding to a downlink TPC command, the UE shall change its uplink DPCH output power at the beginning of the first uplink pilot field after the TPC command reception. Responding to an uplink TPC command, the UTRAN access point shall change its DPCH output power at the beginning of the next downlink pilot field after the reception of the whole TPC command. Note that in soft handover, the TPC command is sent over one slot when DPC_MODE is 0 and over three slots when DPC_MODE is 1. Note also that the delay from the uplink TPC command reception to the power change timing is not specified for UTRAN. The UE shall decide and send TPC commands on the uplink based on the downlink SIR measurement. For the DPCH, the TPC command field on the uplink starts, when measured at the UE antenna, 512 chips after the end of the downlink pilot field. The UTRAN access point shall decide and send TPC commands based on the uplink SIR measurement. However, the SIR measurement periods are not specified either for UE nor UTRAN.

ETSI TS 125 214 V12.1.0 (2015-01) Annex B § B.1 ; *See also* ETSI TS 125 214 V12.1.0 (2015-01) Annex B § B.2:

220. Other 3G standard documents likewise state that devices implementing the 3G/WCDMA standards use data signals to estimate a desired SIR:

> # 9 Measurements provided by the physical layer
>
> One of the key services provided by the physical layer is the measurement of various quantities, which are used to trigger or perform a multitude of functions. Both the UE and the UTRAN are required to perform a variety of measurements. The standard will not specify the method to perform these measurements or stipulate that the list of measurements provided in this clause must all be performed. While some of the measurements are critical to the functioning of the network and are mandatory for delivering the basic functionality (e.g., handover measurements, power control measurements), others may be used by the network operators in optimising the network (e.g., radio environment).

ETSI TS 125 302 V15.0.0 (2018-07) § 9.

> # 9.2 UE Measurements
>
> For definitions of the measurements, see [6] and [11].

9.2.12 Transport channel BLER

This measure is mandatory for UE.

Measurement	Transport channel BLER (BLock Error Rate)
Source	L1(UE)
Destination	RRC (RNC,UE)
Reporting Trigger	Periodic, on demand
Description	Estimation of the transport channel block error rate (BLER).

ETSI TS 125 302 V15.0.0 (2018-07) § 9.2.12.

5.2.2 SIR

Definition	Type 1: Signal to Interference Ratio, is defined as: (RSCP/ISCP)×SF. The measurement shall be performed on the DPCCH of a Radio Link Set. In compressed mode the SIR shall not be measured in the transmission gap. The reference point for the SIR measurements shall be the Rx antenna connector. If the radio link set contains more than one radio link, the reported value shall be the linear summation of the SIR from each radio link of the radio link set. If Rx diversity is used in the Node B for a cell, the SIR for a radio link shall be the linear summation of the SIR from each Rx antenna for that radio link. When cell portions are defined in the cell, the SIR measurement shall be possible in each cell portion. where: RSCP = Received Signal Code Power, unbiased measurement of the received power on one code. ISCP = Interference Signal Code Power, the interference on the received signal. SF=The spreading factor used on the DPCCH. Type 2: Signal to Interference Ratio, is defined as: (RSCP/ISCP)×SF. The measurement shall be performed on the PRACH control part. The reference point for the SIR measurements shall be the Rx antenna connector. When cell portions are defined in the cell, the SIR measurement shall be possible in each cell portion. where: RSCP = Received Signal Code Power, unbiased measurement of the received power on the code. ISCP = Interference Signal Code Power, the interference on the received signal. SF=The spreading factor used on the control part of the PRACH.

ETSI TS 125 215 V11.0.0 (2012-11) § 5.2.2.

221. And the design documents I reviewed make it clear that the Apple/Intel Accused Products measure the SIR based on a digital signal:

3.2.2 Collecting Measured SIR Results

As already mentioned, the collection of the measured SIR results of the previous frames is also one task of the OLPC frame interrupt. Because there is the need within OLPC of having also a running average of the measured SIR results with different average window sizes an averaging of measured SIR results is also performed within the frame tick.

Two different running average purposes are defined. One used for offset compensation (see chapter Figure 25) and one for the windup effect (see chapter 3.4.6). The following table shows the window sizes for the two cases.

Table 8. Window Sizes of Measured SIR running average

Usage	Window Size
Offset Compensation	16
Windup Effect	4

After the initial settling phase (see chapter 3.4.2) new SIR measurements are collected via the function `l1u_olpc_ctrl_put_meas_sir`. Within this function the measurement result is put into the corresponding running average buffer and then each running average gets calculated individually. The calculation is done in such a way that the maximum number of samples used is limited by the window size but if the number of samples is less than the window size still an averaging is performed using the current available number of samples.

In order to access the measured SIR results later when the SIR control algorithm is running get functions are defined. The last measured SIR result can be accessed via `l1u_olpc_ctrl_get_last_meas_sir`, the running average value for the windup effect via `l1u_olpc_ctrl_get_meas_sir_avgr_for_olpc_lock` and the running average for the offset compensation via `l1u_olpc_ctrl_get_meas_sir_avgr_for_offs_comp`.

APL-TOTDDE_00693407 at 19; *see also* Afzal Ahmad Deposition (3/19/2024) at 75:23-76:18 ("When the DPCH is configured, based on the current radio condition, or based on the initial stage of the decoder signal, you decide what is the target.").

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222. This is borne out by my analysis of the produced source code. The source code file /pcc/upc/l1u_l1g/l1u/l1u_olpc_ctrl.cpp is the primary file that is relevant to the Apple/Intel Accused Products' OLPC algorithm. APPLE_INTEL_000007-51.

223. l1u_olpc_ctrl.cpp file contains global definitions related to SIR, which is measured as a running average. APPLE_INTEL_000027-28.

224. Function l1u_olpc_ctrl_frame_tick is called on every frame and receives the measured SIR average from the inner loop firmware. APPLE_INTEL_000023-24 at lines 5531-5554; *see also* Afzal Ahmad Deposition (3/19/2024) at 58:17-60:8.

225. Then function l1u_olpc_ctrl_determine_lock_status uses the measured average SIR value and compares it to see if the value is within thresholds from the target SIR. APPLE_INTEL_000007-08; *see also* Afzal Ahmad Deposition (3/19/2024) at 105:21-107:3 ("It uses all this information in order to compute the SIR target value. That is for the OLPC algorithm").

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226. Therefore, it is my opinion that the Apple/Intel Accused Products perform claim element **[1.a]**.

c) **[1.b]** ***setting a desired signal to interference ratio target (SlR_{target}) that is close to a signal to interference ratio required (SIR_{rec}) during the normal mode of the outer loop***

227. Element **[1.b]** in claim 1 recites "setting a desired signal to interference ratio target (SlR_{target}) that is close to a signal to interference ratio required (SIR_{rec}) during the normal mode of the outer loop." I understand that the parties agree that the phrase "signal to interference ratio required (SIR_{rec})" in this element should be construed as "signal to interference ratio required (SIR_{req})." Applying this construction, it is my opinion that the Apple/Intel Accused Products perform this step.

228. I also understand that certain of the Defendants have argued that "SIR_{req}" means "theoretical minimum of the desired signal to interference ratio received (SIR_{rec}) that satisfies the target frame error rate (FER_{target})." I disagree, as the claim term and specification are clear that the SIR_{req} is simply "a signal to interference ratio required during the normal mode of the outer loop." In any event, under any of the parties' proposed constructions, the Apple/Intel Accused Products perform element **[1.b]**, for the reasons I discuss in more detail below.

229. As discussed above, the Apple/Intel Accused Products comply with the 3G standard. The ETSI TS describes how 3G implements outer loop power control:

> **7.2.4.8.1 UL Outer Loop Power Control**
>
> The UL Outer Loop Power Control located in the SRNC [TDD – except for uplink shared channels where it is located in the CRNC] sets the target quality value for the UL Inner Loop Power Control which is located in Node B for FDD and 1.28 Mcps TDD and is located in the UE for 3.84 Mcps TDD. It receives input from quality estimates of the transport channel. The UL outer loop power control is mainly used for a long-term quality control of the radio channel.
>
> In FDD and 1.28 Mcps TDD this function is located in the UTRAN, in 3.84 Mcps TDD the function is performed in UTRAN and the target quality value is sent to the UE by the SRNC or the CRNC, respectively.
>
> In FDD and 1.28 Mcps TDD, if the connection involves both a SRNS and a DRNS the function UL Outer Loop Power Control (located in the SRNC [1.28 Mcps TDD – or in the CRNC, respectively]) sets the target quality for the UL Inner Loop Power Control function (located in Node B).
>
> **7.2.4.8.2 DL Outer Loop Power Control**
>
> The DL Outer Loop Power Control sets the target quality value for the DL inner loop power control. It receives input from quality estimates of the transport channel, measured in the UE. The DL outer loop power control is mainly used for a long-term quality control of the radio channel.
>
> This function is located mainly in the UE, but some control parameters are set by the UTRAN.
>
> The SRNC, regularly (or under some algorithms), sends the target down link power range based on the measurement report from UE.

ETSI TS 125 401 V4.2.0 (2001-09) at 23.

230. As the document notes, OLPC "sets the target quality value for the UL [uplink] Inner Loop Power Control," that "is mainly used for long-term quality control of the radio channel." Likewise, OLPC "sets the target quality value for the DL [downlink] inner loop power control." ETSI TS 125 401 V4.2.0 (2001-09) at 23; *see also* ETSI TS 125 301 V13.0.0 (2016-01) at 33. The target quality value discussed in these references is the SIR_{target} of the claim. SIR_{target} is set to maintain required call quality, which is measured by a Block Error Rate (BLER) set by the network:

> ## 14.9s Downlink power control
>
> ### 14.9.1 Generalities
>
> This function is implemented in the UE in order to set the SIR target value on each CCTrCH used for the downlink power control. This SIR value shall be adjusted according to an autonomous function in the UE in order to achieve the same measured quality as the quality target set by UTRAN. The quality target is set as the transport channel BLER value for each transport channel as signalled by UTRAN.
>
> When transport channel BLER is used the UE shall run a quality target control loop such that the quality requirement is met for each transport channel, which has been assigned a BLER target.
>
> The UE shall set the SIR target when the physical channel has been set up or reconfigured. It shall not increase the SIR target value before the power control has converged on the current value. The UE may estimate whether the power control has converged on the current value, by comparing the averaged measured SIR to the SIR target value.

ETSI TS 125 331 V10.20.0 (2016-08) at 1825.

231. This is also described in Holma and Toskala's *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, which notes that OLPC "sets the target for fast power control so that the required quality is provided." Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2002) at 232; *see also id.* at 239 ("[t]he outer loop power control is needed to keep the quality of communication at the required level by setting the target for the fast power control.").

232. The OLPC Design Documentation makes clear that the Apple/Intel Accused Products are setting a SIR_{target} that is close to a SIR_{req}, specifying that the "[m]ain task of OLPC is to control the SIR in such a way that the quality target of all involved transport channels can be achieved using as little DPCH downlink power as possible." This is done using the slow OLPC loop, which "sets a specific target SIR every time new decoder results of all involved TRCH [transport channels] are available":

3.4 Controlling SIR

Main task of OLPC is to control the SIR in such a way that the quality target of all involved transport channels can be achieved using as little DPCH downlink power as possible. To control the SIR two control loops are running on the UE side. A slow OLPC loop which sets a specific target SIR every time new decoder results of all involved TRCH are available and a fast ILPC loop which measures the SIR every slot, compares it with the set target SIR from OLPC and then either sends a TPC up or down command to the node B in the corresponding UL slot. The following figure illustrates the inter working between OLPC and ILPC.

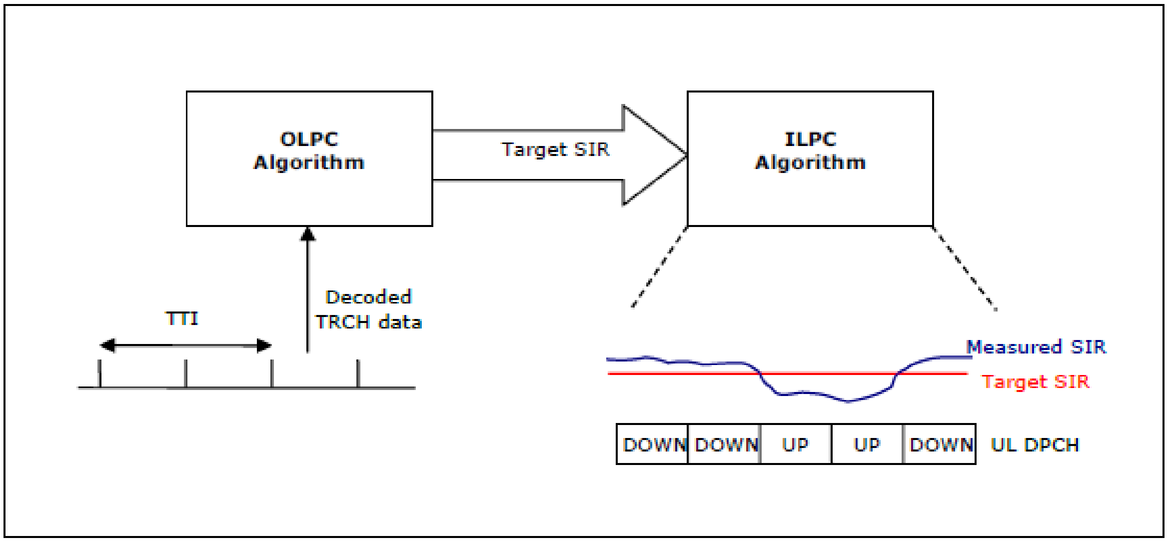

Figure 13. Inter working between OLPC and ILPC

APL-TOTDDE_00693407 at 26; *see also* Afzal Ahmad Deposition (3/19/2024) at 75:23-76:18 ("When the DPCH is configured, based on the current radio condition, or based on the initial stage of the decoder signal, you decide what is the target."), 101:9-103:14.

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233. My review of the produced source code confirms that the Apple/Intel Accused Products perform this step. The source code file /pcc/upc/l1u_l1g/l1u/l1u_olpc_ctrl.cpp contains functions for OLPC that calculate the SIR_{target}. *See* APPLE_INTEL_000007-51.

234. The function l1u_olpc_ctrl_track_bler_mode of that file looks for Cyclic Redundancy Check (CRC) errors in the signal which are indicative of the BLER. If there are too many errors, the function calls l1u_olpc_ctrl_increase_target_sir to increase the SIR_{target}, otherwise

it may call l1u_olpc_ctrl_decrease_target_sir to decrease SIR_{target}. APPLE_INTEL_000017-18 at lines 3414-3453.

235. Similarly, the function l1u_olpc_ctrl_track_srb_mode may call l1u_olpc_ctrl_increase_target_sir to increase the SIR_{target}. APPLE_INTEL_000013-14 at lines 3173-3195. These functions are called during normal operation of the outer loop, and are used to set a desired signal to interference ratio target (SlR_{target}) that is close to a signal to interference ratio required (SIR_{rec}). *See also* Afzal Ahmad Deposition (3/19/2024) at 60:9-61:1 ("Q: So this is referring to the two tracking modes we talked about. The SRB signaling radio barrier tracking mode, and then the BLER tracking mode for the transport channels, right? A: Yes.").

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236. Even under Defendants' proposed construction of SIR_{req} as a "theoretical minimum of the desired signal to interference ratio received (SIR_{rec}) that satisfies the target frame error rate (FER_{target})," the Apple/Intel Accused Products perform this element. As discussed above, the Apple/Intel Accused Products calculate a SIR_{req} as a required SIR based on CRC errors that indicate a Block Error Rate (BLER). BLER is calculated on a block level while FER is calculated on a frame level and both are calculated based on CRC. A frame is a collection of blocks. Therefore, where the Apple/Intel Accused Products calculate a SIR_{req} to minimize BLER based on CRC, the SIR_{req} is implicitly designed to satisfy a target frame error rate (e.g. ER based on multiple blocks).

237. Therefore, it is my opinion that the Apple/Intel Accused Products perform claim element **[1.b]**.

d) [1.c] *detecting a start (402) of the outer loop wind-up*

238. It is my opinion that the Apple/Intel Accused Products perform claim element **[1.c]**, which recites "detecting a start (402) of the outer loop wind-up." As an initial matter, I understand that the parties disagree on the meaning of the term "outer loop wind-up." I understand that TOT believes that outer loop wind-up should have its plain and ordinary meaning, which is "an outer loop condition wherein the signal to interference ratio received (SIR_{rec}) does not follow the desired signal to interference ratio target (SIR_{target}), for reasons such as worsening of channel conditions or saturation of the transmitter." I understand that Defendants have proposed that outer loop wind-up means "outer loop condition or mode that would dictate increases to the signal to interference ratio target (SIR_{target}) that cannot be followed by the signal to interference ratio received (SIR_{rec}) because of sustained worsening of the channel's conditions or sustained transmission of the transmitter at the maximum power available for the connection." Whichever construction is deemed appropriate, it does not affect my opinion that the Apple/Intel Accused Products perform this claim element.

239. As discussed above, the Apple/Intel Accused Products comply with the 3G standard. The ETSI TS mandates that 3G-compliant devices detect a start of outer loop wind-up and limit SIR_{target} when a windup condition is detected:

> 7.8.1.1 Definition and applicability
>
> Power control in the downlink is the ability of the UE receiver to converge to required link quality set by the network while using as low power as possible in downlink. If a BLER target has been assigned to a DCCH (See clause C.3), then it has to be such that outer loop is based on DTCH and not on DCCH. The requirements and this test apply to all types of UTRA for the FDD UE for Release 5 and earlier releases.

ETSI TS 134 121-1 V13.0.0 (2016-08) at 647.

7.8.3 Power control in the downlink, wind up effects (Release 5 and earlier)

7.8.3.1 Definition and applicability

This requirement verifies that, after the downlink maximum power is limited in the UTRAN and it has been released again, the downlink power control in the UE does not have a wind up effect, i.e. the required DL power has increased during time period the DL power was limited. The requirements and this test apply to all types of UTRA for the FDD UE for Release 5 and earlier releases.

Id. at 663.

7.8.3A Power control in the downlink, wind up effects (Release 6 and later)

7.8.3A.1 Definition and applicability

This requirement verifies that, after the downlink maximum power is limited in the UTRAN and it has been released again, the downlink power control in the UE does not have a wind up effect, i.e. the required DL power has increased during time period the DL power was limited. The requirements and this test apply to Release 6 and later release for all types of UTRA for the FDD UE.

7.8.3A.2 Minimum requirements

This test is run in three stages where stage 1 is for convergence of the power control loop. In stage two the maximum downlink power for the dedicated channel is limited not to be higher than the parameter specified in table 7.8.3A.1. All parameters used in the three stages are specified in table 7.8.3A.1. The downlink $\frac{DPCH\_E_c}{I_{or}}$ power ratio measured values, which are averaged over one slot, during stage 3 shall be lower than the value specified in table 7.8.3A.2 more than 90 % of the time. Power control of the UE is ON during the test.

Id. at 665.

240. Documentation produced in this litigation supports that the Apple/Intel Accused Products detect a start of outer loop wind-up. The documentation specifies that windup effects are to be prevented, which requires that windup be detected in order to prevent it:

3.4.6 Preventing Windup Effects

The windup effect happens when the node B does not control the downlink power any longer based on the TPC bits received by the UE. This can either be due to downlink power saturation (min or max downlink power reached) or due to bad radio conditions so that the node b can not decode the TPC bits. In such situation the measured SIR may not change. As the OLPC on UE side is still running it can happen that the target SIR drifts away from the measured SIR, which means the difference between measured SIR and target SIR becomes very big. If in this case the node B suddenly starts reacting on the TPC bits again, then due to the big difference in measured versus target SIR ILPC on UE side would ask all the time for ramping power up or down till the measured SIR converges again to the target SIR. This will either lead to a sudden big increase in downlink power which will disturb other UEs or a sudden drop of the downlink power which ends up in bad receiver conditions.

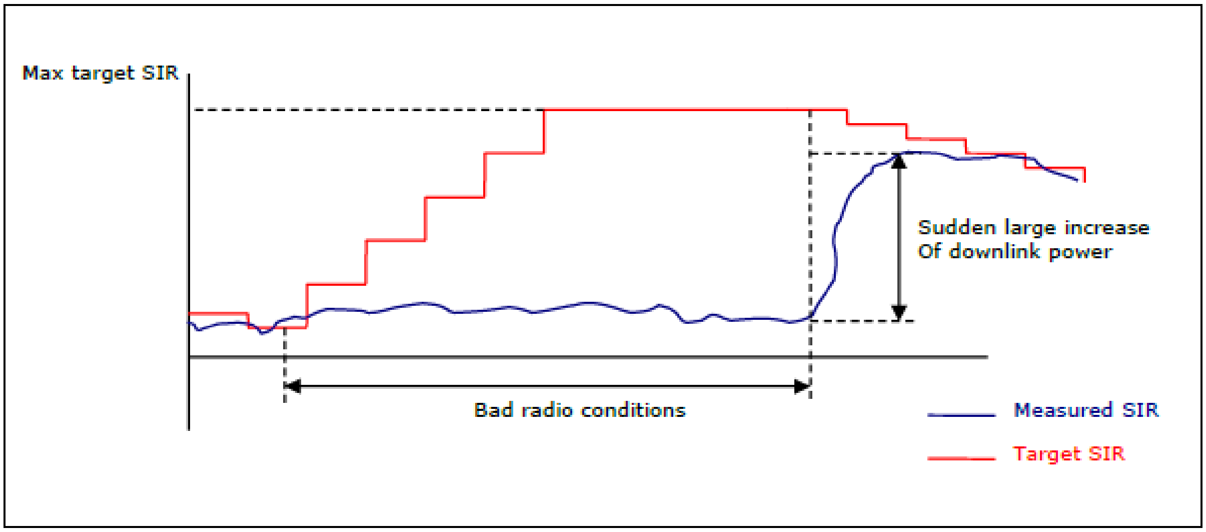

Figure 34, Example of Windup Effect

Figure 34 shows an example of the windup effect. In the time period with bad radio conditions the node B is not able to decode the TPC and therefore does not increase the downlink power which results in a very constant SIR. On the UE side all decoded blocks do have a CRC error resulting in a permanent increase of the target SIR. At the point in time the radio conditions do improve a sudden in crease of target SIR happens because ILPC wants to converge measured SIR to target SIR and therefore sends all the time TPC up commands which can now be decoded again by the node B.

APL-TOTDDE_00693407 at 47-48; *see also* Afzal Ahmad Deposition (3/19/2024) at 88:3-91:11 ("Q: So if the difference between the target and the measured value gets to be more than two dB, that is when you are detecting or declaring this windup has probably occurred, right? A: Yes."), 93:4-20 (referring to 2 dB threshold), 101:9-104:13.

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241. Review of the Apple/Intel source code confirms that the Apple/Intel Accused Devices perform the step of detecting a start of outer loop wind-up. The file pcc/upc/l1u_l1g/l1u/l1u_olpc_ctrl.cpp contains the functions for detecting wind-up. *See* APPLE_INTEL_000007-51.

242. The file contains a number of global definitions that set the thresholds for detecting start of outer loop wind-up including:

LPC_MAX_POSITIVE_ILPC_SIR_DELTA = 2 dB,

OLPC_MAX_NEGATIVE_ILPC_SIR_DELTA = -2 dB,

OLPC_MAX_NEGATIVE_ILPC_SIR_DELTA_SRB = -5 dB. *Id.*, *see also* Afzal Ahmad Deposition (3/19/2024) at 104:7-13.

243. The function l1u_olpc_ctrl_determine_lock_status uses these thresholds to in part detect start of outer loop wind-up if they are met. For example, the function checks delta_sir at l. 1052. APPLE_INTEL_000007 at l. 1052; *see also* Afzal Ahmad Deposition (3/19/2024) at 101:9-104:13 ("this function checks whether the further SIR step up or down are allowed . . . if enough measured SIR samples, then this is based on the average SIR"). does not follow the desired signal to interference ratio target

244. function l1u_olpc_ctrl_decoded_dl_data_tick is called each time decoded TRCH data is received. It then checks the ILPC lock status. APPLE_INTEL_000007 at lines 5603-5604. If OLPC is active, the function then calls l1u_olpc_ctrl_track_srb_mode, and l1u_olpc_ctrl_track_bler_mode to detect wind-up in the SRB channel. This SRB mode has been in the code since at least February of 2017. Afzal Ahmad Deposition (3/19/2024) at 44:12-17; 46:9-47:18. When thresholds are met in the OLPC and SRB/BLER modes, the code will set a lock status. APPLE_INTEL_000007-08 at lines 1070-1107. *See also* Afzal Ahmad Deposition (3/19/2024) at 60:9-61:1 ("Q: So this is referring to the two tracking modes we talked about. The SRB signalling radio barrier tracking mode, and then the BLER tracking mode for the transport channels, right? A: Yes."); 107:8-108:23, 109:10-111:2.

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245. As a result, the Apple/Intel Accused Products perform this claim limitation under either the plain and ordinary meaning of "outer loop wind-up" which is "an outer loop condition wherein the signal to interference ratio received (SIR_{rec}) does not follow the desired signal to

interference ratio target (SIR_{target}), for reasons such as worsening of channel conditions or saturation of the transmitter," or under Defendants' proposed construction which is "outer loop condition or mode that would dictate increases to the signal to interference ratio target (SIR_{target}) that cannot be followed by the signal to interference ratio received (SIR_{rec}) because of sustained worsening of the channel's conditions or sustained transmission of the transmitter at the maximum power available for the connection." As shown above, when conditions deteriorate to the extent that increasing SIR_{target} does not affect SIR_{rec} and the programmed thresholds are met, the Apple/Intel Accused Products enter wind-up mode. In other words, SIR_{rec} is not following the SIR_{target}, as in TOT's proposed construction. Or, as in Defendants' proposed construction, the OLPC algorithm is determining that increases to the signal to interference ratio target (SIR_{target}) cannot be followed, e.g. because a maximum threshold has been hit with no meaningful improvement in SIR_{rec}. Moreover, the thresholds are set in such a way that they would be triggered by "sustained worsening of the channel's conditions or sustained transmission of the transmitter at the maximum power available for the connection." As a result, it is my opinion that the Apple/Intel Accused Products perform this claim limitation under either construction.

246. Therefore, it is my opinion that the Apple/Intel Accused Products perform claim element **[1.c]**.

e) **[1.d]** ***setting a specific desired signal to interference ratio target (SIR$_{target}$) during the outer loop wind-up, and***

247. In my opinion, the Apple/Intel Accused Products perform claim element **[1.d]**, which recites "setting a specific desired signal to interference ration target (SIR_{target}) during the outer loop wind-up." As I discussed above with respect to element **[1.c]**, I understand that the parties dispute the proper construction of "outer loop wind-up." Under any of the parties' proposed constructions, it is my opinion that the Apple/Intel Accused Products perform the step in element

[1.d] of "setting a specific desired signal to interference ratio target (SIR_{target}) during the outer loop wind-up."

248. As discussed above, the Apple/Intel Accused Products comply with the 3G standard for WCDMA. Documents explaining WCDMA and 3G standards demonstrate the requirement that compliant devices set a specific SIR_{target} during outer loop wind-up. For example, Holma and Toskala note that setting a desired SIR_{target} during wind-up is a requirement of the 3GPP standard:

> The outer loop problems from limited power control dynamics can be avoided by setting tight limits for the E_b/N_0 target or by an intelligent outer loop power control algorithm. Such an algorithm would not increase the E_b/N_0 target if the increase did not improve the quality. The 3GPP specifications include this requirement for the UE in [2].

Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2002) at 244.

249. Holma and Toskala describe that the SIR_{target} is set to a desired level. *See id.* at 239 ("[t]he outer loop power control is needed to keep the quality of communication at the required level by setting the target for the fast power control.") When the UE is already at maximum or minimum value, then the SIR_{target} is not increased but is instead set to an optimal value.

> **9.2.2.5 Limited Power Control Dynamics**
>
> At the edge of the coverage area the UE may hit its maximum transmission power. In that case the received BLER can be higher than desired. If we apply directly the outer loop algorithm of Figure 9.10, the uplink SIR target would be increased. The increase of the SIR target does not improve the uplink quality if the Node B is already sending only power-up commands to the UE. In that case the E_b/N_0 target might become unnecessarily high. When the UE returns closer to the Node B, the quality of the uplink connection is unnecessarily high before the outer loop lowers the E_b/N_0 target back to the optimal value. The situation in which the UE hits its maximum transmission power is shown in Figure 9.14. In this example,

> The same problem could also occur if the UE hits its minimum transmission power. In that case, the E_b/N_0 target would become unnecessarily low. The same problems can be observed also in the downlink if the power of the downlink connection is using its maximum or minimum value.

Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2002) at 243; *see also id.* at 240 (Figure 9.10).

250. In addition, the ETSI TS mandates that the downlink power control sets power to a target, which corresponds to the SIR_{target}:

> ## 8.8 Power control in downlink
>
> Power control in the downlink is the ability of the UE receiver to converge to required link quality set by the network while using as low power as possible in downlink . If a BLER target has been assigned to a DCCH (See Annex A.3), then it has to be such that outer loop is based on DTCH and not on DCCH.
>
> The requirements in this subclause were derived with the assumption that the UTRAN responds immediately to the uplink TPC commands by adjusting the power of the first pilot field of the DL DPCCH that commences after end of the received TPC command.

ETSI TS 125 101 V10.1.0 (2011-05) § 8.8.

251. The Apple/Intel Accused Products follow this requirement, as technical documentation shows that the devices attempt to limit the wind-up effect by setting a desired SIR_{target}. Specifically, in the figure below, bad radio conditions are shown where the measured SIR is below the SIR_{target}. The device sets the SIR_{target} higher when bad radio conditions exist, but the SIR remains low, likely because the base station is unable to decode the Transmit Power Control (TPC) commands from the device. Once the disconnect between SIR_{target} and measured SIR reaches a 2 dB threshold, the Apple/Intel Accused Products implement a special mechanism that sets the SIR_{target} at a certain level and does not increase it while bad radio conditions exist. That SIR_{target}, which is the top level plateau of the red line, is the specific desired signal to interference ratio target of the claim.

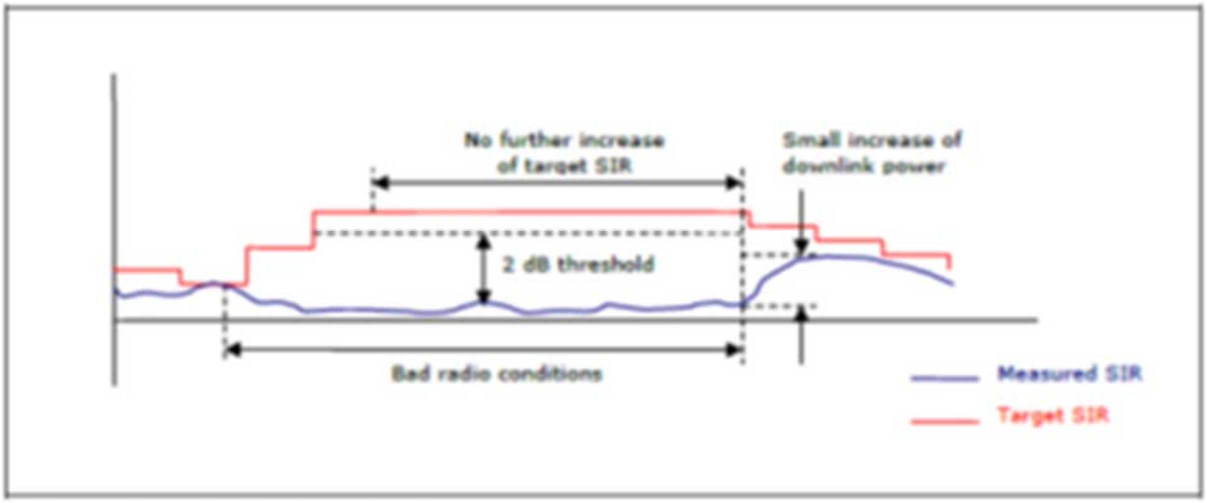

Figure 35 Limit Windup Effect

Figure 35 shows the same scenario as Figure 34 but this time including the method used by OLPC to limit the windup effect. As soon as target SIR is 2 dB above the measured SIR OLPC stops increasing target SIR even so CRC errors are received. At the time the radio conditions are improving the increase of downlink power is much smaller compared to the original case.

APL-TOTDDE_00693407 at 49; *see also id.* at 43 (graph showing windup detection in SRB TRCH channels where original value is restored upon exit of SRB tracking); *see also* Afzal Ahmad Deposition (3/19/2024) at 78:23-81:23 ("That is because the reason is once I come out of the SRB mode, I need to restore the previous value in order to operate the same time.").

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252. The source code of the Apple/Intel Accused Products also demonstrates that this claim element is met. Again, this functionality exists in /pcc/upc/l1u_l1g/l1u/l1u_olpc_ctrl.cpp. APPLE_INTEL_000007-51. As discussed above, several threshold values are defined in this file and the function l1u_olpc_ctrl_determine_lock_status locks the OLPC algorithm when the thresholds are detected. Specifically, the function l1u_olpc_ctrl_increase_target_sir will not increase the SIR_{target} when locked. APPLE_INTEL_000019 at lines 3970-3973. Likewise, function l1u_olpc_ctrl_decrease_target_sir will not decrease SIR_{target} while locked. APPLE_INTEL_000019-21 at lines 4027-4029.

253. In addition, if there is a CRC error in the SRB channel, the function l1u_olpc_ctrl_track_srb_mode will set the algorithm into SRB tracking mode, APPLE_INTEL_000013-15 at lines 3171-3177, such that the algorithm will call l1u_olpc_ctrl_set_srb_tracking_mode. APPLE_INTEL_000013-14; *see also* Afzal Ahmad Deposition (3/19/2024) at 63:1-64:13, 109:10-111:2, 111:14-19. In tracking mode, an upward adjustment to SIR_{target} is made while the global variable scaled_Target_SIR_before_srb_mode is set to the last set SIR_{target}. APPLE_INTEL_000009 at l. 2914, *see also* Afzal Ahmad Deposition (3/19/2024) at 112:2-22 ("it causes a function where from the OLPC you send to this. This is the new SIR target. This is essentially holding the pervious one before you enter into SRB mode"). This upward-adjusted SIR_{target} is a specific desired SIR value as required by the claim.

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254. Based on this evidence, it is my opinion that the Apple/Intel Accused Products perform claim element **[1.d]**.

f) **[1.e]** ***detecting a start (403) of the outer loop unwinding***

255. It is my opinion that the Apple/Intel Accused Products perform claim element **[1.e]**, which recites "detecting a start (403) of the outer loop unwinding." I understand that the parties disagree as to the construction of the term "outer loop unwinding." I understand that TOT has proposed that this term has its plain and ordinary meaning, which is "exiting or recovering from outer loop wind-up." I also understand that some Defendants have proposed that this term means "outer loop condition or mode involving the process of lowering the desired signal to interference ratio target (SIR_{target}) set during the outer loop wind-up." Whichever construction is deemed appropriate, it does not affect my opinion that the Apple/Intel Accused Products perform this claim element.

256. As noted above, technical documentation shows that the Apple/Intel Accused Products will cap SIR_{target} until unwinding occurs, then begin to modify SIR_{target} again:

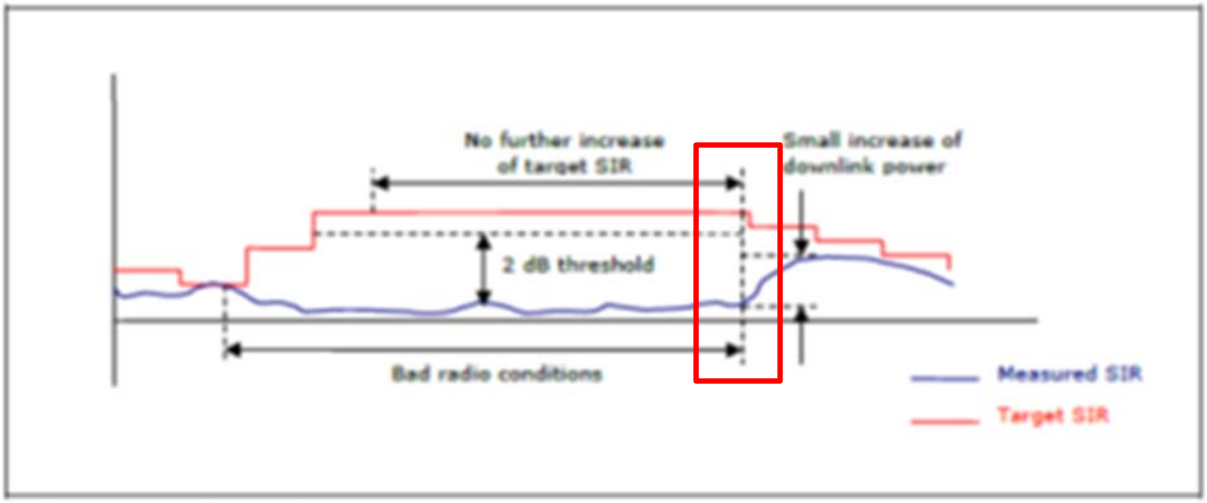

Figure 35 Limit Windup Effect

Figure 35 shows the same scenario as Figure 34 but this time including the method used by OLPC to limit the windup effect. As soon as target SIR is 2 dB above the measured SIR OLPC stops increasing target SIR even so CRC errors are received. At the time the radio conditions are improving the increase of downlink power is much smaller compared to the original case.

APL-TOTDDE_00693407 at 49; *see also id.* at 43 (graph showing windup detection in SRB TRCH channels where original value is restored upon exit of SRB tracking, i.e. unwinding).

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257. The code implementing outer loop power control, /pcc/upc/l1u_l1g/l1u/l1u_olpc_ctrl.cpp, likewise demonstrates that the Apple/Intel Accused Products detect unwinding. As noted above, the code contains global definitions setting threshold values including OLPC_MAX_NEGATIVE_ILPC_SIR_DELTA = -2 dB and OLPC_MAX_NEGATIVE_ILPC_SIR_DELTA_SRB = -5 dB. APPLE_INTEL_000028. These values correspond to the difference or "delta" between measured SIR and SIR_{target}. If the function 11u_olpc_ctrl_determine_lock_status previously set the algorithm into a locked state and then the

thresholds above are met, then unwinding has been detected and the function can then unlock the algorithm. APPLE_INTEL_000007-08.

258. In addition, the function l1u_olpc_ctrl_track_srb_mode can determine when unwinding has been detected in order to leave SRB tracking mode. APPLE_INTEL_000015 at lines 3258-3285. When SRB tracking mode is exited, the last set value of SIR_{target} set in the variable scaled_Target_SIR_before_srb_mode is used to restore the SIR_{target}. APPLE_INTEL_000015 at lines 3269-3285; *see also* Afzal Ahmad Deposition at 111:6-19 ("This is the exit part of the SRB mode . . . Basically it is trying – you are starting at the same point from where you left.").

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259. The evidence shows that the Apple/Intel Accused Products perform the step of detecting the start of the outer loop unwinding, and that they perform this step under either TOT or Defendants' constructions. TOT's construction of plain and ordinary meaning (exiting or recovering from outer loop wind-up) is met, because the OLPC algorithm checks whether a negative threshold is met for SIR_{target} moving downward, and if met, then that means that the system is exiting or recovering from outer loop wind-up, as the received SIR is no longer higher than the SIR_{target}, but is instead better, meaning conditions have improved. It also meets Defendants' construction of "outer loop condition or mode involving the process of lowering the desired signal to interference ratio target (SIR_{target}) set during the outer loop windup," as meeting the negative threshold demonstrates that SIR_{target} is lowering from its previously frozen state.

260. Based on this evidence, it is my opinion that the Apple/Intel Accused Products perform claim element **[1.e]**.

g) **[1.f]** ***wherein the desired signal to interference ratio target (SIRtarget) is modified at the start (403) of the outer loop***

unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up.

261. In my opinion, the Apple/Intel Accused Products perform claim element [1.f], which recites "wherein the desired signal to interference ratio target (SIR_{target}) is modified at the start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up." As discussed above, when unwinding is detected, the Apple/Intel Accused Products set the SIR_{target} to a stored value set just before outer loop wind-up was detected.

262. I understand that the parties disagree as to the construction of the term "wherein the desired signal to interference ratio target (SIR_{target}) is modified at the start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up." I understand that TOT proposes the plain and ordinary meaning of the term, which is "wherein the desired signal to interference ratio target (SIR_{target}) is modified at the start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up." I understand that Defendants propose "wherein the desired signal to interference ratio target (SIR_{target}) is modified at the start (403) of the outer loop unwinding to the last specific historical value of the SIR_{target} that was previously set for the outer loop power control in normal mode just prior to the start of the outer loop wind up." I further understand that Defendants claim that "[p]atentee disclaimed methods that modify the desired signal to interference ratio target (SIR_{target}) where SIR_{target} converges over some time period to the required SIR, and limited the claim to a modification of SIR_{target} that essentially eliminates the convergence period altogether." I disagree with Defendants' proposal, but in any case, the Apple/Intel Accused Products perform this step under either construction.

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263. As discussed above, if there is a CRC error in the SRB channel, the function l1u_olpc_ctrl_track_srb_mode will set the algorithm into SRB tracking mode, APPLE_INTEL_000013-15 at lines 3171-3177, such that the algorithm will call l1u_olpc_ctrl_set_srb_tracking_mode. APPLE_INTEL_000013-14. In tracking mode, an upward adjustment to SIR_{target} is made while the global variable scaled_Target_SIR_before_srb_mode is set to the last set SIR_{target}. APPLE_INTEL_000009 at l. 2914. In other words, the algorithm sets that global value to the level just before wind-up is detected.

264. Then, the function l1u_olpc_ctrl_track_srb_mode monitors and determines when unwinding has been detected in order to leave SRB tracking mode. APPLE_INTEL_000015 at lines 3258-3285. When SRB tracking mode is exited, the last set value of SIR_{target} set in the variable scaled_Target_SIR_before_srb_mode is used to restore the SIR_{target} such that it is matched it to the outer loop power control in normal mode just prior to the start of the outer loop wind up. APPLE_INTEL_000015 at lines 3269-3285; Afzal Ahmad Deposition at 111:6-19 ("This is the exit part of the SRB mode . . . Basically it is trying – you are starting at the same point from where you left."), 112:2-22 ("You store the value and enter the SRB, then exit from the SRB, restore the value and leave the SRB mode.").

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265. This adjustment can also be seen here, where after SRB tracking mode ends the SIR_{target} is returned to the prior level:

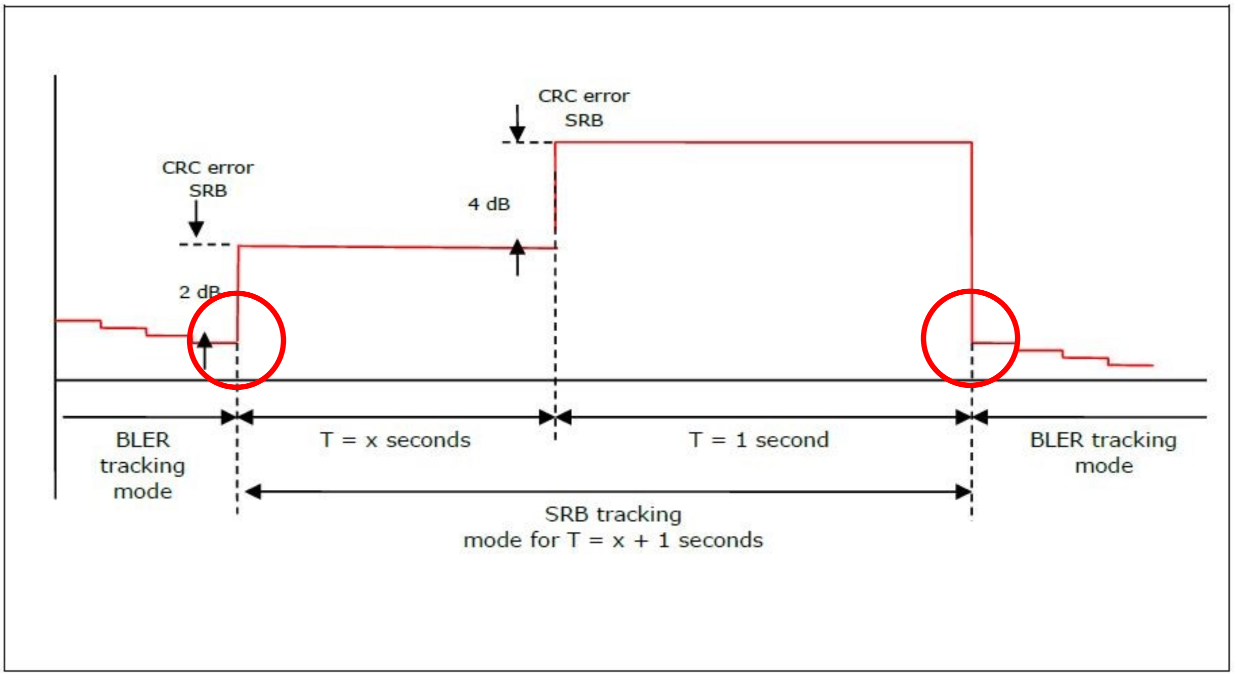

Figure 29. Target SIR Adjustment in case of several CRC error on SRB TRCH and previous OLPC mode is not Proactive mode

APL-TOTDDE_00693407 at 43, *see also* Afzal Ahmad Deposition (3/19/2024) at 78:23-81:23 ("That is because the reason is once I come out of the SRB mode, I need to restore the previous value in order to operate the same time.").

266. This functionality meets both proposed constructions. First, with regard to TOT's proposal of plain and ordinary meaning, which is "wherein the desired signal to interference ratio target (SIR_{target}) is modified at the start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up," the algorithm described above meets that definition. Specifically, as described above, the OLPC algorithm stores the SIR_{target} value before entering SRB mode in scaled_Target_SIR_before_srb_mode and then restores that value when exiting SRB mode. As such it is matched to the outer loop power control in normal mode just prior to the start of the outer loop wind up.

267. With respect to Defendants' proposal that the claim term means "wherein the desired signal to interference ratio target (SIR_{target}) is modified at the start (403) of the outer loop

unwinding to the last specific historical value of the SIR_{target} that was previously set for the outer loop power control in normal mode just prior to the start of the outer loop wind up," and that "[p]atentee disclaimed methods that modify the desired signal to interference ratio target (SIR_{target}) where SIR_{target} converges over some time period to the required SIR, and limited the claim to a modification of SIR_{target} that essentially eliminates the convergence period altogether," even under this proposed construction the Apple/Intel Accused Products perform this step. Specifically, as described above, the OLPC algorithm stores the SIR_{target} value before entering SRB mode in scaled_Target_SIR_before_srb_mode and then restores that value when exiting SRB mode. As such SIR_{target} when exiting SRB mode is set to the last specific historical value of SIR_{target}, which essentially eliminates the convergence period.

268. Tests performed on a sample Apple/Intel Accused Product further confirms that the Apple/Qualcomm Accused Products perform claim element **[1.f]**. Specifically, at my direction, Claude Royer Consultant Inc. ("CRC-I") conducted experimental testing of an iPhone 11 Pro Max, which is one of the Apple/Intel Accused Product models. The test was designed to show how the transmit power of the phone reacted to a simulated windup condition at the instant that the condition alleviated, and is similar to the testing I discussed earlier in my report regarding the testing of certain Apple, Samsung, and LG phone models with Qualcomm modems. Similar to the earlier-described testing of those phones, the sample iPhone 11 Pro Max was tested while simulating its operation on a WCDMA network and, by comparison, its operation on a cdma2000 network. In the former case, the phone dramatically and suddenly reduced its usage of power at the unwinding to a level matching the power level just prior to the test's emulation of windup. In contrast, in the cdma2000 case, the phone slowly and gradually reduced its power level over time, and did not even reach the pre-windup power level after more than a minute after the start of the

unwinding. The results of the testing of the iPhone 11 Pro Max while simulating operation on a WCDMA network are shown below:

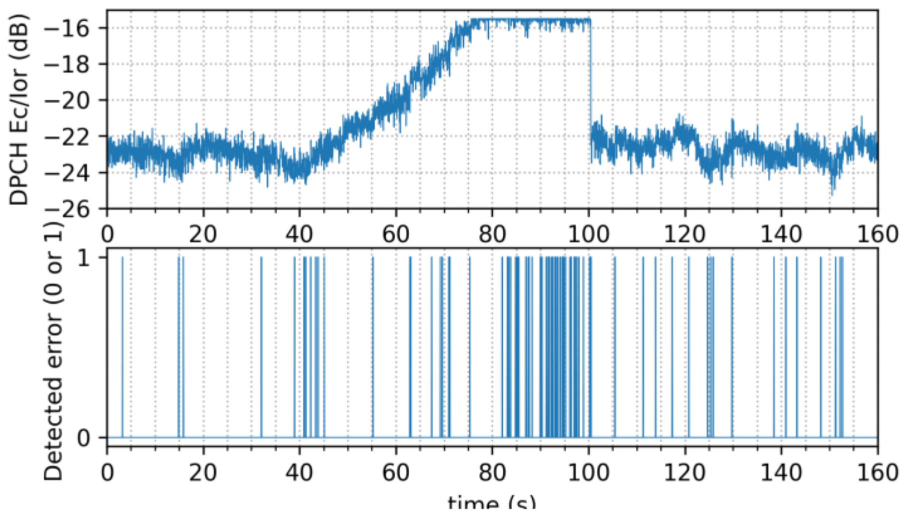

Figure 3: Ec/Ior and BLER versus time collected from the Keysight wireless communications test set (E5515C/8960).

269. By contrast, the results of the testing of the iPhone 11 Pro Max while simulating operation on a cdma2000 network are shown below:

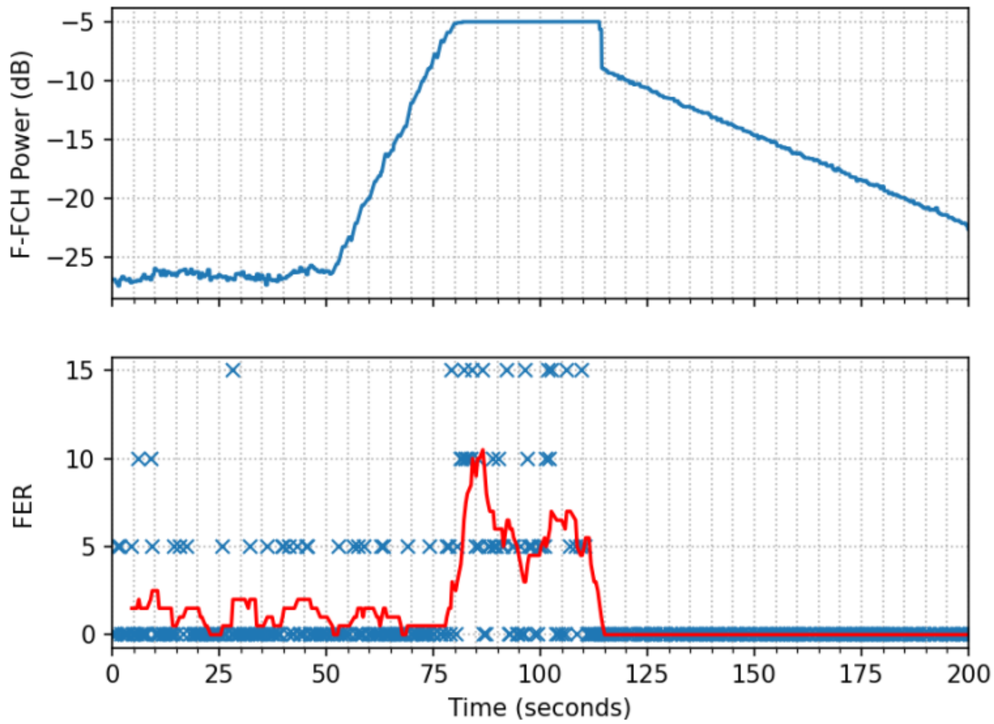

Figure 4: F-FCH power and FER versus time collected from the Keysight wireless communications test set (E5515C/8960).

270. These test results are consistent with the other evidence I have discussed above regarding how the OLPC algorithm operates in the Apple/Intel Accused Products.

271. Further details regarding the procedures and results of this testing are provided in the test summary attached as Exhibit I.

272. Based on all of the evidence discussed above, it is my opinion that the Apple/Intel Accused Products perform claim element **[1.f]**. And because the Apple/Intel Accused Products perform each element of claim 1 of the '865 Patent, it is my opinion that the Apple/Intel Accused Products infringe claim 1.

2. '865 Patent Claim 2: *Outer loop power control method for wireless communications systems, according to claim 1, wherein at the start (403) of the outer loop unwinding the desired signal to interference ratio*

> ***target (SIR_{target}) is set to a value suitably close to the original value (401) set just before the start moment (402) of the outer loop wind-up.***

273. In my opinion, the Apple/Intel Accused Products infringe claim 2 of the '865 Patent, which recites: "Outer loop power control method for wireless communications systems, according to claim 1, wherein at the start (403) of the outer loop unwinding the desired signal to interference ratio target (SIRtarget) is set to a value suitably close to the original value (401) set just before the start moment (402) of the outer loop wind-up." Claim 2 therefore depends on claim 1.

274. As discussed above, it is my opinion that the Apple/Intel Accused Products perform all elements of claim 1. And the Apple/Intel Accused Products perform the further element of an outer loop power control method wherein at the start of the outer loop unwinding the desired signal to interference ratio target (SIR_{target}) is set to a value suitably close to the original value set just before the start moment of the outer loop wind-up.

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275. As discussed above in my analysis for claim **[1.d]**, when entering SRB tracking mode on wind-up, the function l1u_olpc_ctrl_set_srb_tracking_mode is called. APPLE_INTEL_000013-14. The algorithm then calls l1u_olpc_ctrl_set_srb_tracking_mode which saves the last set value of SIR_{target} from before the upward adjustment. APPLE_INTEL_000009 at l. 2914. As discussed in my analysis of claim **[1.f]**, when unwinding the SIRtarget is set to this saved value. The saved last value is suitably close to the value set from before wind-up, as it is set to the same value as when wind-up was detected. *See also* Afzal Ahmad Deposition (3/19/2024) at 78:23-81:23 ("That is because the reason is once I come out of the SRB mode, I need to restore the previous value in order to operate the same time."). As a result, the Apple/Intel Accused Products perform all of the elements of claim 2.

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3. '865 Patent Claim 3: *Outer loop power control method for wireless communications systems, according to claim 1, wherein the start (402) of the outer loop windup is detected when the difference between the desired signal to interference ratio target (SlRtarget) and the desired signal to interference ratio received (SIRrec) exceeds a specific detection margin (M) of the outer loop wind-up.*

276. In my opinion, the Apple/Intel Accused Products infringe claim 3 of the '865 Patent, which recites: "Outer loop power control method for wireless communications systems, according to claim 1, wherein the start (402) of the outer loop windup is detected when the difference between the desired signal to interference ratio target (SlR_{target}) and the desired signal to interference ratio received (SIR_{rec}) exceeds a specific detection margin (M) of the outer loop wind-up." Claim 3 therefore depends on claim 1. As discussed above, it is my opinion that the Apple/Intel Accused Products perform all elements of claim 1. And the Apple/Intel Accused Products perform the further element in claim 3 of an outer loop power control method *w*herein the start (402) of the outer loop windup is detected when the difference between the desired signal to interference ratio target (SlR_{target}) and the desired signal to interference ratio received (SIR_{rec}) exceeds a specific detection margin (M) of the outer loop wind-up.

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277. As discussed above in my analysis for claim **[1.c]**, /pcc/upc/l1u_l1g/l1u/l1u_olpc_ctrl.cpp contains global definitions for a number of delta values for detecting windup (i.e. a specific detection margin). APPLE_INTEL_000007-51. The function l1u_olpc_ctrl_determine_lock_status uses these defined thresholds to check whether the difference between SIR_{target} and SIR_{rec} exceeds those thresholds to detect that wind-up is occurring. *See, e.g.,* APPLE_INTEL_000007 at l. 1052. As a result, the Apple/Intel Accused Products perform all of the elements of claim 3.

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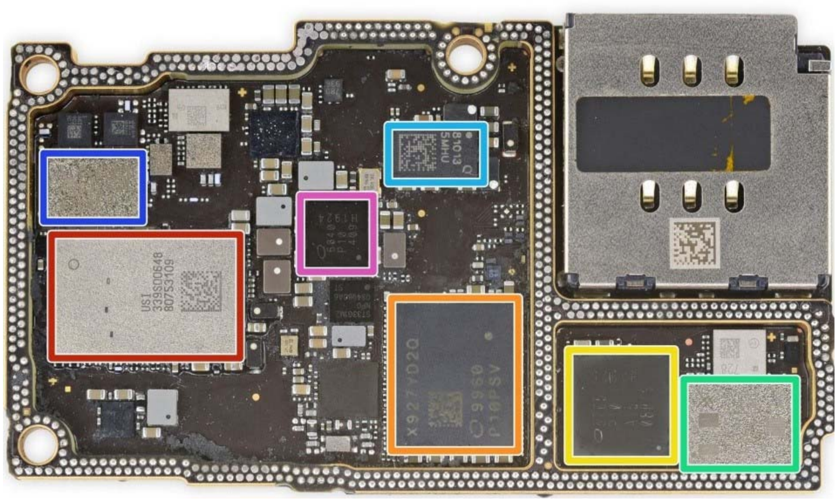
4. '865 Patent Claim 5

278. The Apple/Intel Accused Products infringe each element of claim 5 of the '865 Patent as will be explained below.

a) [5.pre] *An outer loop power control device for wireless communications systems, comprising at least one programmable electronic device, the programmable electronic device operable to perform the steps of:*

279. In my opinion, the Apple/Intel Accused Products meet the preamble of claim 5, to the extent the preamble is found to be limiting. Each of the Apple/Intel Accused Products include an Intel Modem/Baseband Processor which is an outer loop power control device for wireless communications systems, comprising at least one programmable electronic device. For example, the iPhone 11 Pro Max includes an XMM7660 modem component and 5765 RF transceiver which perform the remaining elements of the claim:



iFixit Teardown report, *available at* https://www.ifixit.com/Teardown/iPhone+11+Pro+Max+Teardown/126000 (showing Intel XMM7660 modem component (orange highlight) and 5765 RF transceiver (yellow highlight) in iPhone 11 Pro Max).

280. Exhibit D provides further details regarding the specific Inel Modem/Baseband Processor that is included in each of the Apple/Intel Accused Products.

281. The Apple/Intel Accused Products further satisfy the preamble for the same reasons as I discussed for claim **[1.pre]**, above.

b) [5.a] ***estimating a desired signal to interference ratio received (SIRrec)based on a data signal (107, 108) received from a base station (102, 103) or mobile station (104)***

282. Element **[5.a]** in claim 5 is identical to claim element **[1.a]**, above, as performed by the outer loop power control device of element **[5.pre]**. The Apple/Intel Accused Products perform this claim element for the same reasons as I discussed for claim elements **[1.a]** and **[5.pre]**, above. As such, I incorporate by reference my analysis for those elements.

c) [5.b] ***setting a desired signal to interference ratio target (SlRtarget) that is close to a signal to a signal to interference ratio required (SIRrec) during the normal mode of the outer loop***

283. Element **[5.b]** in claim 5 is identical to claim element **[1.b]**, above, as performed by the outer loop power control device of element **[5.pre]**. The Apple/Intel Accused Products perform this claim element for the same reasons as I discussed for claim elements **[1.b]** and **[5.pre]**, above. As such, I incorporate by reference my analysis for those elements.

d) [5.c] ***detecting a start (402) of the outer loop wind-up***

284. Element **[5.c]** in claim 5 is identical to claim element **[1.c]**, above, as performed by the outer loop power control device of element **[5.pre]**. The Apple/Intel Accused Products perform this claim element for the same reasons as I discussed for claim elements **[1.c]** and **[5.pre]**, above. As such, I incorporate by reference my analysis for those elements.

e) [5.d] ***setting a particular desired signal to interference ratio target (SlRtarget) during the outer loop wind-up, and***

285. Element **[5.d]** in claim 5 is identical to claim element **[1.d]**, above, as performed by the outer loop power control device of element **[5.pre]**. The Apple/Intel Accused Products perform this claim element for the same reasons as I discussed for claim elements **[1.d]** and **[5.pre]**, above. As such, I incorporate by reference my analysis for those elements.

f) [5.e] ***detecting a start (403) of the outer loop unwinding***

286. Element **[5.e]** in claim 5 is identical to claim element **[1.e]**, above, as performed by the outer loop power control device of element **[5.pre]**. The Apple/Intel Accused Products perform this claim element for the same reasons as I discussed for claim elements **[1.e]** and **[5.pre]**, above. As such, I incorporate by reference my analysis for those elements.

g) [5.f] ***wherein the desired signal to interference target (SlRtarget)is modified at the start (403) of the outer loop unwinding, to match it to the outer loop power control in normal mode just prior to the start of the outer loop wind up.***

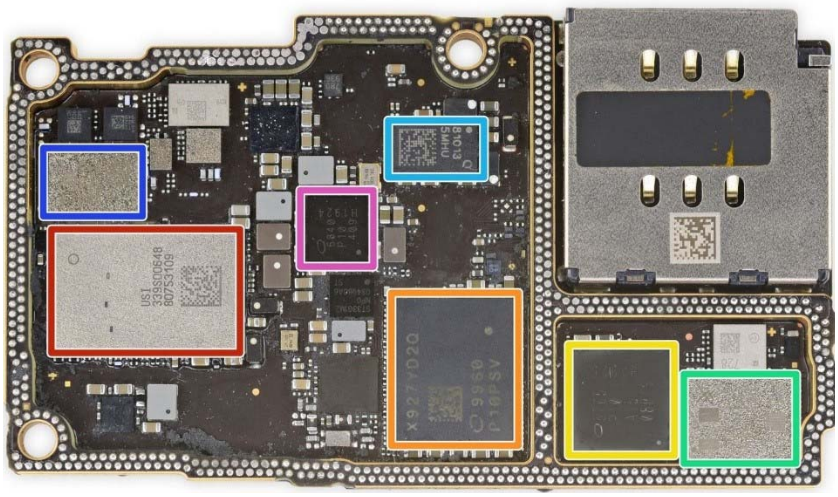
287. Element **[5.f]** in claim 5 is identical to claim element **[1.f]**, above, as performed by the outer loop power control device of element **[5.pre]**. The Apple/Intel Accused Products perform this claim element for the same reasons as I discussed for claim elements **[1.f]** and **[5.pre]**, above. As such, I incorporate by reference my analysis for those elements.

5. '865 Patent Claim 6: ***Outer loop power control device for wireless communications systems, according to claim 5, wherein the programmable electronic device is chosen from among a general purpose processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC) and a programmable card (FPGA) or any combination of these.***

288. In my opinion, the Apple/Intel Accused Products meet the elements of claim 6, which recites: "Outer loop power control device for wireless communications systems, according

to claim 5, wherein the programmable electronic device is chosen from among a general purpose processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC) and a programmable card (FPGA) or any combination of these." Claim 6 therefore depends on claim 5.

289. As described above, the Apple/Intel Accused Products meet the limitations of claim 5. Moreover, the devices described in claim 5 above include processors, DSPs, ASICs and/or FPGAs. For example, the iPhone 11 Pro Max includes an XMM7660 modem component:



iFixit Teardown report, *available at* https://www.ifixit.com/Teardown/iPhone+11+Pro+Max+Teardown/126000 (showing Intel XMM7660 modem component (orange highlight) and 5765 RF transceiver (yellow highlight) in iPhone 11 Pro Max).

290. The XMM7660 modem component is an ASIC that includes DSP processing blocks. *See, e.g.*, XGOLD 766, High-level Architecture Specification, Hardware, Revision 1.0 Build 1, 2018-09-13, APL-TOTDDE_00700739 at 27 ("Hardware Architecture Block Diagram").

291. The Apple/Intel Accused Products therefore meet all of the limitations of claim 6.

6. '865 Patent Claim 7: *Outer loop power control device for wireless communications systems, according to claim 5, further comprising a radio receiver (203) able to receive a data signal (107, 108) from a base*

station (102, 103) or from a mobile station (104) of the wireless communication system.

292. In my opinion, the Apple/Intel Accused Products meet the elements of claim 7, which recites: "Outer loop power control device for wireless communications systems, according to claim 5, further comprising a radio receiver (203) able to receive a data signal (107, 108) from a base station (102, 103) or from a mobile station (104) of the wireless communication system." Claim 7 therefore depends on claim 5. As described above, the Apple/Intel Accused Products meet the limitations of claim 5. Moreover, the devices described in claim 5 above include radio receivers able to receive data signals from a bast station or a mobile station of the wireless communication system.

293. For example, the Apple iPhone 11 Pro Max has an Intel PMB5765 RF transceiver that is capable of receiving a data signal from a base station in a wireless telecommunications system:

	INTEL CORPORATION (UK) LTD - 000382M	PMB5765.P10
....4	0163	Z
	INTEL CORPORATION (UK) LTD - 000382M	PMB5765.P11

APL-TOTDDE00108031-305 at APL-TOTDDE_00108110.

294. The Technical Specifications produced by Apple also confirm that the Apple/Intel Accused Products are capable of transmitting data signals to and receiving data signals from base stations in a cellular network – functionality that requires a radiofrequency transmitter and receiver or transceiver. *See., e.g.*, APL-TOTDDE_00692725-32 (iPhone 7 Technical Specifications) at APL-TOTDDE00692727:

Cellular and Wireless

- **Model A1660 / Model A1661**
  FDD-LTE (Bands 1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 18, 19, 20, 25, 26, 27, 28, 29, 30)
  TD-LTE (Bands 38, 39, 40, 41)
  TD-SCDMA 1900 (F), 2000 (A)
  CDMA EV-DO Rev. A (800, 1900, 2100 MHz)
  UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)
  GSM/EDGE (850, 900, 1800, 1900 MHz)
- **Model A1778 / Model A1784**
  FDD-LTE (Bands 1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 18, 19, 20, 25, 26, 27, 28, 29, 30)
  TD-LTE (Bands 38, 39, 40, 41)
  UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)
  GSM/EDGE (850, 900, 1800, 1900 MHz)
  Models A1778 and A1784 do not support CDMA networks, such as those used by Verizon and Sprint.

See also APL-TOTDDE_00690599-605; APL-TOTDDE_00693077-84; APL-TOTDDE_00693085-92; APL-TOTDDE_00693069-76; APL-TOTDDE_00693134-41; APL-TOTDDE_00688444-51; APL-TOTDDE_00693126-33; APL-TOTDDE_00688357-64; APL-TOTDDE_00688373-80; APL-TOTDDE_00688388; APL-TOTDDE_00693144-50; APL-TOTDDE_00690681-88; APL-TOTDDE_00688414-20; APL-TOTDDE_00690606-13; APL-TOTDDE_00688421-27; APL-TOTDDE_00693119-25; APL-TOTDDE_00688436-43; APL-TOTDDE_00688381-87; APL-TOTDDE_00690614-20; APL-TOTDDE_00690586-88; APL-TOTDDE_00693178-80; APL-TOTDDE_00688354-56; APL-TOTDDE_00690589-91; APL-TOTDDE_00692016.

295. The Apple/Intel Accused Products therefore meet all of the limitations of claim 7.

7. '865 Patent Claim 8: *Outer loop power control device for wireless communications systems, according to claim 5, further comprising a radio transmitter (202) able to send the power control information to a base station (102, 103) or to a mobile station (104) of the wireless communication system.*

296. In my opinion, the Apple/Intel Accused Products meet the elements of claim 8, which recites: "Outer loop power control device for wireless communications systems, according to claim 5, further comprising a radio transmitter (202) able to send the power control information

to a base station (102, 103) or to a mobile station (104) of the wireless communication system." Claim 8 therefore depends on claim 5.

297. As I described above, the Apple/Intel Accused Products meet the limitations of claim 5 and include radio transceivers as described in claim 7. The radio transceivers of the Apple/Intel Accused Products are also able to send power control information to a base station of the wireless communication system, as I discussed above with respect to claim 1.

298. The Apple/Intel Accused Products therefore meet all of the limitations of claim 8.

8. '865 Patent Claim 10: *Outer loop power control device in a wireless communication system, according to claim 5, wherein the outer loop power control device is incorporated in a mobile station for wireless communications systems.*

299. In my opinion, the Apple/Intel Accused Products meet the elements of claim 10, which recites "Outer loop power control device in a wireless communication system, according to claim 5, wherein the outer loop power control device is incorporated in a mobile station for wireless communications systems." Claim 10 therefore depends on claim 5.

300. As described above, the Apple/Intel Accused Products meet the limitations of claim 5. The baseband processors of the Apple/Intel Accused Products (i.e. the outer loop power control device) are incorporated into a mobile station for wireless communications systems (i.e. a mobile phone).

301. For example, the Intel PMB9960 baseband processor is incorporated in the Apple iPhone 11 Pro Max:

APL-TOTDDE_00688365-72 at APL-TOTDDE_00688365. *See also* Exhibit D (identifying the Intel baseband processors that are incorporated into the Apple/Intel Accused Products).

302. The Apple/Intel Accused Products therefore meet all of the limitations of claim 10.

9. '865 Patent Claim 12: *Mobile station for wireless communications systems including the outer loop power control device according to claim 5.*

303. Claim 12 of the '865 Patent recites: "Mobile station for wireless communications systems including the outer loop power control device according to claim 5." In my opinion, the Apple/Intel Accused Products meet all of the elements of claim 12 for the same reasons that they meet all of the elements of claims 5 and 10 as described above. As such I incorporate my analysis of those claims by reference.

C. The Apple/Qualcomm Accused Products Infringe the '376 Patent

304. I understand that TOT asserts claims 1, 6-9, 11, and 13 of the '376 Patent against the Apple/Qualcomm Accused Products. Claim 1 is a method claim directed to an "outer loop power control method," while claims 6-9, 11, and 13 are product claims directed to an "outer loop power control apparatus" or a "mobile station." It is my opinion that the Apple/Qualcomm

Accused Products perform each element of method claim 1 when powered on and in normal use in FDPCH (Fractional Dedicated Physical Channel, or Fractional DPCH) or Enhanced FDPCH mode, and the Apple/Qualcomm Accused Products satisfy all of the elements of product claims 6-9, 11, and 13.

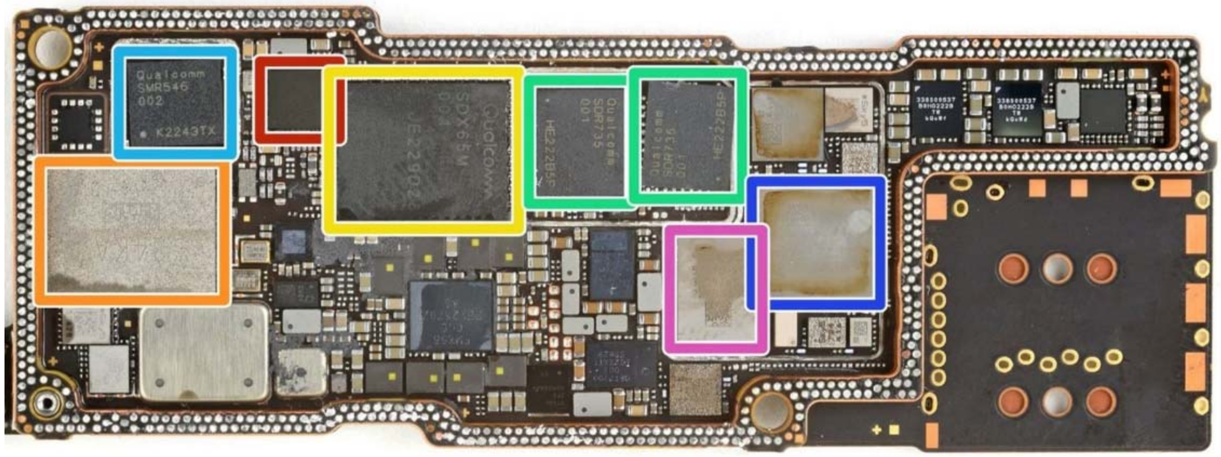
1. '376 Patent Claim 1

305. The Apple/Qualcomm Accused Products infringe each element of claim 1 of the '376 Patent as will be explained below.

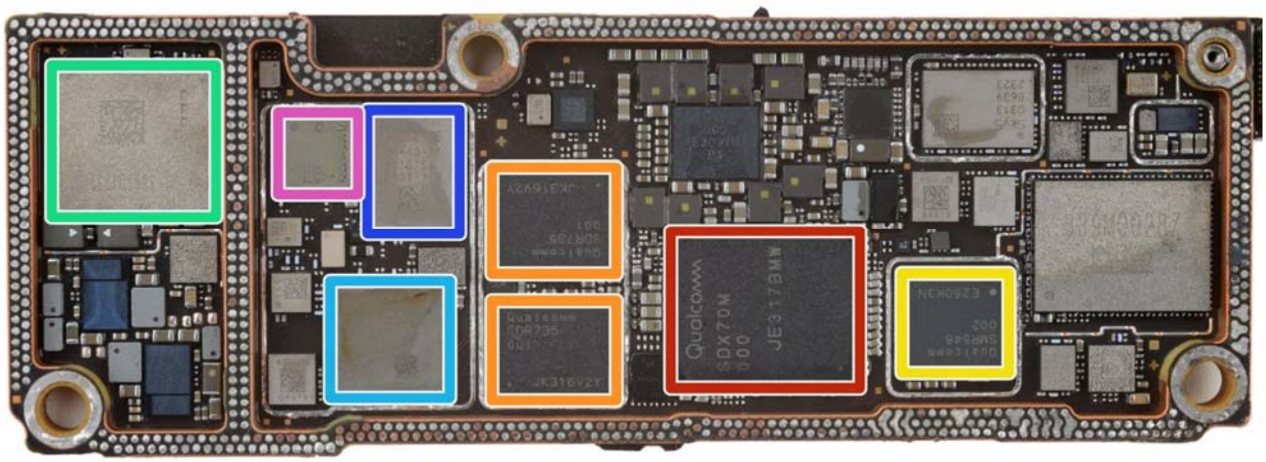
a) [1.pre] *Outer loop power control method for wireless communications systems which based on a data signal (107, 108) received, coming from a base station (102, 103) or from a mobile station (104), comprises the following phases:*

306. I understand that the parties disagree as to whether the preamble of claim 1 is limiting. Whether or not the preamble is limiting, in my opinion the Apple/Qualcomm Accused Products meet the preamble's language of "Outer loop power control method for wireless communications systems which based on a data signal (107, 108) received, coming from a base station (102, 103) or from a mobile station (104), comprises the following phases."

307. As listed in Exhibit C, each of the Apple/Qualcomm Accused Products includes a Qualcomm modem. Other evidence confirms which Qualcomm modems are included in which of the Apple/Qualcomm Accused Products. For example, an iFixit Teardown report, available at https://www.ifixit.com/Guide/iPhone+14+Pro+Max+Chip+ID/153224, shows that Qualcomm's SDX65M modem component can be found in the iPhone 14 Pro Max:



308. As another example, another iFixit Teardown report, available at https://www.ifixit.com/Guide/iPhone+15+Pro+Max+Chip+ID/165320, shows that Qualcomm's SDX70M modem component can be found in the iPhone 15 Pro Max.



309. Based on my analysis of the evidence, including source code for the software/firmware that is included with the Qualcomm modems that are in the Apple/Qualcomm Accused Products, the Apple/Qualcomm Accused Products practice an outer loop power control method for wireless communications systems that is based on a data signal received, coming from a base station.

Begin CONFIDENTIAL – OUTSIDE ATTORNEYS' EYES ONLY – SOURCE CODE

310. For example, the relevant portions of the source code files dlolpc.c, and dolpc.h, containing much of the Qualcomm modem WCDMA downlink Outer Loop Power Control algorithm, were identical across the versions that I reviewed. Set forth below is my analysis of the source code from the produced path /Baseband_FW/Baseband-Mav17-3.31.00/. As I discussed earlier in this report in my analysis for the '865 Patent, based on my review of the various source code versions, the source code that I describe below is representative of the source code for all of the Apple/Qualcomm Accused Products.

311. The source code path /Baseband_FW/Baseband-Mav17-3.31.00/ refers to "Mav17," which as set forth in Exhibit C refers to the baseband project name for the iPhone 8 (A1863), iPhone 8 Plus (A1864), and iPhone X (A1865) products. Therefore, it is my understanding that the specific code produced and cited herein from /Baseband_FW/Baseband-Mav17-3.31.00/ is used in the Qualcomm modems for these models of iPhone products. The source code embodies, and when run in a product operating as designed also performs, an outer loop power control method for wireless communications systems, based on WCDMA technology. For example, the source code files /Baseband_FW/Baseband-Mav17-3.31.00/mav17_umts_sw_33100/modem_proc/wcdma/l1/offline/src/dlolpc.c (APPLE_QUALCOMM_000001-62),[28] /modem_proc/wcdma/l1/offline/src/dlolpc.h (APPLE_QUALCOMM_000063-74),[29] /modem_proc/…/fw/…/src/wfw_tx_modulator.c

[28] *See also* Q2TOTAPPLE1302SC0000001-80, Q2TOTAPPLE1302SC0000106-131, Q2TOTAPPLE1302SC0000177-223, Q2TOTAPPLE1302SC0000224-296, and Q2TOTAPPLE1302SC0000342-414 for the corresponding code in the dlolpc.c file for the other versions I reviewed.

[29] *See also* Q2TOTAPPLE1302SC0000081-91, Q2TOTAPPLE1302SC0000132-145, Q2TOTAPPLE1302SC0000297-310, and Q2TOTAPPLE1302SC0000415-428 for the corresponding code in the dlolpc.h file for the other versions I reviewed.

(APPLE_QUALCOMM_000075-99),[30] and /modem_proc/wcdma/l1/offline/src/wl1dec.c (APPLE_QUALCOMM_000100-116)[31] each contain aspects of the infringing WCDMA downlink Outer Loop Power Control algorithm operative in the Accused Products as used and sold by Apple.

End CONFIDENTIAL – OUTSIDE ATTORNEYS' EYES ONLY – SOURCE CODE

312. Other documents indicate that the Apple/Qualcomm Accused Products perform an outer loop power control method in a wireless communications system, which is based on a data signal received from a base station. The accused products are all preconfigured to operate on 3G networks. As such, they perform methods of outer loop power control, which includes receiving a data signal from a base station.

313. For example, the iPhone 8, which has a Qualcomm baseband processor, supports operation on UMTS frequency bands (i.e., a 3G network):

- **Model A1863***
  FDD-LTE (Bands 1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 18, 19, 20, 25, 26, 28, 29, 30, 66)
  TD-LTE (Bands 34, 38, 39, 40, 41)
  TD-SCDMA 1900 (F), 2000 (A)
  CDMA EV-DO Rev. A (800, 1900, 2100 MHz)
  UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)
  GSM/EDGE (850, 900, 1800, 1900 MHz)
- **Model A1905***
  Models A1905 and A1897 do not support CDMA networks, such as those used by Verizon and Sprint.
  FDD-LTE (Bands 1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 18, 19, 20, 25, 26, 28, 29, 30, 66)
  TD-LTE (Bands 34, 38, 39, 40, 41)
  UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)
  GSM/EDGE (850, 900, 1800, 1900 MHz)

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[30] *See also* Q2TOTAPPLE1302SC0000146-161 and Q2TOTAPPLE1302SC0000311-326 for the corresponding code in the wfw_tx_modulator.c file for the other versions I reviewed.

[31] *See also* Q2TOTAPPLE1302SC0000092-105, Q2TOTAPPLE1302SC0000162-176, Q2TOTAPPLE1302SC0000327-341, and Q2TOTAPPLE1302SC0000429-443 for the corresponding code in the wl1dec.c file for the other versions I reviewed.

APL-TOTDDE_00693077-84 at APL-TOTDDE_00693079. *See also* APL-TOTDDE_00690652-61 at APL-TOTDDE_00690654 (iPhone 13 Pro Max Technical Specifications: "CDMA EV-DO Rev. A (800, 1900 MHz) … UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)"); APL-TOTDDE_00690672-80 at APL-TOTDDE_00690674 (iPad mini (6th generation) - Technical Specifications: "UMTS/HSPA/HSPA+ /DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)"); APL-TOTDDE_00690629-31 at APL-TOTDDE_00690630 (Apple Watch Series 3 – Technical Specifications: "Connectivity . . . LTE and UMTS"). *See also* APL-TOTDDE_00692725-32; APL-TOTDDE_00690599-605; APL-TOTDDE_00693085-92; APL-TOTDDE_00693069-76; APL-TOTDDE_00693183-84; APL-TOTDDE_00693181-82; APL-TOTDDE_00690632-41; APL-TOTDDE_00690662-71; APL-TOTDDE_00690642-51; APL-TOTDDE_00692431; APL-TOTDDE_00692432; APL-TOTDDE_00692027; APL-TOTDDE_00693151-57; APL-TOTDDE_00692018; APL-TOTDDE_00690621-28; APL-TOTDDE_00693144-50; APL-TOTDDE_00688425-27.

314. Exhibit E to my report includes a listing of schematics and bills of materials for the Apple/Qualcomm Accused Products that further show how these products include Qualcomm modems and other components that allow the products to operate on a 3G wireless cellular network.

315. The 3G standards, with which the Apple/Qualcomm Accused Products are advertised to comply, provide for methods of outer loop power control. For example, the UMTS requirements for outer loop power control are described in the following 3G technical specifications:

14.9s Downlink power control

14.9.1 Generalities

This function is implemented in the UE in order to set the SIR target value on each CCTrCH used for the downlink power control. This SIR value shall be adjusted according to an autonomous function in the UE in order to achieve the same measured quality as the quality target set by UTRAN. The quality target is set as the transport channel BLER value for each transport channel as signalled by UTRAN.

When transport channel BLER is used the UE shall run a quality target control loop such that the quality requirement is met for each transport channel, which has been assigned a BLER target.

The UE shall set the SIR target when the physical channel has been set up or reconfigured. It shall not increase the SIR target value before the power control has converged on the current value. The UE may estimate whether the power control has converged on the current value, by comparing the averaged measured SIR to the SIR target value.

ETSI TS 125 331 V10.20.0 (2016-08) § 14.9.1 (TOT00000415-2340 at TOT00002240).

7.2.4.8 RF power control

This group of functions controls the level of the transmitted power in order to minimise interference and keep the quality of the connections. It consist of the following functions: UL Outer Loop Power Control, DL Outer Loop Power Control, UL Inner Loop Power Control, DL Inner Loop Power Control, UL Open Loop Power Control and DL Open Loop Power Control.

ETSI TS 125 401 V4.2.0 (2001-09) § 7.2.4.8 (TOT00000375-414 at TOT00000398).

Responding to a downlink TPC command, the UE shall change its uplink DPCH output power at the beginning of the first uplink pilot field after the TPC command reception. Responding to an uplink TPC command, the UTRAN access point shall change its DPCH output power at the beginning of the next downlink pilot field after the reception of the whole TPC command. Note that in soft handover, the TPC command is sent over one slot when DPC_MODE is 0 and over three slots when DPC_MODE is 1. Note also that the delay from the uplink TPC command reception to the power change timing is not specified for UTRAN. The UE shall decide and send TPC commands on the uplink based on the downlink SIR measurement. For the DPCH, the TPC command field on the uplink starts, when measured at the UE antenna, 512 chips after the end of the downlink pilot field. The UTRAN access point shall decide and send TPC commands based on the uplink SIR measurement. However, the SIR measurement periods are not specified either for UE nor UTRAN.

ETSI TS 125 214 V12.1.0 (2015-01) Annex B § B.1.

B.2 Example of implementation in the UE

The downlink inner-loop power control adjusts the network transmit power in order to keep the received downlink SIR at a given SIR target, SIR_{target}. A higher layer outer loop adjusts SIR_{target} independently for each connection.

The UE should estimate the received downlink DPCCH/DPDCH power of the connection to be power controlled. Simultaneously, the UE should estimate the received interference and calculate the signal-to-interference ratio, SIR_{est}. SIR_{est} can be calculated as RSCP/ISCP, where RSCP refers to the received signal code power on one code and ISCP refers to the non-orthogonal interference signal code power of the received signal on one code. Note that due to the specific SIR target offsets described in [5] that can be applied during compressed frames, the spreading factor shall not be considered in the calculation of SIR_{est}.

The obtained SIR estimate SIR_{est} is then used by the UE to generate TPC commands according to the following rule: if $SIR_{est} > SIR_{target}$ then the TPC command to transmit is "0", requesting a transmit power decrease, while if $SIR_{est} < SIR_{target}$ then the TPC command to transmit is "1", requesting a transmit power increase.

When the UE is in soft handover, the UE should estimate SIR_{est} from the downlink signals of all cells in the active set.

ETSI TS 125 214 V12.1.0 (2015-01) Annex B § B.2.

316. Qualcomm's U.S. Patent Application Pub. No. 2013/0072250 (TOT00116816-35) details aspects of the infringing outer loop power control algorithm as used in FDPCH mode of operation in the Apple/Qualcomm Accused Products. *See, e.g.*, *id.* at [0062] – [0064], [0075], Fig. 6. FDPCH mode relates to the High Speed Downlink Packet Access (HSDPA) functionality in the 3G standard, which improves the data transfer rate between the base station and mobile device. *See id.* at [0074]. As I discuss in more detail below, Qualcomm's modems implement an algorithm that is the same or materially similar to that described in this Qualcomm patent application (13/424,665).

317. Other documents produced by Apple and Qualcomm that I have reviewed further confirm that the Apple/Qualcomm Accused Products practice an outer loop power control method as recited in claim 1. *See, e.g.*, Affidavit of Qualcomm Technologies, Inc., in Spanish proceeding No. 240-18-Ml, July 18, 2018, QCTOTVAPPLE01302_0008063 at 1-2 ("Below follows the details of the operation of the OLPC in Qualcomm's chipsets"); SDX60M Product Requirements Document (for Apple), APL-TOTDDE_00721273 at 21 ("UMTS/HSPA+"); Mclaren

(MDM9x55), Hardware Design Document, QCTOTVAPPLE01302_0002515 at 17 ("high speedModem offline Architecture"), 292 ("WCDMA").

318. Qualcomm's VP of Technology, Rajiv Nambiar, also confirmed in his deposition that all of Qualcomm's 3G chipsets practice an outer loop power control algorithm. *See* 5/17/24 Rajiv Nambiar Deposition (5/17/24) at 21:11-22:19. *See also* Luis Maestro (Nokia) Deposition (3/15/24) at 24:11-25:1 ("Q. Is OLPC part of the 3G standard? A. I believe some parts of the solution are standardized, but then it is up to the vendor and network equipment manufacturers to develop their own algorithms, and that is proprietary.").

319. I understand that defendants may rely on the claim construction argument that the preamble is limiting, to further argue that Accused Products do not infringe, because some of the code that TOT has identified as infringing is alleged to be part of the "inner loop" rather than the "outer loop." In the first instance, even if the preamble is limited to "outer loop," it is my opinion that the Accused Products literally infringe this claim. The functionality described herein that implements the claim elements is outer loop functionality. The software and firmware code described herein implements functions that both meet the claim elements, and are directed to the functioning of the CDMA power control "outer loop."

320. In the alternative, if the Court determines that the preamble is limiting, it is my opinion that the Accused Products infringe under the doctrine of equivalents because, even if relevant portions of the infringing code were deemed exclusively part of the inner loop—which they are not—the differences are a matter of semantics and are insubstantial. Inner and outer loop are both part of a broader power control algorithm and are inextricable in CDMA. Thus, whether particular functions fall within one area of code or another they nonetheless are part of a cohesive system. Moreover, as will be described below, the infringing code performs the same function as

an outer loop algorithm would. As will be described in more detail below, the infringing code performs that functionality in the same way as an outer loop algorithm would. Finally, the infringing code reaches the same result as an outer loop power control algorithm would. Thus, in my opinion if the Court were to find that the preamble of claim 1 is limiting and it is found that the code identified as infringing below is part of the inner loop, the Accused Products nonetheless infringe under the doctrine of equivalents.

321. As I discuss below, each of the steps of the outer loop power control method recited in Claim 1 is performed when an Apple/Qualcomm Accused Product is powered on and used as intended (for example, by Apple personnel in the course of their testing, demonstration, and other use of the product, and/or by each and every end user).

b) [1.a] *establishing a target block error rate ($BLER_{target}$)*

322. Element **[1.a]** in claim 1 recites "establishing a target block error rate ($BLER_{target}$)." In my opinion, the Apple/Qualcomm Accused Products perform this step.

323. For example, based on the 3G standards, the method of outer loop power control performed by the c includes establishing a target block error rate. This is reflected in various 3G technical specifications, such as the following:

9 Measurements provided by the physical layer

One of the key services provided by the physical layer is the measurement of various quantities, which are used to trigger or perform a multitude of functions. Both the UE and the UTRAN are required to perform a variety of measurements. The standard will not specify the method to perform these measurements or stipulate that the list of measurements provided in this clause must all be performed. While some of the measurements are critical to the functioning of the network and are mandatory for delivering the basic functionality (e.g., handover measurements, power control measurements), others may be used by the network operators in optimising the network (e.g., radio environment).

ETSI TS 125 302 V15.0.0 (2018-07) § 9.

9.2 UE Measurements

For definitions of the measurements, see [6] and [11].

9.2.12 Transport channel BLER

This measure is mandatory for UE.

Measurement	Transport channel BLER (BLock Error Rate)
Source	L1(UE)
Destination	RRC (RNC,UE)
Reporting Trigger	Periodic, on demand
Description	Estimation of the transport channel block error rate (BLER).

ETSI TS 125 302 V15.0.0 (2018-07) § 9.2.12.

14.9s Downlink power control

14.9.1 Generalities

This function is implemented in the UE in order to set the SIR target value on each CCTrCH used for the downlink power control. This SIR value shall be adjusted according to an autonomous function in the UE in order to achieve the same measured quality as the quality target set by UTRAN. The quality target is set as the transport channel BLER value for each transport channel as signalled by UTRAN.

When transport channel BLER is used the UE shall run a quality target control loop such that the quality requirement is met for each transport channel, which has been assigned a BLER target.

The UE shall set the SIR target when the physical channel has been set up or reconfigured. It shall not increase the SIR target value before the power control has converged on the current value. The UE may estimate whether the power control has converged on the current value, by comparing the averaged measured SIR to the SIR target value.

ETSI TS 125 331 V10.20.0 (2016-08) § 14.9.1 (TOT00000415-2340 at TOT00002240).

5.1.6 Transport channel BLER

Definition	Estimation of the transport channel block error rate (BLER). The BLER estimation shall be based on evaluating the CRC of each transport block associated with the measured transport channel after RL combination. The BLER shall be computed over the measurement period as the ratio between the number of received transport blocks resulting in a CRC error and the number of received transport blocks. When either TFCI or guided detection is used, the measurement 'Transport channel BLER' may only be requested for a transport channel when the associated CRC size is non zero and at least one transport format in the associated transport format set includes at least one transport block. When neither TFCI nor guided detection is used, the measurement 'Transport channel BLER' may only be requested for a transport channel when the associated CRC size is non zero and all transport formats in the associated transport format set include at least one transport block. The measurement 'Transport channel BLER' does not apply to transport channels mapped on a P-CCPCH and a S-CCPCH. The UE shall be able to perform the measurement 'Transport channel BLER' on any transport channel configured such that the measurement 'Transport channel BLER' can be requested as defined in this section.

ETSI TS 125 215 V11.0.0 (2012-11) § 5.1.6.

8.6.5.4 DCH quality target

If the IE "DCH quality target" is included, the UE shall:

ETSI

3GPP TS 25.331 version 10.20.0 Release 10 442 ETSI TS 125 331 V10.20.0 (2016-08)

1> set, at physical channel establishment, the initial downlink target SIR value based on the received IE "DCH quality target" for the transport channel with respect to all transport formats;

1> adjust the target SIR for the downlink power control to meet the quality target received in the IE "DCH quality target" for the transport channel. The UE shall not compensate for the fact that the required SIR to achieve a target BLER for a particular transport format may be different from the required SIR to achieve the target BLER for another transport format..

NOTE 1: Adjusting the target SIR is possible to do continuously by the UE if a CRC exists in all transport formats in the downlink TFS for a DCH. If a CRC does not exist in all transport formats, the UE can only adjust the target SIR when receiving transport formats containing a CRC and the UE has knowledge about the transport format according to [27].

NOTE 2: If the UTRAN configures a UE to use blind transport format detection and configures a transport channel such that single transport format detection [27] must be used to detect the TF, then it is not possible for the UE to maintain a quality target for that transport channel.

ETSI TS 125 331 V10.20.0 (2016-08) § 8.6.5.4 (TOT00000415-2340 at TOT00000856-57).

10.3.5.10 Quality Target

Information Element/Group name	Need	Multi	Type and reference	Semantics description
BLER Quality value	MP		Real(-6.3 ..0 by step of 0.1)	Signalled value is Log10(Transport channel BLER quality target)

ETSI TS 125 331 V10.20.0 (2016-08) § 10.3.5.10 (TOT00000415-2340 at TOT00001242).

324. The textbook Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2002) at 182, also describes that establishing a target block error rate is a necessary part of the 3G outer loop power control method:

7.8.3.11 Support for Downlink Outer Loop Power Control

All RRC messages that can be used to add or reconfigure downlink transport channels (e.g. *Radio Bearer Set-up/Reconfiguration/Release, Transport Channel Reconfiguration*) include a parameter 'Quality Target' (BLER quality value) that is used to configure the quality requirement (initial downlink SIR target) for each downlink transport channel separately.

The outer loop power control algorithm and its performance are discussed in Section 9.2.2.

Harri Holma & Antti Toskala, *WCDMA for UMTS: Radio Access for Third Generation Mobile Communications*, John Wiley & Sons, Ltd (2002) at 182.

325. Source code for the Qualcomm modems in the Apple/Qualcomm Accused Products also confirms that the Apple/Qualcomm Accused Products perform this step.

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326. For example, the source code file /modem_proc/wcdma/l1/offline/src/dlolpc.c (APPLE_QUALCOMM_000001-62),[32] contains various functions and structures for establishing a target block error rate.

327. For example, the function named dl_olpc_init (APPLE_QUALCOMM_000015-18)[33] initializes a "BLER quality target" for each TrCH that is received. *See, e.g.*, *id.* at APPLE_QUALCOMM_000016 at lines 1512-1543.[34] The target for each channel is received from the network (base station) or set to a default value of 0.01 (-20), then stored to a structure for that channel. *Id.* at lines 1512-1533. *See also id.* at APPLE_QUALCOMM_000013-14[35] (global structure bler_down_step_table relating BLER target that "NW supplies" to up and down SIR target step sizes). The algorithm uses the established target BLER, for example, in the up and down step size calculations in functions dl_olpc_get_curr_up_step_q25 and dl_olpc_ get_curr_down_step_q25 (APPLE_QUALCOMM_000048-50).[36]

328. Similarly, the global structure dl_fdpch_outage_thresh_table (APPLE_QUALCOMM_000011) correlates outage threshold values to established "BER" target

[32] *See also* Q2TOTAPPLE1302SC0000001-80, Q2TOTAPPLE1302SC0000106-131, Q2TOTAPPLE1302SC0000177-223, Q2TOTAPPLE1302SC0000224-296, and Q2TOTAPPLE1302SC0000342-414 for the corresponding code in the dlolpc.c file for the other versions I reviewed.

[33] *See also* Q2TOTAPPLE1302SC0000033-36, Q2TOTAPPLE1302SC0000126-130, Q2TOTAPPLE1302SC0000244-248, Q2TOTAPPLE1302SC0000244-248, Q2TOTAPPLE1302SC0000362-366.

[34] *See also* Q2TOTAPPLE1302SC0000034 at lines 1386-1419, Q2TOTAPPLE1302SC0000127-128 at lines 1516-1548, Q2TOTAPPLE1302SC0000245-246 at lines 1516-1548, Q2TOTAPPLE1302SC0000363-364 at lines 1516-1548.

[35] *See also* Q2TOTAPPLE1302SC0000027-28, Q2TOTAPPLE1302SC0000119-121, Q2TOTAPPLE1302SC0000237-239, Q2TOTAPPLE1302SC0000355-357.

[36] *See also* Q2TOTAPPLE1302SC0000068-71, Q2TOTAPPLE1302SC0000210-213, Q2TOTAPPLE1302SC0000283-286, Q2TOTAPPLE1302SC0000401-404.

percentages. *See, e.g.*, APPLE_QUALCOMM_000011 at lines 759-782.[37] The thresholds are established via a table lookup with target ber_rate and the channel's outage point as inputs, and are written to the firmware in the function dl_fdpch_outage_thresh_init (APPLE_QUALCOMM_000054-55 at lines 5240-5250).[38] *See also* APPLE_QUALCOMM_000011-12 at lines 808-820 (relating TPC command error rates to target SIR values in FDPCH mode).[39] The function dl_olpc_compute_sir_target_from_cmd_error_rate described in source code file /modem_proc/wcdma/l1/offline/src/dlolpc.h (APPLE_QUALCOMM_000069) and dlolpc.c (APPLE_QUALCOMM_000227 at lines 5122-123) uses this table to set a SIRtarget (dl_olpc_target_ebnt_fdpch) based on the established TPC command error rate.[40]

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329. Documentation produced by Apple and Qualcomm also confirms that the Apple/Qualcomm Accused Products perform this step. For example, a Qualcomm Memorandum entitled "DL_OLPC_Algorithm_Saber_AMSS_6.0.doc" (QCTOTVAPPLE01302_0008067 at 2) states that: "In general, the OLPC algorithm attempts to set an overall SIR target (Es/Nt) in a manner that the network-set BLER targets for all downlink transport channels are satisfied. If the

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[37] *See also* Q2TOTAPPLE1302SC0000025 at lines 664-687, Q2TOTAPPLE1302SC0000117-118 at lines 763-786, Q2TOTAPPLE1302SC0000235-236 at lines 763-786, Q2TOTAPPLE1302SC0000353-354 at lines 763-786.

[38] *See also* Q2TOTAPPLE1302SC0000077-78 at lines 4565-75, Q2TOTAPPLE1302SC0000219-20 at lines 5247-57, Q2TOTAPPLE1302SC0000292-93 at lines 5247-57, Q2TOTAPPLE1302SC0000410-11 at lines 5247-57.

[39] *See also* Q2TOTAPPLE1302SC0000025-26 at lines 713-725, Q2TOTAPPLE1302SC0000118 at lines 812-824, Q2TOTAPPLE1302SC0000236 at lines 812-824, Q2TOTAPPLE1302SC0000354 at lines 812-824.

[40] *See also* Q2TOTAPPLE1302SC0000087, Q2TOTAPPLE1302SC0000139, Q2TOTAPPLE1302SC0000304, Q2TOTAPPLE1302SC0000422.

UE measures an SIR lower than this target in a slot, the UE sends an UP (1) TPC command on the Uplink. Similarly, if the measured SIR is larger, the UE sends a DOWN (0)command." *See also id.* at Fig. 1 (detail):

330. In addition, Qualcomm's U.S. Patent Application Pub. No. 2013/0072250 (TOT00116816-35) details aspects of establishing a target bit error rate ("BER") in FDPCH mode of operation in the Apple/Qualcomm Accused Products. *See, e.g.*, *id.* at [0063] ("The Node B sets the quality target, e.g., the target Uplink Transmit Power Control Bit Error Rate (ULTPC BER) for the TPC group that contains the High Speed Downlink Shared Channel (HS-DSCH) serving cell. When the FDPCH is setup or reconfigured, the user equipment (UE) sets the Signal to Interference Ratio (SIR) Target (SIRT) depending on the target ULTPCBER."), [0064] ("uses the TPC BER as the target performance"). *See also id.* at [0066] (describing use of table structure to relate target SIR to "the BER targets")

331. In addition, a Qualcomm System Design Document titled "e-FDPCH SDD" details the OLPC algorithm for F-DPCH and Enhanced F-DPCH that Qualcomm later implemented in source code. *See* QCTOTVAPPLE01302_0010310. This document confirms that a target BER is established. *Id.* at 10328-29 ("target is based on bit error rate (BER) provided by higher layers"). *See also* "FDPCH – IL Target," QCTOTVAPPLE01302_0011000 at 11003-11009.

332. I understand that Apple may argue that the BER target used in FDPCH mode is not the same as a target block error rate, but in my opinion the Apple/Qualcomm Accused Products' use of a BER target in FDPCH mode is equivalent to "establishing a target block error rate ($BLER_{target}$)," and therefore also infringes element **[1.a]** under the doctrine of equivalents. The

BER target in FDPCH mode performs the same function (establishing a target error rate) in substantially the same way (bit errors across data vs. block errors across data), with the same result (a target error rate is established).

333. My opinion that the BER target in FDPCH mode is equivalent to the target block error rate ($BLER_{target}$) is supported by Qualcomm's U.S. Patent Application Pub. No. 2013/0072250, which explains:

> On the other hand, traditional downlink power control uses the CRC error and the block error rate (BLER) target to adjust the requested downlink power. However, since FDPCH has no CRC in the down link FDPCH and uses the TPC BER as the target performance, modification to the power control loop is necessary.

Id. at [0064]. In other words, the Qualcomm application recognizes the BER target as a substitute for a BLER target, since in FDPCH mode there is no CRC from which to obtain a BLER target

334. My opinion that the BER target in FDPCH mode is equivalent to the target block error rate ($BLER_{target}$) is also supported by TOT's R1-050066, TSG-RAN Working Group 1 Meeting #40, February 14-18, 2005 (TOT00155727-30), which explains that "a closed loop power control based on error rate of TPC commands" had been selected by the working group as an alternative given the lack of transport channel BLER as a quality criteria. *Id.* at 155727. TOT and the other industry participants in the 3GPP working group recognized that the BER target could be employed as an equivalent substitute for a BLER target in the same way, and for the same purpose, resulting in a usable quality criteria for the outer loop power control, that avoided "extra power consumption" of using, for example, a fixed power. *Id.* TOT noted to the working group that "quality criteria based on error rates (like TPC command error rate)" or BLER, share a common characteristic of "slow adaptation speed to channel changing conditions" *Id.*

c) [1.b] *calculating an estimate (701) of a desired signal to interference ratio (SIR_{rec}) and of some fading parameters in a*

channel (706) which characterize the data signal (107, 108) received

335. Element **[1.b]** in Claim 1 recites "calculating an estimate (701) of a desired signal to interference ratio (SIR_{rec}) and of some fading parameters in a channel (706) which characterize the data signal (107, 108) received)." I understand that there is a dispute between the parties regarding the construction of the phrase "some fading parameters" in this element. Specifically, I understand that TOT's position is that "some fading parameters" should be construed to mean "one or more fading parameters," while Apple's position is that the phrase should be construed to mean "more than one fading parameter." As I discuss below, under either of these constructions, it is my opinion that the Apple/Qualcomm Accused Products perform this step.

336. For example, based on the 3G standards, the method of outer loop power control performed by the Apple/Qualcomm Accused Products includes calculating an estimate of a desired signal to interference ratio and of some fading parameters in a channel which characterize the data signal received.

337. As explained in the technical specifications for the 3G standards, a mobile terminal (such as one of the accused products) should estimate the received signal to interference ratio to operate the inner loop:

9 Measurements provided by the physical layer

One of the key services provided by the physical layer is the measurement of various quantities, which are used to trigger or perform a multitude of functions. Both the UE and the UTRAN are required to perform a variety of measurements. The standard will not specify the method to perform these measurements or stipulate that the list of measurements provided in this clause must all be performed. While some of the measurements are critical to the functioning of the network and are mandatory for delivering the basic functionality (e.g., handover measurements, power control measurements), others may be used by the network operators in optimising the network (e.g., radio environment).

ETSI TS 125 302 V15.0.0 (2018-07) § 9.

9.2 UE Measurements

For definitions of the measurements, see [6] and [11].

9.2.12 Transport channel BLER

This measure is mandatory for UE.

Measurement	Transport channel BLER (BLock Error Rate)
Source	L1(UE)
Destination	RRC (RNC,UE)
Reporting Trigger	Periodic, on demand
Description	Estimation of the transport channel block error rate (BLER).

ETSI TS 125 302 V15.0.0 (2018-07) § 9.2.12.

14.9s Downlink power control

14.9.1 Generalities

This function is implemented in the UE in order to set the SIR target value on each CCTrCH used for the downlink power control. This SIR value shall be adjusted according to an autonomous function in the UE in order to achieve the same measured quality as the quality target set by UTRAN. The quality target is set as the transport channel BLER value for each transport channel as signalled by UTRAN.

When transport channel BLER is used the UE shall run a quality target control loop such that the quality requirement is met for each transport channel, which has been assigned a BLER target.

The UE shall set the SIR target when the physical channel has been set up or reconfigured. It shall not increase the SIR target value before the power control has converged on the current value. The UE may estimate whether the power control has converged on the current value, by comparing the averaged measured SIR to the SIR target value.

ETSI TS 125 331 V10.20.0 (2016-08) § 14.9.1 (TOT00000415-2340 at TOT00002240).

338. In practicing the 3G standards, the Apple/Qualcomm Accused Products measure the received signal to interference ratio (i.e., SIR_{rec}) at various sampling points:

5.2.2 SIR

Definition	Type 1: Signal to Interference Ratio, is defined as: (RSCP/ISCP)×SF. The measurement shall be performed on the DPCCH of a Radio Link Set. In compressed mode the SIR shall not be measured in the transmission gap. The reference point for the SIR measurements shall be the Rx antenna connector. If the radio link set contains more than one radio link, the reported value shall be the linear summation of the SIR from each radio link of the radio link set. If Rx diversity is used in the Node B for a cell, the SIR for a radio link shall be the linear summation of the SIR from each Rx antenna for that radio link. When cell portions are defined in the cell, the SIR measurement shall be possible in each cell portion. where: RSCP = Received Signal Code Power, unbiased measurement of the received power on one code. ISCP = Interference Signal Code Power, the interference on the received signal. SF=The spreading factor used on the DPCCH. Type 2: Signal to Interference Ratio, is defined as: (RSCP/ISCP)×SF. The measurement shall be performed on the PRACH control part. The reference point for the SIR measurements shall be the Rx antenna connector. When cell portions are defined in the cell, the SIR measurement shall be possible in each cell portion. where: RSCP = Received Signal Code Power, unbiased measurement of the received power on the code. ISCP = Interference Signal Code Power, the interference on the received signal. SF=The spreading factor used on the control part of the PRACH.

ETSI TS 125 215 V11.0.0 (2012-11) § 5.2.2.

B.2 Example of implementation in the UE

The downlink inner-loop power control adjusts the network transmit power in order to keep the received downlink SIR at a given SIR target, SIR_{target}. A higher layer outer loop adjusts SIR_{target} independently for each connection.

The UE should estimate the received downlink DPCCH/DPDCH power of the connection to be power controlled. Simultaneously, the UE should estimate the received interference and calculate the signal-to-interference ratio, SIR_{est}. SIR_{est} can be calculated as RSCP/ISCP, where RSCP refers to the received signal code power on one code and ISCP refers to the non-orthogonal interference signal code power of the received signal on one code. Note that due to the specific SIR target offsets described in [5] that can be applied during compressed frames, the spreading factor shall not be considered in the calculation of SIR_{est}.

The obtained SIR estimate SIR_{est} is then used by the UE to generate TPC commands according to the following rule: if $SIR_{est} > SIR_{target}$ then the TPC command to transmit is "0", requesting a transmit power decrease, while if $SIR_{est} < SIR_{target}$ then the TPC command to transmit is "1", requesting a transmit power increase.

When the UE is in soft handover, the UE should estimate SIR_{est} from the downlink signals of all cells in the active set.

ETSI TS 125 214 V12.1.0 (2015-01) Annex B § B.2.

339. As specified in the 3G standards, the uplink inner loop similarly entails estimating the signal to interference ratio:

5.1.2.2 Ordinary transmit power control

5.1.2.2.1 General

The uplink inner-loop power control adjusts the UE transmit power in order to keep the received uplink signal-to-interference ratio (SIR) at a given SIR target, SIR_{target}.

The serving cells (cells in the active set) should estimate signal-to-interference ratio SIR_{est} of the received uplink DPCH. The serving cells should then generate TPC commands and transmit the commands once per slot according to the following rule: if $SIR_{est} > SIR_{target}$ then the TPC command to transmit is "0", while if $SIR_{est} < SIR_{target}$ then the TPC command to transmit is "1". When UL_DTX_Active is TRUE (see section 6C), a TPC command is not required to be transmitted in any downlink slot starting during an uplink DPCCH slot which is in an uplink DPCCH transmission gap as defined in subclause 6C.2, in which case it is not known to be present.

ETSI TS 125 214 V12.1.0 (2015-01) § 5.1.2.2.

340. As specified in the 3G standards, the Apple/Qualcomm Accused Products likewise determine SIR measures for downlink power control. Then, at each sampling point, the SIR_{Target} value is subtracted from the measured received SIR to generate an SIR_{error} value:

5.2.3 SIR_{error}

Definition	$SIR_{error} = SIR - SIR_{target\_ave}$, where: SIR = the SIR measured by UTRAN, defined in section 5.2, given in dB. SIR_{target_ave} = the SIR_{target} averaged over the same time period as the SIR used in the SIR_{error} calculation. In compressed mode $SIR_{target}=SIR_{cm\_target}$ shall be used when calculating SIR_{target_ave}. In compressed mode the SIR_{target_ave} shall not be calculated over the transmission gap. The averaging of SIR_{target} shall be made in a linear scale and SIR_{target_ave} shall be given in dB.

ETSI TS 125 215 V11.0.0 (2012-11) § 5.2.3.

341. The Apple/Qualcomm source code confirms that the Apple/Qualcomm Accused Products perform the step of estimating SIR, as I discuss below.

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342. For example, the source code file /modem_proc/…/fw/…/src/wfw_tx_modulator.c (APPLE_QUALCOMM_000075-99),[41] uses signal to interference ratios measured from the

[41] *See also* Q2TOTAPPLE1302SC0000146-161, Q2TOTAPPLE1302SC0000311-326.

received signal to compare with a target signal to interference ratio and make a decision about whether to send power control bits.

343. For example, the function named wfw_tx_fpc_decision_proc (APPLE_QUALCOMM_000087-89)[42] makes power control bit up/down decisions, based on comparison of target SIR values (e.g., "fdpchOutageSirTh," "fpcTargetEbNtWindUp") to actual measured signal and noise values. *See, e.g.*, *id.* ("actualEb," "fpcNtIoSat," "sirEstimate[]"). Similarly, the function wfw_tx_prog_calc_tpc_bit_proc [APPLE_QUALCOMM_000090-99][43] utilizes calculated signal and noise values, and calls function wfw_tx_fpc_decision_proc. *See, e.g.*, *id.* ("fpcEsIoSat," "fpcNtIoSat").

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344. Documents produced by Apple and Qualcomm also confirm that the Apple/Qualcomm Accused Products perform this step. For example, Qualcomm's Memorandum entitled "DL_OLPC_Algorithm_Saber_AMSS_6.0.doc" (QCTOTVAPPLE01302_0008067 at 2) states: "In general, the OLPC algorithm attempts to set an overall SIR target (Es/Nt) in a manner that the network-set BLER targets for all downlink transport channels are satisfied. If the UE measures an SIR lower than this target in a slot, the UE sends an UP (1) TPC command on the Uplink. Similarly, if the measured SIR is larger, the UE sends a DOWN (0)command." *See also id.* at Fig. 1 (detail):

DL TPC = 1, Measured SIR < Target SIR
0, Measured SIR >= Target SIR

Target SIR increased on CRC Error
decreased on CRC Pass

[42] *See also* Q2TOTAPPLE1302SC0000146-149, Q2TOTAPPLE1302SC0000311-314.

[43] *See also* Q2TOTAPPLE1302SC0000150-161, Q2TOTAPPLE1302SC0000315-326.

345. In addition, a Qualcomm System Design Document titled "e-FDPCH SDD" details the OLPC algorithm for F-DPCH and Enhanced F-DPCH that Qualcomm later implemented in source code. *See* QCTOTVAPPLE01302_0010310. This document confirms that a signal to interference ratio is estimated. *Id.* at 10319 ("TPC bits are used to calculate SIRest"), 10328-30 ("this algorithm calculates the SIRest and compare with the outage threshold"). *See also* "FDPCH – IL Target," QCTOTVAPPLE01302_0011000 at 11003, 11009 ("SIR estimate").

346. The Apple/Qualcomm Accused Products also estimate one or more fading parameters in a channel according to claim element **[1.b]**. For example, the OLPC algorithm calculates whether each slot is in outage and the number of slots that are in outage. The Apple/Qualcomm source code confirms that the Apple/Qualcomm Accused Products perform the step of estimating fading parameters.

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347. For example, the source code file /modem_proc/wcdma/l1/offline/src/dlolpc.c (APPLE_QUALCOMM_000001-62),[44] contains various functions and structures for initializing and estimating fading parameters.

348. For example, the functions named dl_olpc_fdpch_outage_init and dl_olpc_fdpch_outage_thresh_init (APPLE_QUALCOMM_000054-55)[45] set up an "outage_point," "outage_window," and outage slot count, and compute and write to firmware an

[44] *See also* Q2TOTAPPLE1302SC0000001-80, Q2TOTAPPLE1302SC0000106-131, Q2TOTAPPLE1302SC0000177-223, Q2TOTAPPLE1302SC0000224-296, and Q2TOTAPPLE1302SC0000342-414 for the corresponding code in the dlolpc.c file for the other versions I reviewed.

[45] *See also* Q2TOTAPPLE1302SC0000076-78, Q2TOTAPPLE1302SC0000219-220, Q2TOTAPPLE1302SC0000292-293, Q2TOTAPPLE1302SC0000410-411.

outage threshold: "outageThresh," based on the BER target. *See, e.g.*, APPLE_QUALCOMM_000055 at lines 5240-5246.[46]

349. In the source code file /modem_proc/…/fw/…/src/wfw_tx_modulator.c (APPLE_QUALCOMM_000075-99),[47] the function wfw_tx_fpc_decision_proc (APPLE_QUALCOMM_000087-89)[48] includes code to determine if a slot is in outage based on the outage threshold, and to count the number of such slots. *See, e.g.*, APPLE_QUALCOMM_000088 at lines 9508-9523.[49]

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350. As discussed above, I understand that the parties dispute whether "some fading parameters" should be construed to mean "one or more fading parameters" or "more than one fading parameter." My opinion is that under either construction the Apple/Qualcomm Accused Products satisfy this limitation. The outage slot count and outage threshold result for each slot are each estimates of fading parameters. Each of these is a numerical or other measure describing the fading of the channel impacting the call quality.

351. Also, as I previously discussed, Qualcomm's U.S. Patent Application Pub. No. 2013/0072250 (TOT00116816-35) details aspects of determining and counting slots in outage in FDPCH mode of operation in the Apple/Qualcomm Accused Products. *See, e.g.*, *id.* at [0083] ("Additionally, an outer loop power control function can be performed, which as noted above,

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[46] *See also* Q2TOTAPPLE1302SC0000077-78 at lines 4565-4571, Q2TOTAPPLE1302SC0000220 at lines 5247-5253, Q2TOTAPPLE1302SC0000293 at lines 5247-5253, Q2TOTAPPLE1302SC0000411 at lines 5247-5253.

[47] *See also* Q2TOTAPPLE1302SC0000146-161, Q2TOTAPPLE1302SC0000311-326.

[48] *See also* Q2TOTAPPLE1302SC0000146-149, Q2TOTAPPLE1302SC0000311-314.

[49] *See also* Q2TOTAPPLE1302SC0000147-148 at lines 11904-11919, Q2TOTAPPLE1302SC0000312-313 at lines 11905-11920.

improves the performance of the power control. For example, referring back to FIG. 6, for each frame, the number of outage slots (i.e., slots with SIRE less than SIR outage threshold, in 620). These outage slots can be counted, in 622.").

352. In addition, the Qualcomm System Design Document titled "e-FDPCH SDD" confirms that multiple fading parameters, including indications that a slot is in outage and a number of slots in outage for every frame, are estimated by the OLPC algorithm. *See* QCTOTVAPPLE01302_0010310 at 10328 ("Every frame FW will indicate to SW about number of slots wherein SIRest was below outage threshold"). *See also* "FDPCH – IL Target," QCTOTVAPPLE01302_0011000 at 11007-9.

d) **[1.c]** ***estimating some fading margins (M_1, M_2, . . . , M_N) associated with some outage probabilities (p_{o1}, p_{o2}, . . . , p_{oN}) and with the fading parameters in the channel (706)***

353. Element **[1.c]** in claim 1 recites "estimating some fading margins (M_1, M_2, . . . , M_N) associated with some outage probabilities (p_{o1}, p_{o2}, . . . , p_{oN}) and with the fading parameters in the channel (706)." I understand that there is a dispute between the parties regarding the construction of the phrases "some fading margins" and "some outage probabilities" in this element. Specifically, I understand that TOT's position is that "some fading margins" should be construed to mean "one or more fading margins," and "some outage probabilities" should be construed to mean "one or more outage probabilities." Apple's position, on the other hand, is that "some fading margins" should be construed to mean "more than one fading margin," and "some outage probabilities" should be construed to mean "more than one outage probability." As I discuss below, under either of these constructions, it is my opinion that the Apple/Qualcomm Accused Products perform the step of element **[1.c]**.

354. As I already discussed above with respect to element **[1.b]**, the Apple/Qualcomm Accused Products estimate fading parameters in the channel. In addition, the Apple/Qualcomm Accused Products also estimate one or more fading margins, that are associated with one or more outage probabilities and fading parameters according to the claim. For example, the accused OLPC algorithm calculates whether each slot is in outage,and the number of slots that are in outage. The algorithm also computes the number of valid slots, and compares the number of outage slots to the number of valid slots in each outage window to achieve an outage ratio. These outage ratios represent outage probabilities and are associated with the fading parameters (e.g., the slot outage results and number of slots in outage). The allowed outage targets correspond to fading margins for each target outage point. The algorithm estimates fading margins with respect to the outage points by calculating the actual outage in the window and comparing. The Apple/Qualcomm source code confirms that the Apple/Qualcomm Accused Products perform this step.

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355. For example, the source code file /modem_proc/wcdma/l1/offline/src/dlolpc.c (APPLE_QUALCOMM_000001-62),[50] contains various functions and structures for performing this step.

356. For example, the function named dl_olpc_fdpch_compute_sir_target_from_outage (APPLE_QUALCOMM_000055-57)[51] includes code to accumulate the number of valid slots and

[50] *See also* Q2TOTAPPLE1302SC0000001-80, Q2TOTAPPLE1302SC0000106-131, Q2TOTAPPLE1302SC0000177-223, Q2TOTAPPLE1302SC0000224-296, and Q2TOTAPPLE1302SC0000342-414 for the corresponding code in the dlolpc.c file for the other versions I reviewed.

[51] *See also* Q2TOTAPPLE1302SC0000078-80, Q2TOTAPPLE1302SC0000221-223, Q2TOTAPPLE1302SC0000294-296, Q2TOTAPPLE1302SC0000412-414.

slots in outage, and compare to the allowed slots in outage for a particular target outage point. *See, e.g.*, APPLE_QUALCOMM_000056.[52]

357. The global structure dl_fdpch_allowed_outage_slot_table (APPLE_QUALCOMM_000011 at lines 784-804)[53] provides a number of allowed slots in outage that can be present corresponding to the overall outage point. The table contains allowed outage values for each possible target outage point, and for various outage window sizes. *Id.*

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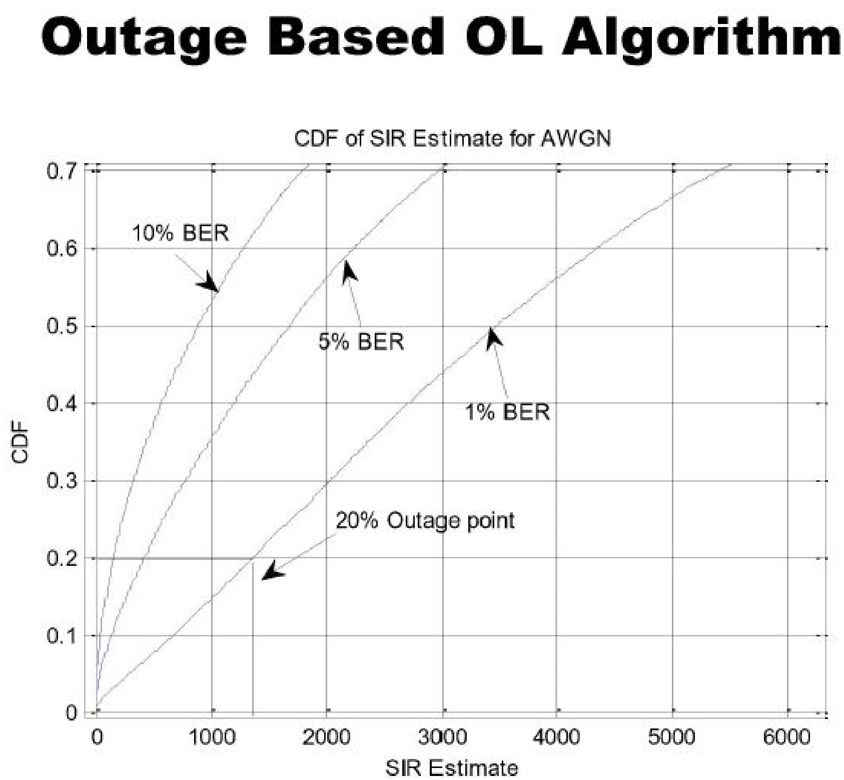
358. Qualcomm's technical documents also describe the operation of the OLPC algorithm consistent with the source code and with the '376 patent claims. *See, e.g.*, QCTOTVAPPLE01302_0011000 at 0011003-8 (explaining that the algorithm is based on the cumulative distribution function (CDF) corresponding to the designated SIR, with outage points set at a margin relative to the median of the function). *See also id.* at 0011009:

- **FDPCH Power Control Algorithm**
  - Inner Loop
    - Step 1: Given BER Target, choose the IL Target. For instance, for 1% BER, the scaled SIR Target = 3570 (on Mustang).
  - Outer Loop
    - Step 2: Choose an outage point – 6% (1slot/frame) or 20% (3 slots/frame). This is the target outage.
    - Step 2: Choose the SIR outage target corresponding to this outage point. For instance, for 20% outage and 1% BER, the outage target is 1380.
    - Step 3: Choose a measurement window – 1 Frame or 10 Frames. Lets say we choose 1 Frame.
    - Step 4: Measure outage of the SIR estimate. For instance, if the SIR estimate is less than the outage target for 5 slots out of 15, the outage is 33.33%.
    - Step 5: If the measured outage (33.33% in example above) is greater than the desired outage (20% from choice of outage point), increase the IL target (3570 in the example above) by 0.1 dB (In this example the target becomes 3653).

[52] *See also* Q2TOTAPPLE1302SC0000079, Q2TOTAPPLE1302SC0000221-222, Q2TOTAPPLE1302SC0000294-295, Q2TOTAPPLE1302SC0000412-413.

[53] *See also* Q2TOTAPPLE1302SC0000025 at lines 689-709, Q2TOTAPPLE1302SC0000118 at lines 788-808, Q2TOTAPPLE1302SC0000236 at lines 788-808, Q2TOTAPPLE1302SC0000354 at lines 788-808.

See also id. at 00011006:



Cf. TOT00190643-48 at TOT00190647 ("The smooth shape of the SIR CDF's allows the fast convergence of the Newton-Raphson method developed to obtain the SIR margin correspondent to a given outage probability and second order statistical moments."); TOT00105794-811 at TOT00105802 ("SIR CDF's numerical aproximations").As I discussed above, I understand that there is a dispute between the parties regarding whether "some fading margins" should be construed to mean "one or more fading margins" or "more than one fading margin," and whether "some outage probabilities" should be construed to mean "one or more outage probabilities" or "more than one outage probability." My opinion is that under either TOT or Apple's proposed constructions of these terms the Apple/Qualcomm Accused Products satisfy element **[1.c]**.

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359. As discussed above, the global structure dl_fdpch_outage_thresh_table (APPLE_QUALCOMM_000011)[54] correlates multiple outage threshold values to established "BER" target percentages, and the structure dl_fdpch_allowed_outage_slot_table provides values for multiple target outage points. Each of the entries in the table correlating an outage threshold value to an established "BER" target percentage correlates to a fading margin, and there are multiple such entries in the table. Thus, the Apple/Qualcomm Accused Products estimate "one or more fading margins" as well as "more than one fading margin." And with respect to "some outage probabilities," those margins are each associated with "one or more outage probabilities" as well as "more than one outage probability."

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360. Also, as I previously discussed, Qualcomm's U.S. Patent Application Pub. No. 2013/0072250 (TOT00116816-35) details aspects of determining and counting slots in outage within a window, and comparing with a target outage ratio, in FDPCH mode of operation in the Apple/Qualcomm Accused Products. *See, e.g.*, *id.* at [0083]:

[54] *See also* Q2TOTAPPLE1302SC0000025, Q2TOTAPPLE1302SC0000117, Q2TOTAPPLE1302SC0000235, Q2TOTAPPLE1302SC0000353.

> **[0083]** Additionally, an outer loop power control function can be performed, which as noted above, improves the performance of the power control. For example, referring back to FIG. **6**, for each frame, the number of outage slots (i.e., slots with SIRE less than SIR outage threshold, in **620**). These outage slots can be counted, in **622**. The process can continue for n frames, in **624**. It will be appreciated that although the frame counting function is not expressly illustrated it can be implemented in many ways as will be appreciated (e.g., an outer loop triggered by end of frame detection, etc.). The operations for evaluating the slots within a given frame are illustrated in FIG. **6**. However, regardless of how n and the end of n frames is tracked, once it is reached, for every n frames (e.g., n=5, 10, 20 or any integer number of frames), a comparison of the total number of outage slots to the outage ratio times the total number of slots with valid TPC can be determined, in **630**.

See also id. at [0010]:

> **[0010]** Accordingly, an embodiment can include a method for closed loop power control of a signal having slots. The method can include detecting valid slots based on a given validity criterion; classifying the valid slots outage slots if an estimated signal quality does not exceed an outage signal quality; accumulating, over an outer loop duration spanning a plurality of the slots, a total valid slot count and a total outage slot count; comparing the total outage slot count to a preset ratio of the total valid slot count; and updating a target signal quality based on the comparison.

e) **[1.d]** ***indicating a status of the data blocks (707) based on the checking of a Cyclic Redundancy Code (CRC), and***

361. Element **[1.d]** in Claim 1 recites "indicating a status of the data blocks (707) based on the checking of a Cyclic Redundancy Code (CRC)." In my opinion, the Apple/Qualcomm Accused Products perform this step.

362. For example, based on the 3G standards, the method of outer loop power control performed by the Apple/Qualcomm Accused Products includes indicating a status of the data blocks based on the checking of a Cyclic Redundancy Code.

5.1.6 Transport channel BLER

Definition	Estimation of the transport channel block error rate (BLER). The BLER estimation shall be based on evaluating the CRC of each transport block associated with the measured transport channel after RL combination. The BLER shall be computed over the measurement period as the ratio between the number of received transport blocks resulting in a CRC error and the number of received transport blocks. When either TFCI or guided detection is used, the measurement "Transport channel BLER" may only be requested for a transport channel when the associated CRC size is non zero and at least one transport format in the associated transport format set includes at least one transport block. When neither TFCI nor guided detection is used, the measurement "Transport channel BLER" may only be requested for a transport channel when the associated CRC size is non zero and all transport formats in the associated transport format set include at least one transport block. The measurement "Transport channel BLER" does not apply to transport channels mapped on a P-CCPCH and a S-CCPCH. The UE shall be able to perform the measurement "Transport channel BLER" on any transport channel configured such that the measurement "Transport channel BLER" can be requested as defined in this section.
Applicable for	Connected Intra

ETSI TS 125 215 V11.0.0 (2012-11) § 5.1.6.

363. Other documents produced by Apple and Qualcomm also confirm that the Apple/Qualcomm Accused Products perform this step. For example, Qualcomm's Memorandum entitled "DL_OLPC_Algorithm_Saber_AMSS_6.0.doc" (QCTOTVAPPLE01302_0008067 at 2) states: "In general, the OLPC algorithm attempts to set an overall SIR target (Es/Nt) in a manner that the network-set BLER targets for all downlink transport channels are satisfied. If the UE measures an SIR lower than this target in a slot, the UE sends an UP (1) TPC command on the Uplink. Similarly, if the measured SIR is larger, the UE sends a DOWN (0)command." *See also id.* at Fig. 1 (detail):

DL TPC = 1, Measured SIR < Target SIR
0, Measured SIR >= Target SIR

Target SIR increased on CRC Error
decreased on CRC Pass

364. The Apple/Qualcomm source code also confirms that the Apple/Qualcomm Accused Products perform this step.

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365. For example, the source code file /modem_proc/wcdma/l1/offline/src/dlolpc.c (APPLE_QUALCOMM_000001-62),[55] contains various functions and structures for performing this step. *See, e.g.*, the function named dl_olpc_report_channel_crc_status (APPLE_QUALCOMM_000040-41).[56] In addition, the function dl_olpc_estimate_curr_bler (APPLE_QUALCOMM_000051-53)[57] uses the number of blocks received with CRC and the number of CRC errors to estimate the BLER value for the channel. These functions are performed for each TrCH block received with valid CRC. For instance, the function dl_read_decode_tb_header in file wl1dec.c decodes the header and determines the CRC errors, then passes that information to the OLPC algorithm, in order to update the BLER and SIRtarget, by calling function dl_olpc_report_channel_crc_status (e.g., APPLE_QUALCOMM_000104-116 at 108, 112).[58]

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366. In addition, as I discussed above with respect to claim element **[1.a]**, the Apple/Qualcomm Accused Products also infringe by checking bit errors in the TPC command data in FDPCH mode. Checking bit errors in this manner also infringes the element **[1.d]** step of "indicating a status of the data blocks (707) based on the checking of a Cyclic Redundancy Code

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[55] *See also* Q2TOTAPPLE1302SC0000001-80, Q2TOTAPPLE1302SC0000106-131, Q2TOTAPPLE1302SC0000177-223, Q2TOTAPPLE1302SC0000224-296, and Q2TOTAPPLE1302SC0000342-414 for the corresponding code in the dlolpc.c file for the other versions I reviewed.

[56] *See also* Q2TOTAPPLE1302SC0000058-59, Q2TOTAPPLE1302SC0000199-201, Q2TOTAPPLE1302SC0000272-274, Q2TOTAPPLE1302SC0000390-392.

[57] *See also* Q2TOTAPPLE1302SC0000072-75, Q2TOTAPPLE1302SC0000214-217, Q2TOTAPPLE1302SC0000287-290, Q2TOTAPPLE1302SC0000405-408.

[58] *See also* Q2TOTAPPLE1302SC0000092-105 at 97, 100; Q2TOTAPPLE1302SC0000162-176 at 167, 171; Q2TOTAPPLE1302SC0000327-341 at 332, 336; Q2TOTAPPLE1302SC0000429-443 at 434, 438.

(CRC)" under the doctrine of equivalents, because it performs the same function (indicating a status of the data block) in substantially the same way (with an error calculation), with the same result (an error status is indicated). *See, e.g.*, U.S. Patent Application Pub. No. 2013/0072250 (TOT00116816-35) at [0064], which discusses substitution TPC command bit error and the bit error rate (BER), for CRC error and the block error rate (BLER), as the relevant target performance.

f) [1.e] ***establishing a target desired signal to interference ratio (SIR_{target}) for the outer loop, based on said status of the data blocks (707), the fading margins ($M_1, M_2, \ldots, M_N$) and the target block error ($BLER_{target}$) of the outer loop, by means of a dynamic adjusting function which performs a mapping between a quality criterion based on the outage probabilities ($p_{o1}, p_{o2}, \ldots, p_{oN}$) and the quality criterion based on the target block error rate ($BLER_{target}$), so that the power is adapted to the propagation conditions of the data signal (107, 108).***

367. Element **[1.e]** in Claim 1 recites "establishing a target desired signal to interference ratio (SIR_{target}) for the outer loop, based on said status of the data blocks (707), the fading margins ($M_1, M_2, \ldots, M_N$) and the target block error ($BLER_{target}$) of the outer loop, by means of a dynamic adjusting function which performs a mapping between a quality criterion based on the outage probabilities ($p_{o1}, p_{o2}, \ldots, p_{oN}$) and the quality criterion based on the target block error rate ($BLER_{target}$), so that the power is adapted to the propagation conditions of the data signal (107, 108)." I understand that there is a dispute between the parties regarding the construction of the phrase "by means of a dynamic adjusting function which performs a mapping between a quality criterion based on the outage probabilities ($p_{o1}, p_{o2}, \ldots, p_{oN}$) and the quality criterion based on the target block error rate ($BLER_{target}$)" in this element. Specifically, I understand that TOT's position is that this phrase has its plain and ordinary meaning, which TOT contends is "using or employing a dynamic adjusting function which performs a mapping between a quality criterion based on the

outage probabilities ($p_{\sigma 1}$, $p_{\sigma 2}$, . . . , $p_{\sigma N}$) and the quality criterion based on the target block error rate ($BLER_{target}$)." I also understand that Apple contends that this phrase should be construed as a means-plus-function limitation, to which TOT disagrees. It is my opinion that, under TOT's proposed construction, the Apple/Qualcomm Accused Products perform this step. In addition, I understand that TOT also argued that if the Court construed the claim as a means plus function claim, the corresponding structure would include a linear combination or an adder. *See* '376 Patent at 10:50-57 ("$SIR_{target}=SIR_{outage} +k_1*M$"). It is also my opinion that, under TOT's proposed structure, the Apple/Qualcomm Accused Products perform this step.

368. For example, the method of outer loop power control performed by the Apple/Qualcomm Accused Products includes establishing a target desired signal to interference ratio for the outer loop, based on the status of the data blocks, the fading margins and the target block error of the outer loop, using or employing a dynamic adjusting function which performs a mapping between a quality criterion based on the outage probabilities and the quality criterion based on the target block error rate, so that the power is adapted to the propagation conditions of the data signal. This is evidenced in the Apple/Qualcomm source code that I reviewed.

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369. For example, the source code file /modem_proc/wcdma/l1/offline/src/dlolpc.c (APPLE_QUALCOMM_000001-62),[59] contains various functions and structures for performing this step.

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[59] *See also* Q2TOTAPPLE1302SC0000001-80, Q2TOTAPPLE1302SC0000106-131, Q2TOTAPPLE1302SC0000177-223, Q2TOTAPPLE1302SC0000224-296, and Q2TOTAPPLE1302SC0000342-414 for the corresponding code in the dlolpc.c file for the other versions I reviewed.

370. For example, the function named dl_olpc_fdpch_compute_sir_target_from_outage (APPLE_QUALCOMM_000055-57)[60] dynamically adjusts a target SIR for the outer loop, in conjunction with other code and structures discussed herein, according to the claim element. *See, e.g.*, *id.* at APPLE_QUALCOMM_000055 ("determines the correct SIR target based on outage reported by FW every frame"),[61] APPLE_QUALCOMM_000056 (including code to accumulate the number of valid slots and slots in outage, and compare to the allowed slots in outage for a particular target outage point),[62] APPLE_QUALCOMM_000056-57 at lines 5341-5364 (adjusting the SIR target based on comparing the actual outage in the window to the allowed outage for the outage point, then writing the adjusted SIR target to the inner loop via global variable fpcTargetEbNt for the channel).[63] Because the SIR target is derived in part from the allowed slots in outage for the outage point, it is also based, in part, on the fading margins according to the claim.

371. In addition, the global structure dl_fdpch_outage_thresh_table (APPLE_QUALCOMM_000011)[64] correlates outage threshold values to established "BER" target percentages, which as I discussed above with respect to claim element **[1.a]** is equivalent to using the target block error rate ($BLER_{target}$). *See, e.g.*, APPLE_QUALCOMM_000011 at lines 759-

[60] *See also* Q2TOTAPPLE1302SC0000078-80, Q2TOTAPPLE1302SC0000221-223, Q2TOTAPPLE1302SC0000294-296, Q2TOTAPPLE1302SC0000412-414.

[61] *See also* Q2TOTAPPLE1302SC0000078, Q2TOTAPPLE1302SC0000221, Q2TOTAPPLE1302SC0000294, Q2TOTAPPLE1302SC0000412.

[62] *See also* Q2TOTAPPLE1302SC0000079, Q2TOTAPPLE1302SC0000221-222, Q2TOTAPPLE1302SC0000294-295, Q2TOTAPPLE1302SC0000412-413.

[63] *See also* Q2TOTAPPLE1302SC0000079-80 at lines 4665-4688, Q2TOTAPPLE1302SC0000222 at lines 5348-5371, Q2TOTAPPLE1302SC0000295 at lines 5348-5371, Q2TOTAPPLE1302SC0000413 at lines 5348-5371.

[64] *See also* Q2TOTAPPLE1302SC0000025, Q2TOTAPPLE1302SC0000117, Q2TOTAPPLE1302SC0000235, Q2TOTAPPLE1302SC0000353.

782.[65] The target BER performs the same claimed function as the target BLER of the outer loop, namely setting a quality criteria based on a target error rate, and does do in the same way with the same result.

372. The function named dl_olpc_fdpch_outage_init (APPLE_QUALCOMM_000054)[66] initializes fdpch outage based olpc parameters, including setting the outage points at either 6 percent or 20 percent and the outage window in the range of 1-10. *See, e.g.,* APPLE_QUALCOMM_000054 at lines 5155-5161.[67] The function named dl_olpc_fdpch_outage_thresh_init (APPLE_QUALCOMM_000054-55)[68] takes in the target BER (ber_rate), uses dl_fdpch_outage_thresh_table to determine the outage threshold corresponding to that target BER for the given outage point, and writes that threshold to firmware using a global variable (fdpchOutageSirTh). *Id.* This target outage SIR threshold is used to compare with the actual estimated SIR in function wfw_tx_fpc_decision_proc (APPLE_QUALCOMM_000087-89)[69] in firmware file wfw_tx_modulator.c, and the result is reported back as whether the slot is in outage. *See id.* at lines 9508-9523. In this way, the SIR target is based on the status of the data blocks and the target error rate.

[65] *See also* Q2TOTAPPLE1302SC0000025 at lines 664-687, Q2TOTAPPLE1302SC0000117-118 at lines 763-786, Q2TOTAPPLE1302SC0000235-236 at lines 763-786, Q2TOTAPPLE1302SC0000353-354 at lines 763-786.

[66] *See also* Q2TOTAPPLE1302SC0000076, Q2TOTAPPLE1302SC0000219, Q2TOTAPPLE1302SC0000292, Q2TOTAPPLE1302SC0000410.

[67] *See also* Q2TOTAPPLE1302SC0000076 at lines 4484-4490, Q2TOTAPPLE1302SC0000219 at lines 5162-5168, Q2TOTAPPLE1302SC0000292 at lines 5162-5168, Q2TOTAPPLE1302SC0000410 at lines 5162-5168.

[68] *See also* Q2TOTAPPLE1302SC0000076-77, Q2TOTAPPLE1302SC0000219-20, Q2TOTAPPLE1302SC0000292-93, Q2TOTAPPLE1302SC0000410-11.

[69] *See also* Q2TOTAPPLE1302SC0000146-149, Q2TOTAPPLE1302SC0000311-314.

373. As detailed above, the adjusting function performs a mapping between the outage probability based quality criteria and the target error rate. The target BER is mapped, via the outage threshold table, to the threshold used to determine outage for each slot and the outage probability ratio.

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374. Other evidence further confirms that the Apple/Qualcomm Accused Products perform this step. For example, Qualcomm's U.S. Patent Application Pub. No. 2013/0072250 (TOT00116816-35) details aspects of establishing a target block error rate in FDPCH mode of operation in the Apple/Qualcomm Accused Products, including dynamically adjusting the target SIR based on channel conditions such as outage ratios (i.e., probabilities) and target quality criteria (e.g., BER). *See, e.g.*, *id.* at [0084]:

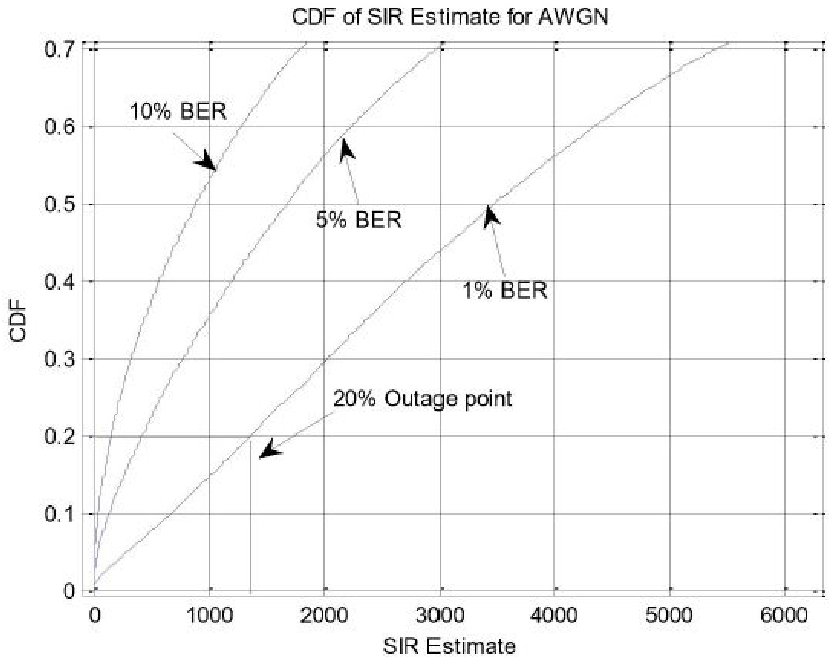
> **[0084]** If the actual outage ratio is greater than a preset target outage ratio (e.g., in the range of 6%-20% of the valid slots), as determined in **630**, which means the channel condition is bad, the SIRT can be increased by X dB, in **634**. On the other hand, if the outage ratio is less than or equal to the preset target outage ratio, SIRT is decreased by X dB, in **632**, since the channel condition is good. The step size can be adjusted within a range of values (e.g., X<1 dB). For example, in one aspect X can be 0.2 dB to keep the power change reasonable. Accordingly, for this example, if the outage ratio is larger than the target outage ratio, SIRT can be multiplied by 1.0471. On the other hand, the SIR target can be multiplied by 0.9550 if the outage ratio is lower than the target outage point.
>
> **[0085]** Additionally, it will be appreciated that a windowing or threshold function may be provided in relationship to the adjustment of the Target Signal Quality (SIRT) based on the comparison in **630**. For example, there could be a first outage ratio for an increase and a second outage ratio for a decrease, and any comparison that fell between those ratios would result in no change in the SIRT.

375. Other Qualcomm technical documents also describe the operation of the OLPC algorithm consistent with the source code and with the '376 patent claims. *See, e.g.*, QCTOTVAPPLE01302_0011000 at 0011007 (discussing adjusting the SIR target upward if there is a SIR outage on more than an allowed number of slots in a window). *See also id.* at 0011009:

- **FDPCH Power Control Algorithm**
  - Inner Loop
    - Step 1: Given BER Target, choose the IL Target. For instance, for 1% BER, the scaled SIR Target = 3570 (on Mustang).
  - Outer Loop
    - Step 2: Choose an outage point – 6% (1slot/frame) or 20% (3 slots/frame). This is the target outage.
    - Step 2: Choose the SIR outage target corresponding to this outage point. For instance, for 20% outage and 1% BER, the outage target is 1380.
    - Step 3: Choose a measurement window – 1 Frame or 10 Frames. Lets say we choose 1 Frame.
    - Step 4: Measure outage of the SIR estimate. For instance, if the SIR estimate is less than the outage target for 5 slots out of 15, the outage is 33.33%.
    - Step 5: If the measured outage (33.33% in example above) is greater than the desired outage (20% from choice of outage point), increase the IL target (3570 in the example above) by 0.1 dB (In this example the target becomes 3653).

See also id. at 00011006:

Outage Based OL Algorithm

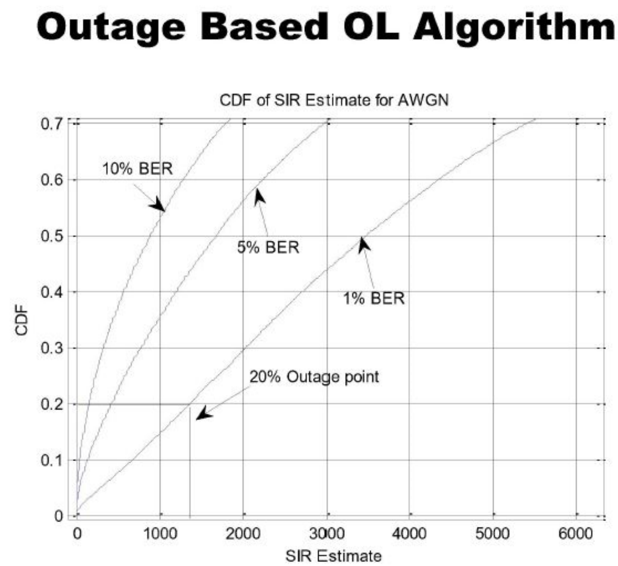


See also id. at 00011008:

Outage Target Table for FDPCH

BER Target	20% Outage point	6% Outage Point
1%	1380	424
2%	952	232
3%	708	144
4%	556	92
5%	440	64
6%	348	48
7%	280	36
8%	228	28
9%	188	20
10%	152	16

376. If the Court construes the "by means of a dynamic adjusting function . . ." phrase in element **[1.e]** as a means-plus-function limitation, then I understand that TOT asserts that the function for this limitation would be "performs a mapping between a quality criterion based on the outage probabilities (p_{o1}, p_{o2}, . . . , p_{oN}) and the quality criterion based on the target block error rate ($BLER_{target}$)," and the corresponding structure would be "a linear combination or an adder." My opinion is that, under this alternative construction, the Apple/Qualcomm Accused Products still infringe element **[1.e]**. As I already discussed above, the Qualcomm modems included in the Apple/Qualcomm Accused Products perform an OLPC algorithm in FDPCH mode that "performs a mapping between a quality criterion based on the outage probabilities (p_{o1}, p_{o2}, . . . , p_{oN}) and the quality criterion based on the target block error rate ($BLER_{target}$)." In addition, the structure used in this algorithm for performing this function includes a linear combination or an adder. *See* '376 Patent at 10:50-57 ("SIR_{target}=SIR_{outage} +k_1*M"). For example, Qualcomm documents confirm that there is a linear relationship between a SIR target set at the median of the CDF function for a particular bit error rate, and the margin between it and the SIR outage point. *See, e.g.*, QCTOTVAPPLE01302_0011000 at 0011003-06 (showing 20% outage point of 1380 and 1% BER SIR target of 3570 on CDF graph of SIR estimate):



377. Qualcomm built this linear combination into the code analyzed above in the form of tables and code relating these parameters. Therefore, the Apple/Qualcomm Accused Products satisfy the "by means of a dynamic adjusting function . . ." phrase in element **[1.e]**, even under this alternative construction of that phrase as a means-plus-function limitation.

378. In summary, because the Apple/Qualcomm Accused Products perform each element of claim 1 of the '376 Patent, it is my opinion that these products infringe claim 1.

2. '376 Patent Claim 6

379. The Apple/Qualcomm Accused Products infringe each element of claim 6 of the '376 Patent as will be explained below.

a) [6.pre] ***An outer loop power control apparatus for wireless communications systems, comprising at least one programmable electronic device the programmable electronic device operable to, based on a data signal received from a base station or from a mobile station, perform the steps of:***

380. I understand that the parties disagree as to whether the preamble of claim 6 is limiting. Whether or not the preamble is limiting, in my opinion the Apple/Qualcomm Accused Products meet the preamble's language of "An outer loop power control apparatus for wireless

communications systems, comprising at least one programmable electronic device the programmable electronic device operable to, based on a data signal received from a base station or from a mobile station, perform the steps of."

381. Each of the Apple/Qualcomm Accused Products includes a Qualcomm modem, which is (along with the processing elements executing its software and firmware) an outer loop power control device for wireless communications systems, comprising at least one programmable electronic device operable to, based on a data signal received from a base station, perform all of the steps recited in claim 6, as I discuss below.

382. I have already identified in Exhibit C the specific Qualcomm modems that are present in each of the Apple/Qualcomm Accused Products. That information is based on Apple's interrogatory responses as well as other evidence which I have previously discussed such as the iFixit Teardown reports.

383. Each of these Qualcomm modems includes at least one programmable electronic device operable to perform, based on a data signal received from a base station, the steps recited in claim 6. And the steps recited in claim 6 are performed whenever an Apple/Qualcomm Accused Product is powered on and used as intended (e.g., by Apple personnel in the course of their testing, demonstration, and other use of the product, and/or by each and every end user).

b) [6.a] *establishing a target block error rate ($BLER_{target}$)*

384. Element **[6.a]** in claim 6 recites "establishing a target block error rate ($BLER_{target}$)." This is identical to the language of element **[1.a]** in claim 1. Therefore, for the same reasons discussed above for element **[1.a]**, it is my opinion that the Apple/Qualcomm Accused Products satisfy element **[6.a]**. As such, I incorporate by reference my analysis for element **[1.a]**.

c) [6.b] *calculating an estimate (701) of a desired signal to interference ratio (SIR_{rec}) and of some fading parameters in a channel (706) which characterize the data signal (107, 108) received*

385. Element **[6.b]** in claim 6 recites "calculating an estimate (701) of a desired signal to interference ratio (SIR_{rec}) and of some fading parameters in a channel (706) which characterize the data signal (107, 108) received." This is identical to the language of element **[1.b]** in claim 1. Therefore, for the same reasons discussed above for element **[1.b]**, it is my opinion that the Apple/Qualcomm Accused Products satisfy element **[6.b]**. As such, I incorporate by reference my analysis for element **[1.b]**.

d) [6.c] *estimating some fading margins (M1, M2, . . . , MN) associated with some outage probabilities (po1, po2, . . . , poN) and with the fading parameters in the channel (706)*

386. Element **[6.c]** in claim 6 recites "estimating some fading margins (M1, M2, . . . , MN) associated with some outage probabilities (po1, po2, . . . , poN) and with the fading parameters in the channel (706)." This is identical to the language of element **[1.c]** in claim 1. Therefore, for the same reasons discussed above for element **[1.c]**, it is my opinion that the Apple/Qualcomm Accused Products satisfy element **[6.c]**. As such, I incorporate by reference my analysis for element **[1.c]**.

e) [6.d] *indicating a status of the data blocks (707) based on the checking of a Cyclic Redundancy Code (CRC), and*

387. Element **[6.d]** in claim 6 recites "indicating a status of the data blocks (707) based on the checking of a Cyclic Redundancy Code (CRC)." This is identical to the language of element **[1.d]** in claim 1. Therefore, for the same reasons discussed above for element **[1.d]**, it is my opinion that the Apple/Qualcomm Accused Products satisfy element **[6.d]**. As such, I incorporate by reference my analysis for element **[1.d]**.

f) [6.e] *establishing a target desired signal to interference ratio (SIR_{target}) for the outer loop, based on said status of the data blocks (707), the fading margins (M1, M2, MN) and the target block error ($BLER_{target}$) of the outer loop, by means of a dynamic adjusting function which performs a mapping between a quality criterion based on the outage probabilities (po1, po2, . . . , poN) and the quality criterion based on the target block error rate ($BLER_{target}$), so that the power is adapted to the propagation conditions of the data signal (107, 108).*

388. Element **[6.e]** in claim 6 recites "establishing a target desired signal to interference ratio (SIR_{target}) for the outer loop, based on said status of the data blocks (707), the fading margins (M1, M2, MN) and the target block error ($BLER_{target}$) of the outer loop, by means of a dynamic adjusting function which performs a mapping between a quality criterion based on the outage probabilities (po1, po2, . . . , poN) and the quality criterion based on the target block error rate ($BLER_{target}$), so that the power is adapted to the propagation conditions of the data signal (107, 108)." This is identical to the language of element **[1.e]** in claim 1. Therefore, for the same reasons discussed above for element **[1.e]**, it is my opinion that the Apple/Qualcomm Accused Products satisfy element **[6.e]**. As such, I incorporate by reference my analysis for element **[1.e]**.

389. In summary, because the Apple/Qualcomm Accused Products satisfy each element of claim 6 of the '376 Patent, it is my opinion that these products infringe claim 6.

3. '376 Patent Claim 7: *The outer loop power control apparatus for wireless communications systems, according to claim 6, wherein the programmable electronic device is selected among a general-purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC) and a programmable array (FPGA) or any combination of the foregoing.*

390. In my opinion, the Apple/Qualcomm Accused Products meet the elements of claim 7, which recites: "The outer loop power control apparatus for wireless communications systems, according to claim 6, wherein the programmable electronic device is selected among a general-purpose processor, a digital signal processor (DSP), an application specific integrated circuit

(ASIC) and a programmable array (FPGA) or any combination of the foregoing." Claim 7 is therefore dependent on claim 6.

391. The Apple/Qualcomm Accused Products satisfy all elements of claim 6 of the '376 Patent, for the reasons I have already discussed above.

392. In addition, the Apple/Qualcomm Accused Products satisfy the additional element in claim 7 "wherein the programmable electronic device is selected among a general-purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC) and a programmable array (FPGA) or any combination of the foregoing." The processors identified in my analysis of claim 5 above are DSPs, ASICs, and/or FPGAs. For example, the MDM9655 modem is an ASIC that includes DSP processing blocks. *See, e.g.*, QCTOTVAPPLE01302_0002515 at 33 ("MDM9x55 block diagram").

393. The Apple/Qualcomm Accused Products therefore meet all of the limitations of claim 7.

4. '376 Patent Claim 8: *The outer loop power control apparatus for wireless communications systems, according to claim 6, further comprising: a radiofrequency receiver (203) capable of receiving the data signal (107, 108) coming from the base station (102, 103) or from the mobile station (104) of the wireless communications system.*

394. In my opinion, the Apple/Qualcomm Accused Products meet the elements of claim 8, which recites: "The outer loop power control apparatus for wireless communications systems, according to claim 6, further comprising: a radiofrequency receiver (203) capable of receiving the data signal (107, 108) coming from the base station (102, 103) or from the mobile station (104) of the wireless communications system." Claim 8 is therefore dependent on claim 6.

395. The Apple/Qualcomm Accused Products satisfy all elements of claim 6 of the '376 Patent, for the reasons I have already discussed above.

396. In addition, the Apple/Qualcomm Accused Products satisfy the additional element in claim 8 of "a radiofrequency receiver (203) capable of receiving the data signal (107, 108) coming from the base station (102, 103) or from the mobile station (104) of the wireless communications system." Each of the Apple/Qualcomm Accused Products has transceiver components connected to their Qualcomm modem that are capable of transmitting data signals to and receiving data signals from a base station.

397. For example, the Technical Specifications produced by Apple confirm that the Apple/Qualcomm Accused Products are capable of transmitting data signals to and receiving data signals from base stations in a cellular network – functionality that requires a radiofrequency transmitter and receiver or transceiver. *See., e.g.*, APL-TOTDDE00690592-98 (iPhone SE Technical Specifications) at APL-TOTDDE00690593:

Cellular and Wireless

- **Model A1662**
  - LTE (Bands 1, 2, 3, 4, 5, 8, 12, 13, 17, 18, 19, 20, 25, 26, 29)
  - CDMA EV-DO Rev. A (800, 1700/2100, 1900, 2100 MHz)
  - UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)
  - GSM/EDGE (850, 900, 1800, 1900 MHz)
- **Model A1723**
  - LTE (Bands 1, 2, 3, 4, 5, 7, 8, 12, 17, 18, 19, 20, 25, 26, 28)
  - TD-LTE (Bands 38, 39, 40, 41)
  - TD-SCDMA 1900 (F), 2000 (A)
  - CDMA EV-DO Rev. A (800, 1700/2100, 1900, 2100 MHz)
  - UMTS/HSPA+/DC-HSDPA (850, 900, 1700/2100, 1900, 2100 MHz)
  - GSM/EDGE (850, 900, 1800, 1900 MHz)

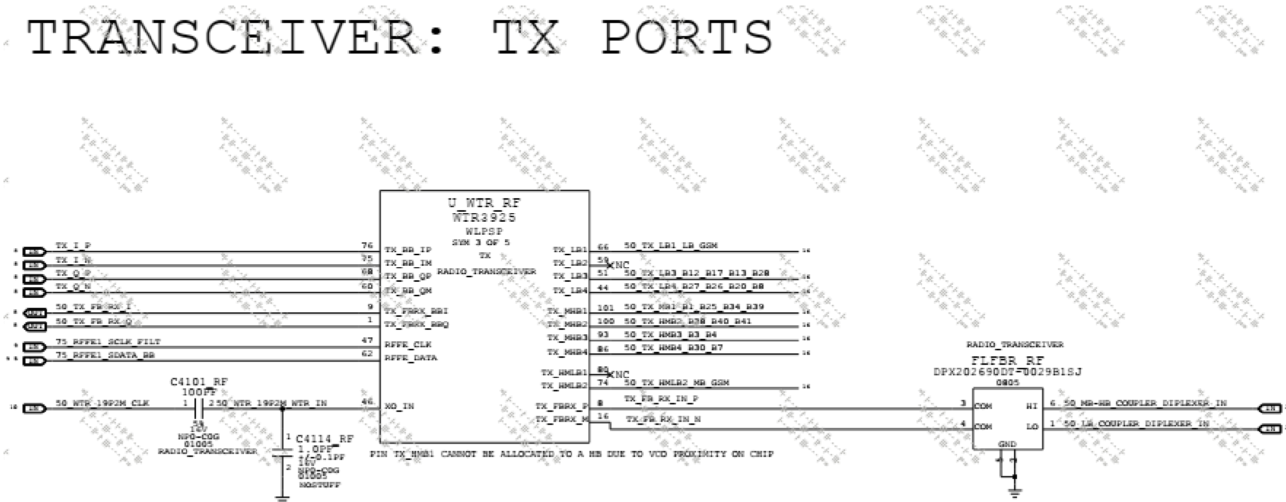
See also APL-TOTDDE_00692725-32; APL-TOTDDE_00690599-605; APL-TOTDDE_00693077-84; APL-TOTDDE_00693085-92; APL-TOTDDE_00693069-76; APL-TOTDDE_00693183-84; APL-TOTDDE_00693181-82; APL-TOTDDE_00690632-41; APL-TOTDDE_00690662-71; APL-TOTDDE_00690642-51; APL-TOTDDE_00690652-61; APL-

TOTDDE_00692431; APL-TOTDDE_00692432; APL-TOTDDE_00690672-80; APL-TOTDDE_00692027; APL-TOTDDE_00693151-57; APL-TOTDDE_00692018; APL-TOTDDE_00690621-28; APL-TOTDDE_00693144-50; APL-TOTDDE_00688425-27; APL-TOTDDE_00690629-31.

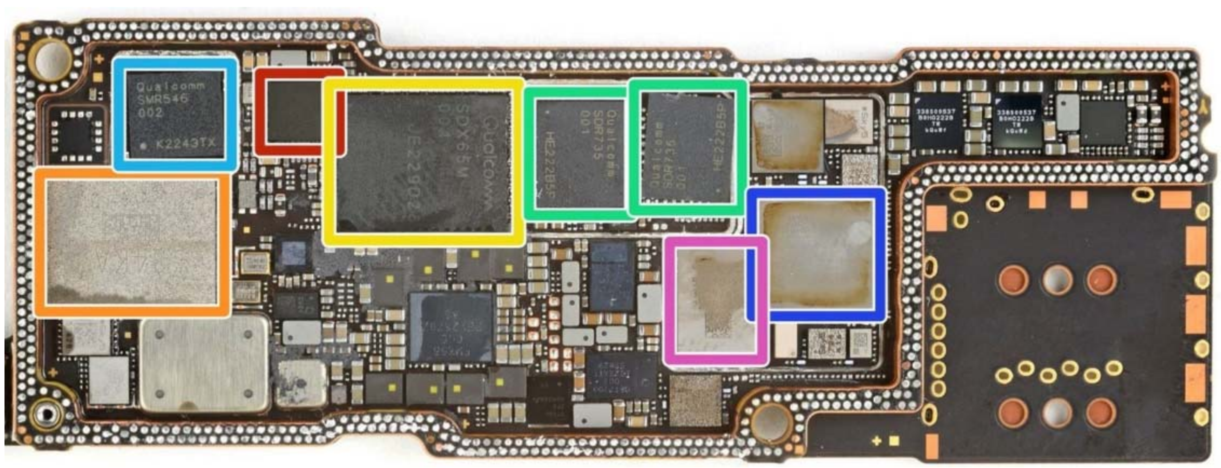
398. The Schematics and Bills of Materials listed in Exhibit E also show that the Apple/Qualcomm Accused Products include RF transceiver components and RF Front End components that are capable of receiving radio data signals from a base station. *See, e.g.*, APL-TOTDDE00000355-413 (schematics for "N71," which is the product code for iPhone 6s) at APL-TOTDDE00000355:

PAGE	CSA	CONTENTS
31	46	I/O:DOCK FLEX B2B
32	47	I/O:BUTTON FLEX B2B
33	49	BASEBAND:RADIO SYMBOL
34	1	page1
35	2	ELNA & UAT ANT FEED
36	3	FE: ANT CONNECTORS AND UAT TUNER
37	4	WLAN LAT 2.4GHZ BAW BPF
38	30	DEBUG CONN & TEST POINTS
39	31	CELLULAR BASEBAND: POWER1
40	32	CELLULAR BASEBAND: POWER2
41	33	CELLULAR BASEBAND: CONTROL AND INTERFACES
42	34	CELLULAR BASEBAND: GPIOS
43	35	CELLULAR PMU: CONTROL AND CLOCKS
44	36	CELLULAR PMU: SWITCHERS AND LDOS
45	37	CELLULAR PMU: ET MODULATOR
46	38	CELLULAR TRANSCEIVER: POWER
47	39	CELLULAR TRANSCEIVER: PRX PORTS
48	40	CELLULAR TRANSCEIVER: DRX/GPS PORTS
49	41	CELLULAR TRANSCEIVER: TX PORTS

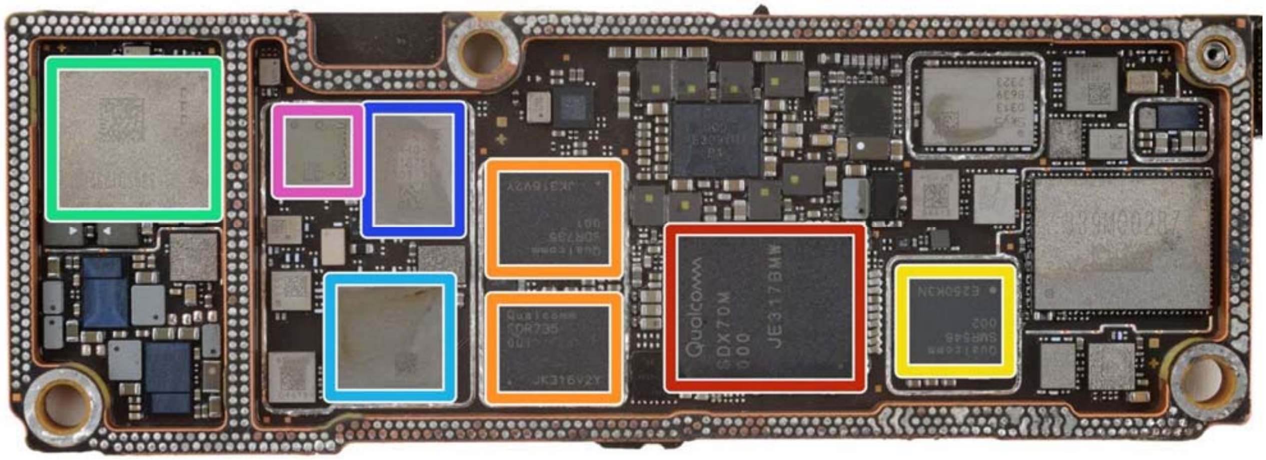
See also id. at APL-TOTDDE00000403:



399. This is also confirmed by the iFixit Teardown reports that I discussed earlier. For example, the iFixit Teardown report, *available at* https://www.ifixit.com/Guide/iPhone+14+Pro+Max+Chip+ID/153224, shows SDR735 transceiver components (boxed in green) in an iPhone 14 Pro Max:



Similarly, the iFixit Teardown report, *available at* https://www.ifixit.com/Guide/iPhone+15+Pro+Max+Chip+ID/165320, shows SDR735 transceiver components (boxed in orange) in an iPhone 15 Pro Max:



400. The Apple/Qualcomm Accused Products therefore meet all of the limitations of claim 8.

5. '376 Patent Claim 9: *The outer loop power control apparatus for wireless communications systems, according to claim 6, further comprising a radiofrequency transmitter (202) capable of sending the power control information to the base station (102, 103) or to the mobile station (104) of the wireless communications system.*

401. In my opinion, the Apple/Qualcomm Accused Products meet the elements of claim 9, which recites: "The outer loop power control apparatus for wireless communications systems, according to claim 6, further comprising a radiofrequency transmitter (202) capable of sending the power control information to the base station (102, 103) or to the mobile station (104) of the wireless communications system." Claim 9 is therefore dependent on claim 6.

402. The Apple/Qualcomm Accused Products satisfy all elements of claim 6 of the '376 Patent, for the reasons I have already discussed above.

403. In addition, the Apple/Qualcomm Accused Products satisfy the additional element in claim 9 of "further comprising a radiofrequency transmitter (202) capable of sending the power control information to the base station (102, 103) or to the mobile station (104) of the wireless communications system." As I discussed above with respect to claim 8, each of the Apple/Qualcomm Accused Products has transceiver components connected to their Qualcomm

modem that are capable of transmitting data signals to and receiving data signals from a base station. Those transceiver components include radio transmitters that are able to send power control information to the base station.

404. The Apple/Qualcomm Accused Products therefore meet all of the limitations of claim 9.

6. '376 Patent Claim 11: *The outer loop power control apparatus in a wireless communications system, according to claim 7, wherein the outer loop power control apparatus is incorporated in a mobile station for wireless communications systems.*

405. In my opinion, the Apple/Qualcomm Accused Products meet the elements of claim 11, which recites: "The outer loop power control apparatus in a wireless communications system, according to claim 7, wherein the outer loop power control apparatus is incorporated in a mobile station for wireless communications systems." Claim 11 is therefore dependent on claim 7.

406. The Apple/Qualcomm Accused Products satisfy all elements of claim 7 of the '376 Patent, for the reasons I have already discussed above.

407. In addition, the Apple/Qualcomm Accused Products satisfy the additional element in claim 11 "wherein the outer loop power control apparatus is incorporated in a mobile station for wireless communications systems." The Apple/Qualcomm Accused Products act as mobile stations according to 3G standards. The Apple/Qualcomm Accused Products are therefore "mobile station[s] for wireless communications systems." In addition, the Apple/Qualcomm Accused Products include the Qualcomm modems and associated software/firmware, which as discussed with respect to claim 6 above are "the outer loop power control apparatus."

408. For example, the Qualcomm SDX60M (X60) modem baseband processor is incorporated into the Apple iPhone 13 Pro Max smartphone:

iPhone 13 Pro Max – Technical Specifications

Year introduced : 2021
Identify your iPhone model

APL-TOTDDE_00690652-61 at APL-TOTDDE_00690652. As another example, the Qualcomm MDM9655 modem baseband processor, discussed earlier in this report, is incorporated into the Apple iPhone 8 smartphone:

iPhone 8 – Technical Specifications

APL-TOTDDE_00693077-84 at APL-TOTDDE_00693077. *See also* Exhibit C (identifying the Qualcomm baseband processors that are incorporated into the Apple/Qualcomm Accused Products).

409. The Apple/Qualcomm Accused Products therefore meet all of the limitations of claim 11.

7. '376 Patent Claim 13

410. The Apple/Qualcomm Accused Products infringe each element of claim 13 of the '376 Patent as will be explained below.

a) [13.pre] ***A mobile station for wireless communications systems, comprising an outer loop power control apparatus the apparatus comprising:***

411. I understand that the parties disagree as to whether the preamble of claim 13 is limiting. Whether or not the preamble is limiting, in my opinion the Apple/Qualcomm Accused Products meet the preamble's language of "A mobile station for wireless communications systems, comprising an outer loop power control apparatus the apparatus comprising." The Apple/Qualcomm Accused Products are mobile stations for wireless communications systems and include an outer loop power control apparatus, as I already discussed above with respect to claims 1 and 6. The Apple/Qualcomm Accused Products therefore satisfy the preamble of claim 13, to the extent it is found to be limiting.

b) [13.a] ***at least one programmable electronic device, the programmable electronic device operable to, based on a data signal received from a base station or from a mobile station, perform the steps of:***

412. Element **[13.a]** in claim 13 recites "at least one programmable electronic device, the programmable electronic device operable to, based on a data signal received from a base station or from a mobile station, perform the steps of." The Apple/Qualcomm Accused Products include Qualcomm modems, which include a processor/modem component that constitutes at least one programmable electronic device. The device is operable to, based on a data signal received from a base station, perform the steps recited in claim 13, as I already discussed above with respect to

claims 1 and 6, and as I further discuss below. The Apple/Qualcomm Accused Products therefore satisfy element **[13.a]**.

c) [13.b] *establishing a target block error rate ($BLER_{target}$)*

413. Element **[13.b]** in claim 13 recites "establishing a target block error rate ($BLER_{target}$)." This is identical to the language of element **[1.a]** in claim 1. Therefore, for the same reasons discussed above for element **[1.a]**, the Apple/Qualcomm Accused Products satisfy element **[13.b]**. As such, I incorporate by reference my analysis for element **[1.a]**.

d) [13.c] *calculating an estimate (701) of a desired signal to interference ratio (SIR_{rec}) and of some fading parameters in a channel (706) which characterize the data signal (107, 108) received*

414. Element **[13.c]** in claim 13 recites "calculating an estimate (701) of a desired signal to interference ratio (SIR_{rec}) and of some fading parameters in a channel (706) which characterize the data signal (107, 108) received." This is identical to the language of element **[1.b]** in claim 1. Therefore, for the same reasons discussed above for element **[1.b]**, the Apple/Qualcomm Accused Products satisfy element **[13.c]**. As such, I incorporate by reference my analysis for element **[1.b]**.

e) [13.d] *estimating some fading margins (M1, M2, . . . , MN) associated with some outage probabilities (po1, po2, . . . , poN) and with the fading parameters in the channel (706)*

415. Element **[13.d]** in claim 13 recites "estimating some fading margins (M1, M2, . . . , MN) associated with some outage probabilities (po1, po2, . . . , poN) and with the fading parameters in the channel (706)." This is identical to the language of element **[1.c]** in claim 1. Therefore, for the same reasons discussed above for element **[1.c]**, the Apple/Qualcomm Accused Products satisfy element **[13.d]**. As such, I incorporate by reference my analysis for element **[1.c]**.

f) [13.e] ***indicating a status of the data blocks (707) based on the checking of a Cyclic Redundancy Code (CRC), and***

416. Element **[13.e]** in claim 13 recites "indicating a status of the data blocks (707) based on the checking of a Cyclic Redundancy Code (CRC)." This is identical to the language of element **[1.d]** in claim 1. Therefore, for the same reasons discussed above for element **[1.d]**, the Apple/Qualcomm Accused Products satisfy element **[13.e]**. As such, I incorporate by reference my analysis for element **[1.d]**.

g) [13.f] ***establishing a target desired signal to interference ratio (SIR_{target}) for the outer loop, based on said status of the data blocks (707), the fading margins (M1, M2, . . . , MN) and the target block error ($BLER_{target}$) of the outer loop, by means of a dynamic adjusting function which performs a mapping between a quality criterion based on the outage probabilities (po1, po2, . . . , poN) and the quality criterion based on the target block error rate ($BLER_{target}$), so that the power is adapted to the propagation conditions of the data signal (107, 108); and***

417. Element **[13.f]** in claim 13 recites "establishing a target desired signal to interference ratio (SIR_{target}) for the outer loop, based on said status of the data blocks (707), the fading margins (M1, M2, MN) and the target block error ($BLER_{target}$) of the outer loop, by means of a dynamic adjusting function which performs a mapping between a quality criterion based on the outage probabilities (po1, po2, . . . , poN) and the quality criterion based on the target block error rate ($BLER_{target}$), so that the power is adapted to the propagation conditions of the data signal (107, 108)." This is identical to the language of element **[1.e]** in claim 1. Therefore, for the same reasons discussed above for element **[1.e]**, the Apple/Qualcomm Accused Products satisfy element **[13.f]**. As such, I incorporate by reference my analysis for element **[1.e]**.

h) [13.g] ***wherein the programmable electronic device is selected among a general-purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC) and a***

programmable array (FPGA) or any combination of the foregoing.

418. Element **[13.g]** in claim 13 recites "wherein the programmable electronic device is selected among a general-purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC) and a programmable array (FPGA) or any combination of the foregoing." This is identical to the language of the additional limitation in dependent claim 7. Therefore, for the same reasons discussed above for claim 7, the Apple/Qualcomm Accused Products satisfy element **[13.g]**. As such, I incorporate by reference my analysis for claim 7.

419. In summary, because the Apple/Qualcomm Accused Products satisfy each element of claim 13 of the '376 Patent, it is my opinion that these products infringe claim 13.

VII. BENEFITS ATTRIBUTABLE TO APPLE'S INFRINGEMENT

420. As I discussed earlier in my report, the '865 and '376 Patents provide a number of benefits, including reduced interference, increased network capacity, and improved quality of service. And additional capacity means that a cellular network can support more voice calls as well as faster data rates for wireless customers. Conversely, inadequate network capacity can lead to problems for customers such as dropped calls, poor voice quality, and slow data speeds.

421. As a result of Apple's adoption of TOT's OLPC solutions, wireless carriers have been able to provide services to more customers without the need to use other approaches to increase network capacity, such as purchasing and deploying additional network infrastructure equipment, or purchasing additional spectrum. And reduced interference benefits Apple because it ensures that mobile devices do not interfere with each other as the number of phones per base station in the network reaches its limit. Interference reduces the amount of data that can be carried by the channel. Interference can lead to errors which require retransmission of data packets, which reduces data download speed and can adversely impact voice quality. Apple's adoption of the

patented OLPC solutions also helps devices ensure a certain level of quality of service and improve their ability to adapt quickly to changing propagation conditions in the radiofrequency channel while also minimizing the amount of power used for the connection.

422. Both of the Asserted Patents claim power control techniques that benefit the entire cellular network ecosystem. The Asserted Patents cause transmitted power to much more closely match the power actually required to maintain a specified level of service than prior art power control techniques. In this case, the accused functionality is downlink power control. Thus, the claims at issue here include mechanisms for each Accused Product to request transmissions at a power level high enough to operate as required by the carriers and the standards and further meet Apple's performance standards at any particular time and also to quickly reduce requested transmission power when conditions improve to minimize interference to the benefit of every device in the ecosystem, including better call quality and higher bandwidth. Under some circumstances, the magnitude of the benefit that the '865 or '376 Patent delivers in terms of power savings may vary – but they are both directed to the same goal: to request transmissions at power levels that correlate to the power level actually required at all times, including in particular, when conditions rapidly improve or are better than expected.

423. As I discussed earlier in my report, the benefits of the '865 Patent include quickly returning the SIR_{target} to a suitable value after a windup condition, thereby reducing the amount of power necessary for a mobile device to maintain communications with a base station in a cellular network. *See* '865 Patent at 4:16-39. This in turn increases the overall capacity of the cellular network.

424. As opposed to 2G systems, 3G systems are characterized by integrated capacity and interference calculations. *UMTS RAN Capacity Analysis for Special Events*, Vujic and Certic,

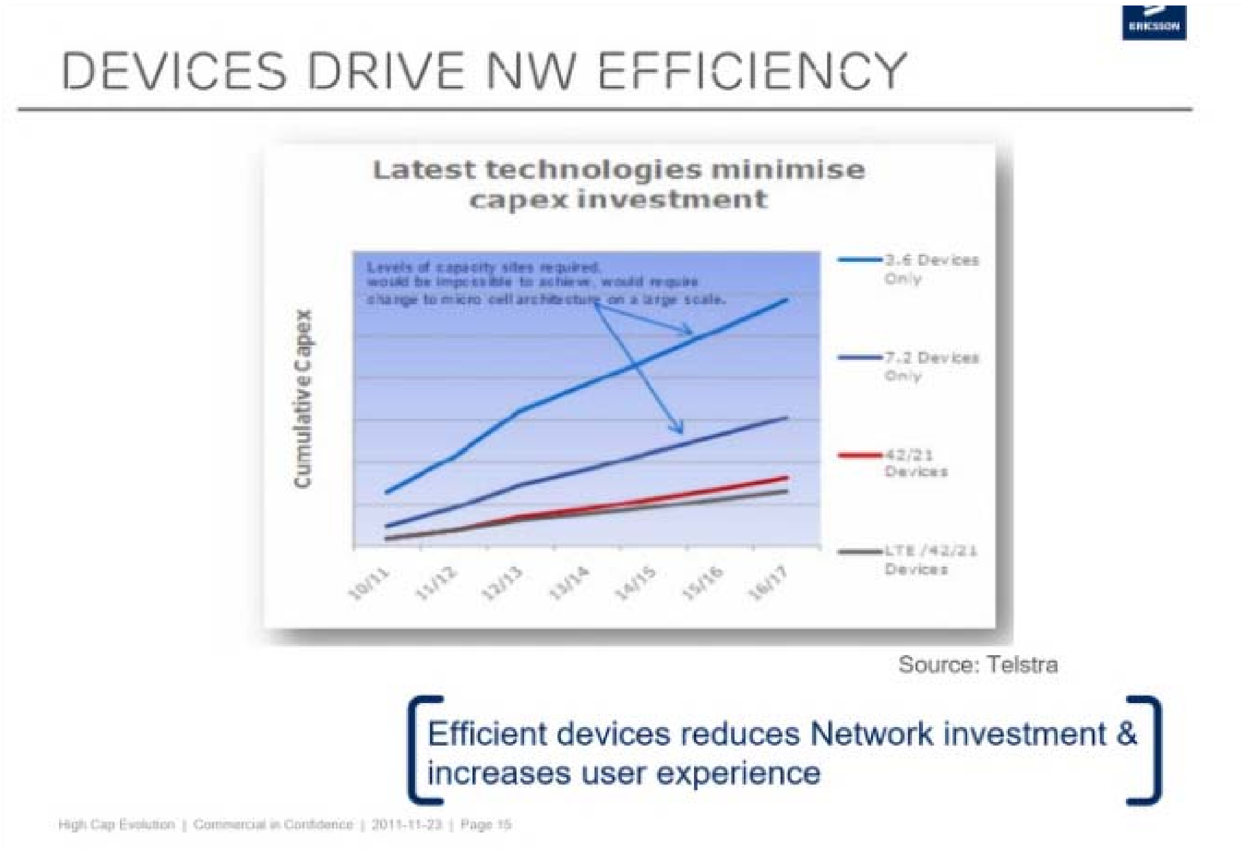
Wireless Pers. Commun., 1/28/2014 at 2. This means that, rather than talking about capacity of a system, 3G is characterized by network load. *UMTS RAN Capacity Analysis for Special Events*, Vujic and Certic, Wireless Pers. Commun., 1/28/2014 at 2. In situations of high demand, a system is not limited by uplink interference or capacity, but instead by the downlink capacity available to end-users. *Id.* at 14.

425. Dynamic power control is one of the most important aspects of WCDMA. Dynamic power control dynamically adjusts the radio-link transmit power to compensate for variations and differences in the instantaneous channel conditions. *Studies on High Speed Uplink Packet Access Performance Enhancements*, Frans Laakso, Jyvaskyla Studies in Computing 206, 12/19/2014 at 42. The aim of these adjustments is to maintain a near constant Signal to Interference Ratio (SIR) at the receiver to successfully transmit data without a too high error probability.

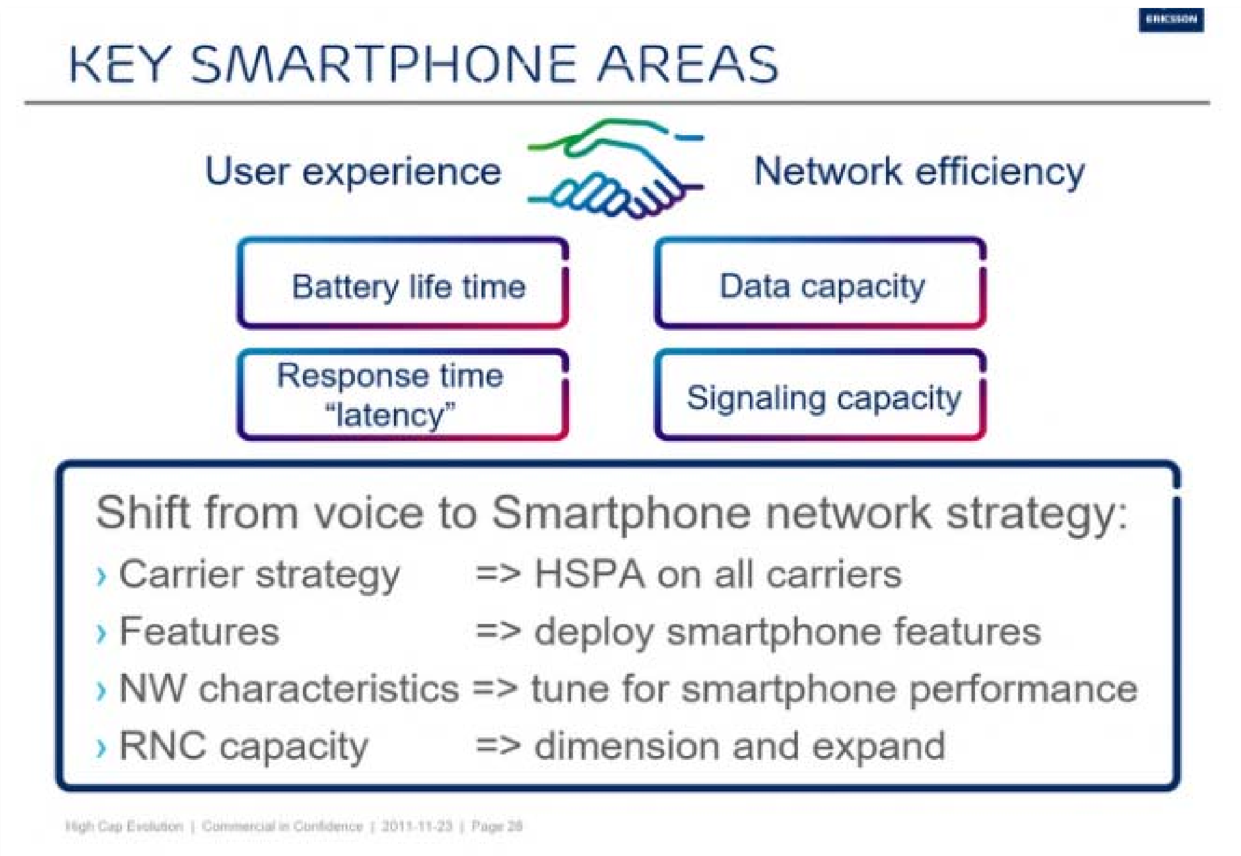
426. In principle, transmit power control increases the power at the transmitter when the radio link experiences poor radio conditions, and vice versa. Laakso at 42. As such, the transmit power is, in essence, inversely proportional to the channel quality. *Id.* Power control mitigates the effects of fading and ensures that each user receives and transmits with just enough energy to prevent blocking of distant users, and that the users won't exceed reasonable interference levels. *Id*. When a mobile device increases transmission power to compensate for bad conditions, other mobile devices experience higher interference and might be forced to increase transmission power as well, creating a cycle. *Id.*; *see also Signal and Interference Statistics of a CDMA System with Feedback Power Control*, S. Ariyavisitakul and L.F. Chang, IEEE Transactions on Communications vol. 41 no. 11, 11/1993 at 1626 ("Since these codes cannot be exactly orthogonal for a set of asynchronous users, interuser interference usually adds on a power basis and the radio

link performance of any one user becomes poorer as the number of simultaneous users increases."). Devices with low resources will experience high interference and possibly even be blocked by devices with higher resources. Laakso at 42. Indeed, an Ericsson document notes that "interference mitigation becomes even more important" in areas with high-capacity demand. TOT00192637-85 at TOT00192646.

427. Moreover, devices that use resources efficiently improve the functioning of the entire system at a network level. A Qualcomm video notes that overall capacity, including data capacity, is increased when signal strength technology mitigates interference from voice. https://www.qualcomm.com/research/5g/3g at 2:35; *see also* TOT00192970 at TOT00193004 ("Qualcomm, a leader manufacturer is promoting the WCDMA evolution, known as WCDMA_. This evolution is focused on making voice more efficient to support more data."). For example, that Ericsson presentation notes that "efficient devices reduces [sic] Network Investment and increases user experience." TOT00192637-85 at TOT00192644:



428. It also discusses that Mobile phone user experience is hand-in-hand with network efficiency:



Id. at TOT00192650. *See also* TOT00188397-407 at TOT00188398 ("The optimized outer loop power control mechanism proposed by Top Optimized Technologies (ToT) will bring to the network the following two advantages: • Increased cell capacity. • Increased QoS offered to the subscribers."); *id.* at TOT00188407 ("Power control is a critical functionality of 3G networks and can be widely optimized. A slow convergence speed of the outer loop in changing propagation conditions causes: a loss of QoS when SIR target should be increased, and a loss in cell capacity when the SIR target should be decreased. This undesirable lack of speed becomes more important as we try to offer higher quality services, for example with the video call.").

429. The inventors of the '865 Patent presented their improved outer loop power control method to a 3GPP technical specifications working group in multiple meetings in May and August

2013. *See* TOT00192351-52; TOT00155318-27. In their May 2013 presentation, for example, the inventors noted:

3 Optimization

This contribution presents an optimization by which after the end of a power limitation is detected, the **OLPC sets the SIR target value as close as possible to the SIR target just before the wind up situation occurs**, which means setting the SIR target equals to the required in normal mode without a power limitation.

Taking into account the target value established by 3GPP[2] after a wind up, up to 2.5dB of power reduction during the period to recover the link quality stability can be reached by changing the SIR target to the value prior to the wind up situation.

TOT00192351-52 at TOT00192351.

430. In their August 2013 presentation, the inventors included simulation results showing how their improved method could increase network capacity:

1. Introduction

At RAN1 #73 meeting [1] a new network performance optimization was proposed, within study item "DCH Enhancements for UMTS", to minimize the interference in the network after a power limitation occurs. The proposed technique consist in, after the end of wind up is detected, setting the SIR target value as close as possible to the SIR target just before the wind up situation occurs. In this document, link level simulation results and proposals to be discussed for RAN1 to optimize power control in wind up situations are detailed.

TOT00155318-27 at TOT00155318. The results of those simulation tests were reported as follows:

Table 6 shows the gains of the proposed SIR target reset optimization comparing the Ec/Ior levels in Table 4 to 3GPP requirement and wind up detection with SIR target blocked without reset.

Table 6: Ec/Ior gains (dB) for SIR target resetting optimization

Channel	Gain vs No WU detection	Gain vs WU Detection
Case 4	3.7	1.6
PA3	3.8	1.7
PB3	3.9	1.9
VA3	3.9	1.8
VA30	3.8	1.8
VA120	3.7	1.6

> In average, the optimization gains are around 4 dB with respect to the 3GPP requirement with no detection and 1.7 dB with respect to the wind up detection case considered in these simulations. By just resetting the SIR target, this optimization provides big gains with respect to 3GPP requirement and also substantial gain compared to the wind up detecting procedure.

Id. at TOT00155325-26.

431. As I discussed earlier in my report, the benefits of the '376 Patent include a faster setting of the SIR_{target} to the minimum power level necessary for communications with the mobile device, which results in increased capacity of the cellular network. *See* '376 Patent, 5:66-6:12. And as previously discussed, increased capacity leads to better quality of service, such as fewer dropped calls and better data transmission. Thus, the benefits provided by the '376 Patent are similar to the benefits provided by the '865 Patent.

432. The 3rd Generation Partnership Project (3GPP) is a standards organization created in 1998 to develop mobile standards relating to WCDMA and TD-SCDMA networks. https://www.3gpp.org/about-us. One set of the groups under the 3GPP is directed to the TSG Radio Access Network (TSG RAN). These groups are responsible for the definition of the functions, requirements and interfaces of the RAN. https://www.3gpp.org/3gpp-groups/radio-access-networks-ran. In 1999, the TSG-RAN Group 4, including representatives from Nokia and TOT, discussed outer loop power control. TOT00102227-30. The notes of the group explained that OLPC required that the user device (UE) determine a target SIR:

> **2.1 Minimum performance criteria**
>
> Outer loop PC function requires 2 tasks from UE. (a) UE must have the ability to set the correct target threshold for the closed loop PC according to the required link quality given by the network, and (b) it must have the ability to adjust the threshold according the variation of radio environments, in order to maintain the required link quality.
>
> The above consideration leads to 2 performance measures with respect to how well UE performs the task. These are:
>
> (a) Minimum accuracy requirement. This ensures UE is able to maintain the target quality threshold, within certain accuracy. In addition, the needed Ec/Ior for maintaining the target link quality stays as minimum necessary.
>
> (b) Minimum delay requirement. This defines how fast UE is able to detect the change in radio condition, and adjust the target for closed loop PC accordingly. This requirement is also a function of the actual target link quality.

Id. at TOT00102227 (emphasis added).

433. Thus, as early as 1999, it was recognized in the industry that OLPC at the user device was necessary for the functioning of the network. Indeed, in another meeting in 1999, the 3GPP TGS-RAN group noted that performing OLPC in the network would cost possibly hundreds of milliseconds, which was untenable:

> **4. EXAMPLES FOR POSSIBLE PROBLEMS WITH OUTER LOOP**
>
> Figure 3, 4 and 5 show example situations in which fast reaction of outer loop is needed. In Figure 1, situation is shown in which amount of diversity is first small, then gets higher and finally gets again poor. Amount of diversity can change because of handovers, change in UE speed, changing number of channel taps etc. When amount of diversity increases outer loop algorithm made in UE immediately lowers Eb/Io target. Then also DCH powers starts to decrease and less interference is generated to the network. If outer loop PC was made in network, delay of possibly hundreds of milliseconds is experienced before outer loop can react. Then used DCH powers are unnecessary high for hundreds of milliseconds and interference is generated to the network. When amount of diversity again decreases, outer loop in UE immediately increases Eb/Io target and quality of the user is maintained. If outer loop was made in network delay is experienced and quality of connection gets bad for time that can last over hundreds of milliseconds.
>
> Figure 4 shows an example in which diversity improves over very short period. If outer loop is made in network change in diversity is not seen by outer loop or actions are made when returned to initial situation.
>
> Figure 5 shows an example in which diversity gets smaller for very short period. If outer loop is made in network, outer loop is not able to raise Eb/Io target, and too low powers are used. Then quality of link may be poor and several erroneous frames are possibly received. User possibly notices this as a click sound. As shown in simulation example in figure 1 diversity can change frequently. User notices this possibly as frequent clicks in voice.

TOT00158517-23 at TOT00158518 (emphasis added).

434. And the group understood that setting the initial SIR target was an important step:

2. BACKGROUND

When the connection is established Node B allocates a certain power for a downlink DPCH for a given UE. Node B may utilize some UE measurement reports such as reported Ec/Io value, and other parameters like BLER target and data rate when deciding the initial power of a DPCH. The given power may not be very accurate e.g. it may be too high or low resulting in a very good QoS or a bad QoS, respectively. Node B may assume that inaccuracy of initial power setting is not of vital importance since power can be adjusted very fast with the closed loop power control (+-1 dB/ slot). This is true but if a UE is not capable to set its initial SIR target even the accurate initial power of DPCH does not quarantee a good UE behavior in a call set up phase. This is discussed in more detailed below.

In the case that UE has set its initial SIR target much low value and it is not capable to increase the SIR target fast enough the call may be dropped even the initial power was very accurate. The other extreme case happens when UE has set its initial SIR target much too high value and is not capable to decrease the SIR target fast enough. In this case BS needs to send the DPCH with unnecessary high power for a certain time resulting in a capacity loss for a short period. In case of circuit switched service the capacity loss may not be so important but in case of packet service this may be of more importance.

TOT00102408-15 at TOT00102408 (emphasis added).

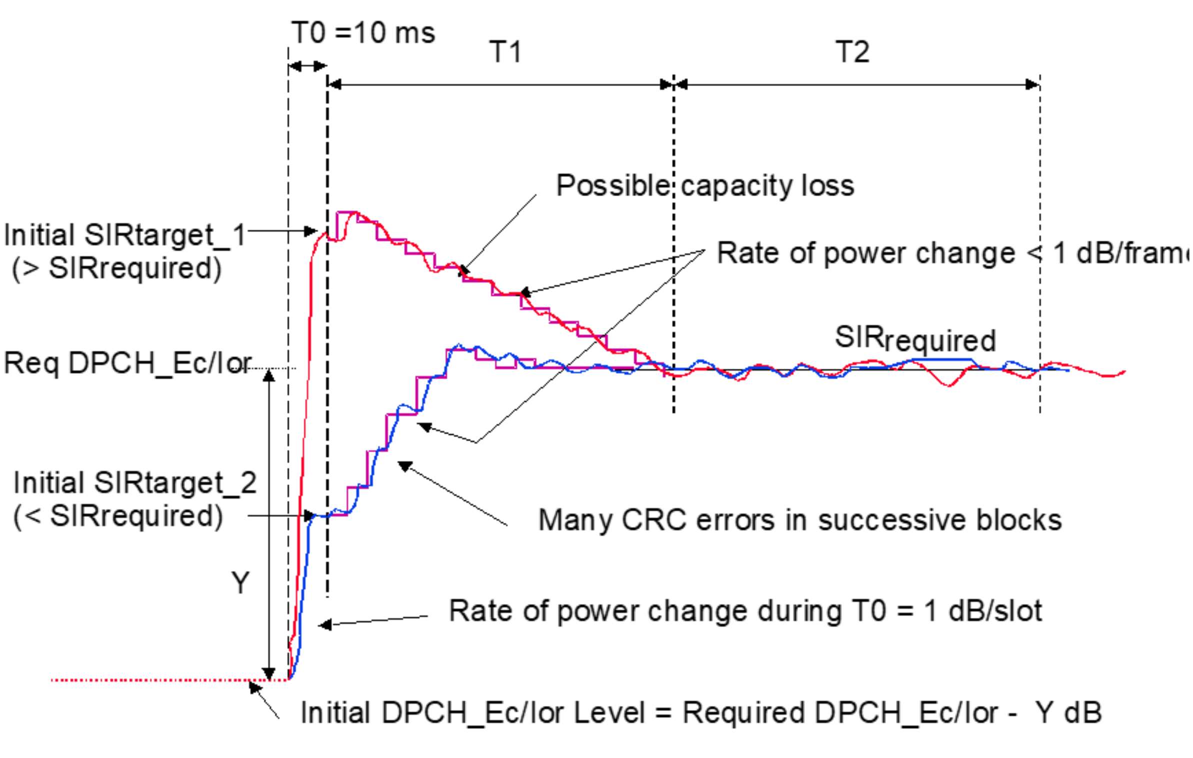


Figure 2: UE behavior when Node B allocates too little power for downlink DPCH.

Id. at TOT00102409.

435. The group also understood the need to test based on BLERs:

Other test parameters

- BLER target to have three different values: 10-1, 10-2 and 10-3. BLER target has big impact on UE initial SIR target setting. Different applications have different BLER target and it is important that initial SIR target setting works in a wide range of BLER target.

Id. at TOT00102411.

436. The inventors of the '376 Patent participated in a meeting of a 3GPP technical specifications working group in February 2005 in which they discussed the advantages of an outer loop power control method that takes into account outage probability. *See* TOT00155727-30. The inventors explained:

2.1 On the problems of error based power control.

Using a quality criteria based on error rates (like TPC command error rate) results in a power control mechanism with a slow adaptation speed to channel changing conditions, in addition, this speed gets slower while the quality of the communication is increased (lower error rate) [5] [6]. See Appendix A for real measurements in a DPCH. Other quality criteria, like the outage probability will fit as a quality criteria for the F-DPCH better than the TPC command error rate.

2.2 The Outage-Based OLPC.

The objective of these solutions is to adapt the fading margin (which is a component of the SIR target) corresponding to the current fading statistics and to the desired Outage Probability. This on-line tuning process of the fade margin in the OLPC corresponds to a mathematical problem known as "Optimal power control in interference limited fading wireless channels with outage-probability specifications",

and it was firstly considered in [7]. Since [8] an analytical solution for this problem exists and the outcome of a dynamic simulation developed to test this solution confirms the ability of the "Outage-Based" OLPC to maintain the required QoS irrespective of the changes in the channel propagation conditions.

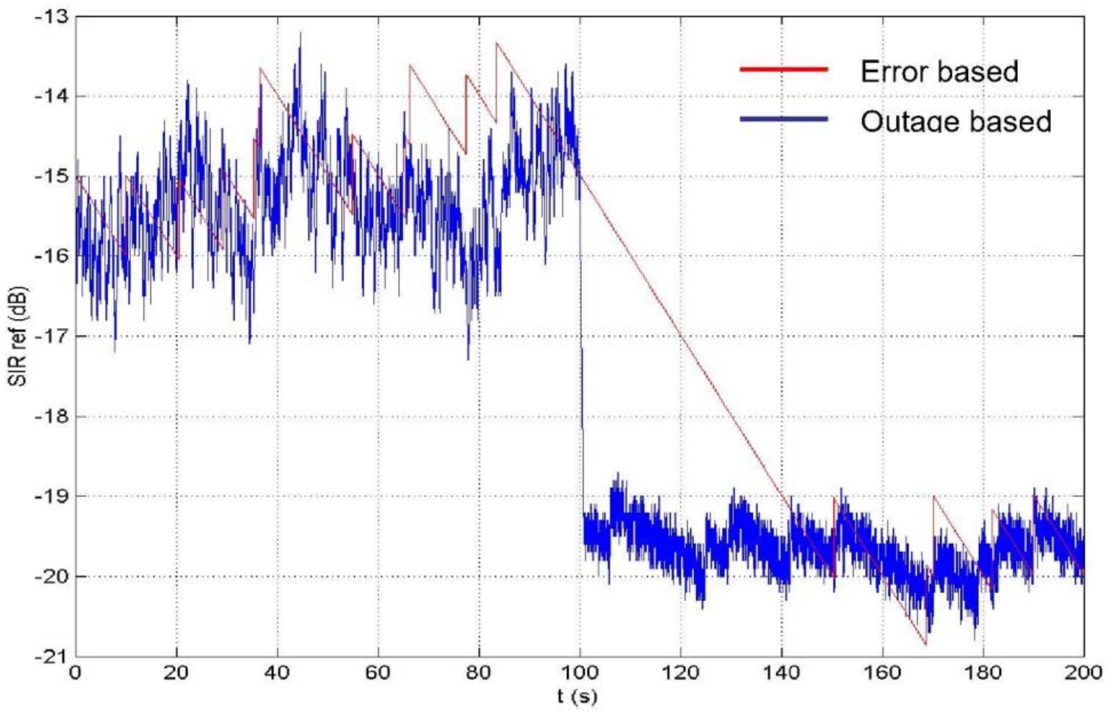
It is proposed for discussion to use an inner loop + outage based outer loop for the F-DPCH power control. The advantages of this method are:

- Its behaviour is not conditioned by error rate measurements.
- It adapts very quickly to changes in propagation conditions and it does it independently of the target quality.

This power control mechanism for F-DPCH will guarantee a high TPC quality and minimum power consumption with the corresponding cell capacity gain. See Appendix 1 for examples in simulation results for a DPCH, specific simulations for F-DPCH are to come in next meetings.

Id. at TOT00155727-28. The inventors presented simulation results showing the benefits of an outage-based outer loop power control method:

> The next figure represents simulations results comparing an error based power control mechanism and an outage based power control mechanism, there is an abrupt change in propagation conditions at 100 seconds. It can be seen that the error based power control simulation result has a very similar behaviour as in previous figure (real measurements), and that the outage-based one reacts much faster.



Id. at TOT00155729-30.

437. Simulations performed by TOT in 2005 indicated that TOT's outage based OLPC method could result in capacity gains of 33% as compared to a standard BLER based OLPC algorithm. *See* TOT00156893-932, at TOT00156926-28. In 2006, TOT performed field measurements of the OLPC methods implemented in two commercial devices, the Nokia 6630 and Samsung ZV-10 mobile phones. *See* TOT00067564-601 at TOT00067574. Comparing the field measurements to TOT's simulations of its outage based OLPC method, TOT determined that its OLPC method could result in capacity gains of 15.8% for voice service, 14.9% for video service,

and 21.72% for data service. *See* TOT00067564-601, at TOT00067589-93. And simulations performed by TOT in 2007 indicated that the outage based OLPC method could result in capacity gains of 16% for voice service, 21% for video service, and 11% for data service as compared to a BLER based OLPC method. *See* TOT00161186-244, at TOT00161221-24.

438. In the 2009-2011 time period, TOT also worked with Nokia and Vodafone on testing of the improved OLPC algorithm taught in the '376 Patent. *See* Luis Maestro (Nokia) Deposition (3/15/24) at 23:7-26:4. The testing included conducting HSUPA (high-speed uplink packet access) system level simulations, as well as developing a prototype system that implemented TOT's improved OLPC algorithm and testing the prototype in both a laboratory setting as well as in the field. *See id.* at 35:5-37:8, 38:20-40:8, 42:7-43:16, 48:5-49:5. TOT and Nokia prepared a presentation to Vodafone summarizing the results of that testing. *See id.* at 95:19-97:1. The presentation reports that, based on the testing, "TOT OLPC shows a link gain of 0.3 dB for the CS service" as compared to Nokia's existing OLPC algorithm, where "CS service" refers to voice calls. Luis Maestro (Nokia) Deposition (3/15/24), Ex. 10 [TOT00014311-32] at TOT00014322; Luis Maestro (Nokia) Deposition (3/15/24) at 104:18-105:18, 135:11-136:10. TOT's conclusions based on the test results were that "[l]arge gains obtained in voice calls when comparing with the commercial NSN [Nokia Siemens Networks] OLPC in Vodaphone network (29% voice capacity gain). This gain is reduced but still noteworthy when comparing with the NSN recommended settings using the lab (8% voice capacity gain)." Luis Maestro (Nokia) Deposition (3/15/24), Ex. 10 [TOT00014311-32] at TOT00014324.

439. I understand from discussions with Miguel Blanco Carmona that Huawei in collaboration with TOT performed testing of both the '865 and '376 OLPC methods in various environments. For example, in 2014, Huawei in collaboration with TOT performed testing of both

methods combined in a Vodaphone network in Madrid, Spain. *See* TOT00194275-325. The testing compared TOT's improved OLPC methods with a classical BELR-based OLPC method as well as Huawei's enhanced OLPC method, described as "a BLER-based OLPC with larger steps at the beginning of the call until the first CRC in error arrives." *Id.* at TOT00194276. TOT and Huawei concluded from the testing that TOT's OLPC methods resulted in total capacity gains between 12% - 30%. *See id.* at TOT00194321.

440. Other testing by ZTE and Huawei of TOT's OLPC methods in other networks yielded similar results. *See* TOT00194379-91 at TOT00194383 ("The first field measurements with the ToT OLPC were taken in ZTE offices in Shenzhen. Gains even higher than 40% were observed."); *id.* at TOT00194386 ("HUAWEI. TOTEM NETWORK (2) . . . The ToT windup solution provided 30% of gain because the unwinding process is faster than the traditional BLER based algorithm."); *id*. at TOT00194389 ("The solution was successfully integrated in Huawei's chipset. . . . ToT OLPC obtained around 12% gain in the driving case comparing to traditional BLER based OLPC."); *id.* at TOT00194390 ("ToT OLPC in commercial network has shown remarkable gains in Huawei equipment: 15% average capacity gain and higher than 20% in high load wrt to baseline . . . 26% HSUPA throughput gain in busy hour wrt to enhanced"). HSUPA (high-speed uplink packet access) throughput as discussed in TOT00194379-91 refers to data throughput, that is, the speed at which data (i.e., streaming, browsing, file content) is transmitted between a mobile device and a base station. Increased capacity in a network allows for better data throughput. As mobile devices have improved over time in terms of the data content that they are able to transmit and receive (such as video streaming, for example), the demand for higher network capacity to support this type of data content has likewise increased. Indeed, technologies like F-

DPCH and eF-DPCH were added to the 3G standard to support the transmission of these types of data.

441. Based on the Huawei test results, which involved testing of both the '865 and '376 OLPC methods in combination, I believe it is reasonable to assume that the use of TOT's patented OLPC methods can increase network capacity somewhere in the range of 10-15%.

VIII. ADDITIONAL OPINIONS RELATED TO DAMAGES

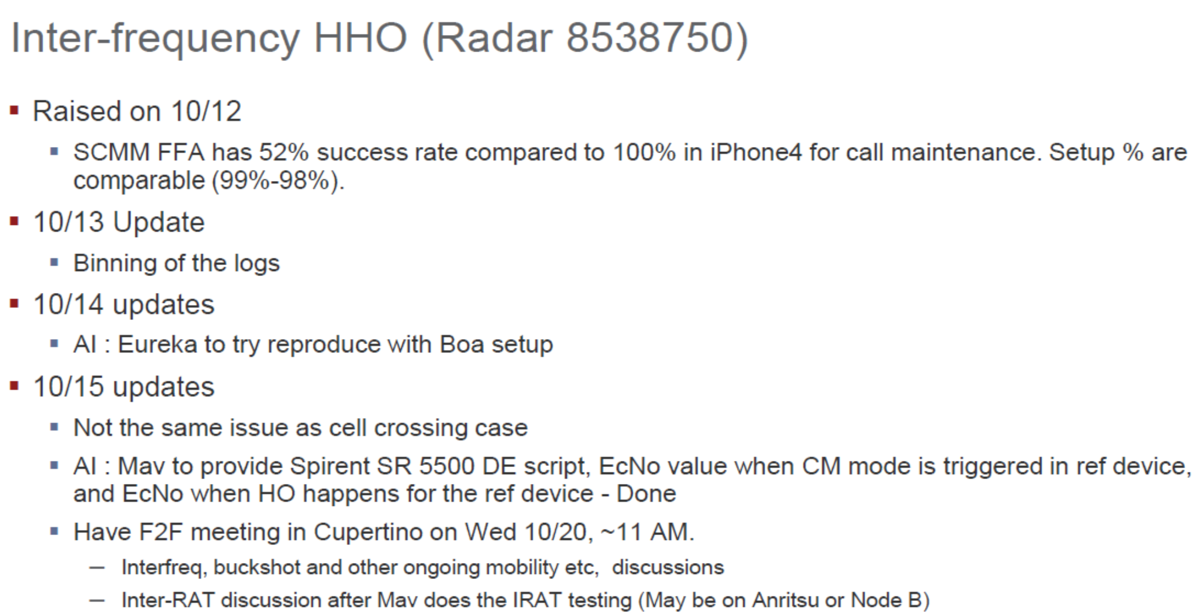
A. Date of First Infringement

442. I understand that, in order to calculate damages based on a hypothetical negotiation, it is important to know the date that infringement first began. Based on my analysis, it is my opinion that Apple's infringement of the '865 Patent first began sometime around October 2011, which is the release date of the iPhone 4S, the first Apple product with a Qualcomm modem that infringes the '865 Patent. This is based on Apple and Qualcomm documentation and testimony that I have reviewed indicating that the infringing OLPC algorithm (involving the 4 dB addition/removal from the SIR_{target} during windup/unwinding) in the Apple/Qualcomm Accused Products was added in early 2011.

443. Apple began discussions with Qualcomm to use Qualcomm baseband chips in the iPhone in 2010. Johnson Sebeni Deposition (Rough) (8/16/24) at 14:16-22. Work began on an iPhone 4S that used the Qualcomm baseband chips. *Id.* at 32:3-12. However, the Qualcomm chips had a number of issues with meeting Apple's Key Performance Indicators (KPIs) relating primarily to various types of handover, which as described above, are also carrier requirements. *Id.* at 24:1-25:1, 33:22-37:7; ¶61. Over a period of at least 6 months, Qualcomm and Apple engineers worked together to test the Qualcomm chips in Apple phones. *See* APL-TOTDDE_00737380-560. When an issue was identified, Apple and Qualcomm would open what was called a "Radar" to address it. Johnson Sebeni Deposition (Rough) (8/16/24) at 41:17-42:7. This resulted in a number of

builds of the Qualcomm chip code to modify the algorithms), as memorialized in a Powerpoint presentation that cumulatively tracked the efforts between Apple (codenamed "Maverick") and Qualcomm (codenamed "Eureka"). *Id.* at 38:9-15; APL-TOTDDE_00737380-560 at -506-513.

444. One such Radar was raised on October 12, 2010 as Radar 8538750. This Radar related to issues with inter-frequency hard handover (HHO), also referred to internally as "inter-frequency." APL-TOTDDE_00737380-560 at -432. The baseline Qualcomm chip had only a 52% success rate for call maintenance on inter-frequency HHO, while the prior iPhone 4 had a 100% success rate. *Id.*



445. Apple and Qualcomm worked on a number of code builds over the next few months. APL-TOTDDE_00737380-560 at -432-462. The initial build was labeled 1762. The following builds were denoted by a letter after that number assigned sequentially, e.g. 1762-A, 1762-B, etc. By January 13, 2011, Apple and Qualcomm were on build 1762-X. *Id.* at -462. Apple and Qualcomm had initially attempted to solve this issue without modifying the important Outer Loop Power Control algorithm:

Inter-frequency HHO (Radar 8538750) (contd.)

- 1/12 Updates (contd)
  - Maverick will compare 1762-T timeline with iphone4.
  - Maverick : E1A to ASU timing in iPhone4 is similar to SCMM. (~500 ms)
  - A new build (1762-X) to be made which will be 1762-P + SIRT set at 9dB, which will take OLPC out of the equation.
  - Eureka to study the demod with 12.2k+DCCH and 5.9k+DCCH cases
- 1/13 Updates
  - 1762-X testing results from Mav, after IMEI fix and 10s plateau. (218 calls)
    - iPhone4 – 78.28 %
    - FFA (1762-P) – 1.89%
    - FFA (1762-X) – 2.79%
    - Logs made available to Eureka
  - Based on the above, it is agreed that OLPC need not be touched for inter-freq

Id. at -462.

446. However, these attempts were unsuccessful even after over an additional month of builds and testing. *Id.* at -463-480. In late February 2011, Apple and Qualcomm proposed changes to the OLPC algorithm to improve inter-frequency HHO. *Id.* at -481:

Inter-frequency HHO (Radar 8538750) (contd.)

- 2/21
  - Two candidate OLPC tweaks are being evaluated.
  - Option 1 :
    - In windup frames :
      - DSP Uses SIR Tgt + WindupSirTgtAdjustment for TPC UP/DOWN Generation. Used for TPC Transmission
      - DSP Uses SIR Tgt for TPC UP/DOWN Generation. Passed to SW for Decision on Windup/Normal
      - Make Windup criteria a bit more aggressive to ensure Windo- ~<u>35</u>/45 Ups (best to make the term programmable)
  - Option 2 :
    - Upon Normal -> Windup transition,
      - Bump up SIR Tgt by "WindupSirTgtAdjustment" (3…5dB)
    - Upon Windup -> Normal transition (will be based on Up/Down computation using SIR Tgt + WindupSirTgtAdjustment)
      - Revert SIR Tgt down by the adjustment
- 2/25
  - Two combinations of beta scaling (150 -> 88% vs 200 -> 92%) are being tried out.
  - Testing needed for the final build are being identified
  - OLPC changes and E2D reporting change combination builds are being tried out at Eureka.

447. Two options were proposed, one where in windup frames the device would use a target SIR increased by a "WindupSirTgtAdjustment" margin, and use that value for the core purpose of deciding whether to transmit TPC up/down commands. *Id.* In that option, the original target SIR without the margin would be used for the internal purpose of generating up/down decisions for windup detection, keeping that functionality the same. *Id.* In Option #2, the OLPC algorithm would bump up the SIR target for all purposes by WindupSirTgtAdjustment when windup was detected, and then when transitioning from windup conditions to normal it would revert SIR down by the same adjustment. *Id.*

448. It was noted that the builds implementing a 4 dB bump as the "adjustment" did well in internal testing, and also that Apple preferred Option 1:

- 3/2
  - Eureka experimentation with beta values (with option #2) - close results
    - Beta scaling default 85 - success rate 174/203 = 85.7%
    - Beta scaling 200 - Success rate 175/203 = 86.2%
  - E2D configuration - Not changing the results. E2D can be removed.
  - Option #2 (with 4 dB bump) build AQ did well in our internal testing. Marginally better, but comparable to AP. Build to be provided to Maverick. Two beta values will be provided so that the final value can be chosen.
  - Option #1 - A build is available at Eureka internally. Needed some iterations. Validation is happening.
  - Mav prefers option #1. Eureka to provide Option #1 build using the beta value chosen from option #2 test results.
  - Eureka Trying to define an adversarial case that can distinguish any issues with OLPC changes for options 1 and 2.
  - Builds 1762-AQ (beta 200/200) and 1762-AS (beta 75/85) provided to Mav with option #2.

Id. at -482.

449. Ultimately, the last entry identifies a final build as 2021-D that had "success numbers [] comparable with reference phone":

Inter-frequency HHO (Radar 8538750) (contd.)

- 3/18
  - From Maverick testing of 2021-D, the success numbers are comparable with reference phone. All numbers are seen lower though. Maverick is trying to find out why.

Id. at -484. As discussed above, my review of source code for later products indicates that when windup is detected, a WindupSirTgtAdjustment of 4dB is added to the SIRtarget that is used for deciding on TPC up/down bits transmission.

450. Starting early January of 2011, in parallel with Radar 8538750, Apple and Qualcomm started working on Radar 8819076 regarding "IRAT HHO Performance on Eureka":

IRAT HHO performance on Eureka is worse than that of Iphone4 on E/// node B (Radar 8819076)

- 1/4: Radar raised.
- 1/5 : Log analysis indicates that the same demod related issue that is being investigated for cell crossing scenario to be the main cause of the failures.
  - Mav reported 7% success rate with 1762-P and 0.5% with SCMM baseline.
- 1/12 : Mav re-test with IMEI discrepancy corrected.
  - iPhone4 – 76%
  - 1762-P – 13%
  - SCMM baseline – 2 %
  - Minor improvement.
- 1/26
  - Maverick sent the scripts and test setup info.

Id. at -485. IRAT HHO refers inter-Radio Access Technology hard handover, e.g., when a mobile device passes between Radio Access Technologies like UMTS to / from GSM or UMTS to / from 4G LTE.

451. In February of 2011, the current Qualcomm build 1762-AB was showing very poor performance as compared to the iPhone 4:

IRAT HHO performance on Eureka is worse than that of Iphone4 on E/// node B (Radar 8819076)

- 2/2
  - Eureka's attempts to reproduce the issue are not successful yet.
  - Maverick test results (with 10s plateau)
    - iPhone4 54%
    - 1762-AB 25%
    - baseline 2%
  - Mav will upload the final numbers and logs.
- 2/13
  - Eureka is successful in getting the scripts running and reproducing the issue with automation.
- 2/14
  - Eureka IRAT testing -1762-AB showing 35% call maintenance rate against a small sample size, manual execution ~95% on iPhone4.
- 2/15
  - Some additional test builds with intra-freq search vs GSM search changes are being tried out.

Id. at -486.

452. On February 28, 2011, the Apple/Qualcomm document notes that they attempted build 1762-BD which was "1762-P + beta 200 + no CM gaps lost for IRAT + sirt bump on windup and decrement of sirt adjustment on getting out of windup+ uplink RLC status when DL hole is detected." *Id.* at -487:

- 2/28
  - After trying different combinations, 1762-BD build (1762-P + beta 200 + no CM gaps lost for IRAT + sirt bump on windup and decrement of sirt adjustment on getting out of windup+ uplink RLC status PDU when DL hole is detected) is found to provide good performance in Eureka test setup.
    - iPhone4 (96.7%) versus 1762-BD (100%), based on 30 calls
  - Build 1762-BD is sent to Mav for testing

Id. The "sirt bump on windup and decrement of sirt adjustment on getting out of windup" is the same as described in Option #2 from Radar 8538750. It was noted that this build had good performance on the Eureka test setup, even outperforming the iPhone 4.

453. Apple and Qualcomm iterated on this build for the next few weeks. *Id.* at -487-494. On March 16, 2011, a descendant of the 1762-BD build, 1762-BH, was planned to be brought to the mainline:

> **IRAT HHO performance on Eureka is worse than that of Iphone4 on E/// node B (Radar 8819076)**
>
> - 3/16 (contd)
>   - Can CM gap be extended for SCCH after a FCCH is found ? It will not fit in the same gap. W will have to be disrupted for a few slots, That TTI may see a CRC error. Worst case can be 2 TTIs. Maverick is OK to try it. Longer term.
>   - Another long term possibility – Go for SCH directly.
>   - Plan to bring 1762-BH changes to mainline.
>   - Mav wants a F2F meeting for long term improvements. To be finalized next week.
> - 3/18
>   - 2021-BI provided. The changes list is in the builds table.
> - 3/19
>   - Mav test results with 2021-BI (281 calls).
>   - iPhone4 -> 71.94 %
>   - 2021-BI -> 69.75 % -- Gap closed !!
>   - 1762 baseline -> 4.27 %

Id. at -494. Shortly thereafter a build 2021-BI was provided that had closed the gap with the iPhone 4. *Id.* By the end of March, Apple and Qualcomm had continued on this path and appeared to reach a solution for the IRAT HHO issue:

IRAT HHO performance on Eureka is worse than that of Iphone4 on E/// node B (Radar 8819076)

- 3/28 (contd)
  - 2021 build is doing what we need for power control. (2021-BK build). No need to make any more changes.
  - Focusing on timeline aspect.
  - Candidate build expected tomorrow. Eureka to send the build to Mav testing after Eureka internal validation.
- 3/29
  - Two builds 2021-BP and 2021-BQ are provided to Mav.
  - Time line optimizations done are - FCCH and SCH are scheduled in RSSI gaps, with 1 RSSI sample on all GSM cells (2021-BP) or 2 RSSI samples on all GSM cells (2021-BQ).

Id. at -496. As noted, the "2021 build is doing what we need for power control," referring to 2021-BK.

454. The Apple/Qualcomm document provides a chart of the builds that were tried which demonstrates which line of builds eventually went into production:

Date	Build	Description
2/16/11	1762-AK	\\qcdfs\qct\qctdata\SANBuilds\users99\rsoordel\M6610ASCMUTS1762_AK 1762-B + bounded intra-cell changes
2/15/11	1762-AL	1762-AI+ timeline changes (E2D instantaneous + 60ms parole period, 80ms TTT reduction for E2D, T2 optimizations) \\frosty\kpiwork\Trek\Builds\1762-AL
2/15/11	1762-AM	1762-AB + SIRT floor bump \\frosty\kpiwork\Trek\Builds\1762-AM
2/17/11	1762-AP	1762-AE with proper RLC fix + SIRT floor bump + beta scale 200 + no e2d after meas enabled \\qcdfs\qct\qctdata\SANBuilds\users99\rsoordel\M6610ASCMUTS1762_AP
2/28/11	1762-BD	1762-BD = 1762-P + beta 200 + no CM gaps lost for IRAT + sirt bump on windup and decrement of sirt adjustment on getting out of windup+ uplink RLC status PDU when DL hole is detected \\frosty\kpiwork\Trek\Builds\1762-BD
3/2/11	1762-AQ	1762-AP with option #2 for OLPC change, beta 200/200, default SIRT bump at 3 dB, configured to 4 dB with QXDM command,. send_data 75 4 31 0 12 4 0 0 0 You should see F3 in logs as - *bump up value to be used %d* \\frosty\kpiwork\Trek\Builds\1762-AQ
3/2/11	1762-AS	1762-AP with option #2 for OLPC change, beta 75/85, default SIRT bump at 3 dB, configured to 4 dB with QXDM command,. send_data 75 4 31 0 12 4 0 0 0 You should see F3 in logs as - *bump up value to be used %d* \\frosty\kpiwork\Trek\Builds\1762-AS
3/3/11	1762-AR	1762-AP with option #1 for OLPC change, beta 200, default SIRT bump at 3 dB, configured to 4 dB with QXDM command as above \\qcdfs\qct\qctdata\SANBuilds\users99\rsoordel\M6610ASCMUTS1762_AR

Date	Build	Description
3/09/11	1762-BE	1762-BD + Removal of SNR threshold during FCCH detection + Usage of RSSI gaps for SCH detection \\qcdfs\QCT\qctdata\SANBuilds\users99\rsoordel\M6610ASCMUTS1762_BE
3/09/11	1762-BG	1762-BD + Removal of SNR threshold during FCCH detection \\qcdfs\QCT\qctdata\SANBuilds\users99\rsoordel\M6610ASCMUTS1762_BG
3/15/11	2021-D	All intra- and inter-freq changes merged on 2021 baseline. \\qcdfs\QCT\qctdata\SANBuilds\users99\rsoordel\M6610ASCMUTS2021_D
3/15/11	1762-BH	1762-BG + remove 480ms RSSI burst time condition (only wait for 3 measurements.) \\qcdfs\QCT\qctdata\SANBuilds\users116\yhong\M6610ASCMUTS1762_BH
3/18/11	2021-BI	\\qcdfs\qct\qctdata\SANBuilds\users116\yhong\M6610ASCMUTS2021_BI 2021-BI = 2021-D build + no step1/step2 + After 3A report is sent out to NW, bump the SIR by 3dB + 3bD bump on windup + SCH on RSSI + removal of 2db thres for FCCH in SW + 480ms RSSI meas period removal + 1 RSSI sample before moving to FCCH + SIR bump of 9db
3/21/11	2021-BJ	Modified 1762-BI build - FCCH threshold set to 0dB, made 2 RSSI samples (instead of 1) before moving to FCCH. SIR Tgt floor stays as BI (12dB/15dB) \\qcdfs\qct\qctdata\SANBuilds\users116\yhong\M6610ASCMUTS2021_BI_formal_change

Id. at -512-513.

455. As we can see, 1762-BD on February 28, 2011 is the build that introduces a "sirt bump on windup and decrement of sirt adjustment on getting out of windup." *Id.* at -512. Note

this is being tested around the same time as the OLPC changes in 1762-AQ and -AS which have that similar target SIR bump and decrement. *Id.* After, 1762-BE and -BG are created that build off of 1762-BD. *Id.* at -513. Then, on March 15, 2011, build 2021-D is created which merges onto the baseline "all intra- and inter-freq changes." *Id.* "Inter-freq" changes would encompass the Inter-frequency HHO issue and the IRAT HHO issue. 2021-D is the baseline for the remaining builds of 2021-BI and -BJ. *Id.* While the chart ends here, it stands to reason that the other 2021-builds referenced such as -BK *et seq.* would likewise continue from this family.

456. From review of the Qualcomm code, both raising the SIRtarget by 4dB, and reverting to the original value on unwinding, were eventually implemented. *See* APPLE_QUALCOMM_000043 at lines 3522-3525 ("sirt_plus_delta_q25 += DL_OLPC_DB_TO_Q25(4);" with comment "sirt raised by 4 dB due to windup detection"); QCTOTVAPPLE01302_0011211 at _0011276 ("SIRT + WindupSirTgtAdjustment [Set to 4dB] used for UP/DOWN generation in ILPC"); APPLE_QUALCOMM_000043 (commented as "sirt lowered by 4 dB due to exit of windup"); QCTOTVAPPLE01302_0008063 at 1-2.

457. I have read the deposition transcript of Apple witness Johnson Sebini, who claimed that this functionality is performed by the inner loop, not the outer loop, and that Option 1 was chosen instead of Option 2. Johnson Sebeni Deposition (Rough) (8/16/24) at 110:13-111:1; 132:4-10. I disagree. As noted in the slides copied above as APL-TOTDDE_00737481, Apple and Qualcomm described these as "OLPC tweaks" and as "OLPC changes." As well, in my review of the Qualcomm code, this functionality is controlled by the OLPC algorithm, and clearly implements both the 4dB increase to the SIRtarget that the OLPC code (in file dlolpc.c) sends to the firmware for generating a decision on TPC bits, which is described for both options, as well as the reversion to the original value mentioned under Option 2. *See* APPLE_QUALCOMM_000043

at lines 3522-3525; QCTOTVAPPLE01302_0011211 at _0011276; APPLE_QUALCOMM_000043. And indeed, Qualcomm's declaration in the Barcelona litigation confirms that this functionality is part of the outer loop power control algorithm:

> (c) When the Qualcomm software detects a windup condition, it increases the SIRT (signal-to-interference target) used for OLPC (outer loop power control) by a fixed windup offset amount, and will not modify the SIRT further until the end of the windup condition is detected.

> (g) When the Qualcomm software detects the end of the windup condition, it decreases the SIRT (signal-to-interference target) used for OLPC (outer loop power control) by the same fixed windup offset amount.

QCTOTVAPPLE01302_0008063 at 2; *see also* QCTOTVAPPLE01302_0011326-30 at QCTOTVAPPLE01302_0011329 (change request record containing entries dated October 2010 to November 2011, stating: "DLPC changes to avoid DOWNs in case of Power limited scenario (a) Virtual SIR = SIR Tgt + 4dB used for TPC generation, and (b) Hysteresis used on Wind-up exit – 30 UPS used for exit . . ."); QCTOTVAPPLE01302_0011331-38 at QCTOTVAPPLE01302_0011335 (Qualcomm engineering memo dated March 14, 2011):

> ***3.1 Anti-Windup Enhancement***
>
> To avoid UE sending DOWNs, while in a power limited scenario, the following design change was made.
>
> (a) In windup frames –
>   a. DSP Uses SIR Tgt + WindupSirTgtAdjustment **[Set to 4dB]** for TPC UP/DOWN Generation
>   b. DSP Uses SIR Tgt for TPC UP/DOWN Generation
>   c. (a) is used for TPC Transmission, (b) is passed to SW for Decision on Windup/Normal
>
> (b) Exit out of windup criteria made more difficult to ensure UE pursues (No Downs) for as long as required – hysteresis was added to make Entry and Exit conditions asymmetric
>   a. Entry to Windup – as before: 40/45 Ups
>   b. Exit from windup – modified to be 30/45Ups

458. I understand that Mr. Sebeni testified that he had never seen the Qualcomm code that was implemented. Johnson Sebeni Deposition (Rough) (8/16/24) at 116:19-22; 125:23-126:5; 132:4-10; 170:3-6.

459. From my review of the documentation, it is clear that Apple and Qualcomm worked together over a period of months to address the problems with inter-frequency and IRAT hard handover. As described above, the applicable 3GPP standards as well as the carriers all require phones to be able to perform inter-frequency and IRAT hard handovers. Thus, in my opinion, the dropped calls during these handovers and problematic test results described in this document would not only have resulted in a negative customer experience with Apple's phones, but these performance issues and failures had to be solved in order for phones to be compliant with the 3GPP standards and in order for Apple phones to be used on the carrier networks, including for example, AT&T and T-Mobile. Lots of solutions were tried, but the solution Qualcomm and Apple ultimately implemented for inter-frequency and IRAT HHO issues includes the same solution that TOT patented in the '865 Patent. That solution is in the code accused of infringement and is in the current Qualcomm code.

460. Since the infringing code was added to the Qualcomm modem software sometime in early 2011, then that code would have been included in the next release after that date of an Apple product with a Qualcomm modem, which is the iPhone 4S released in October 2011. *See* Apple Press Release, "iPhone 4S First Weekend Sales Top Four Million, available at https://www.apple.com/newsroom/2011/10/17iPhone-4S-First-Weekend-Sales-Top-Four-Million/; Digital Trends article, "Every iPhone release in chronological order: 2007-2024," available at https://www.digitaltrends.com/mobile/every-iphone-release-in-chronological-order/;

Tech Insights article, "Apple iPhone 4S teardown," available at https://www.techinsights.com/blog/apple-iphone-4s-teardown.

461. With respect to the Apple/Intel Accused Products, the first Apple/Intel Accused Product that infringes the '865 Patent is the iPhone 7, which was released in September 2016. *See* Apple's Third Supplemental Responses and Objections to Plaintiff's Second Set of Interrogatories (No. 18), dated April 2, 2024, at 36.

462. In addition, based on my analysis, it is my opinion that Apple's infringement of the '376 Patent first began sometime around October 2011, the release date of the iPhone 4S.

Begin CONFIDENTIAL – OUTSIDE ATTORNEYS' EYES ONLY – SOURCE CODE

463. Based on the comments in the source code for the file dlolpc.c, Qualcomm appears to have first added the code for FDPCH mode that infringes the '376 Patent to the software for its modems in October 2010. *See* APPLE_QUALCOMM_000002 at line 110 ("10/19/10 ks Added support for outage OLPC for efdpch"); *id.* at line 109 ("10/20/10 ks Updated outage threshold table").[70]

End CONFIDENTIAL – OUTSIDE ATTORNEYS' EYES ONLY – SOURCE CODE

464. Since the infringing code was added to the Qualcomm modem software sometime around October 2010, then that code would have been included in the next release after that date of an Apple product with a Qualcomm modem, which is the iPhone 4S released in October 2011. *See* Apple Press Release, "iPhone 4S First Weekend Sales Top Four Million, available at https://www.apple.com/newsroom/2011/10/17iPhone-4S-First-Weekend-Sales-Top-Four-Million/; Digital Trends article, "Every iPhone release in chronological order: 2007-2024,"

[70] *See also* Q2TOTAPPLE1302SC0000015 at lines 72-72, Q2TOTAPPLE1302SC0000107 at lines 113-114, Q2TOTAPPLE1302SC0000225 at lines 113-114, Q2TOTAPPLE1302SC0000343 at lines 113-114.

available at https://www.digitaltrends.com/mobile/every-iphone-release-in-chronological-order/; Tech Insights article, "Apple iPhone 4S teardown," available at https://www.techinsights.com/blog/apple-iphone-4s-teardown.

B. Non-Infringing Alternatives

465. I understand that Apple contends that there are a number of non-infringing alternatives to the infringing OLPC functionality in its accused products. *See* Apple's Second Supplemental Responses and Objections to Plaintiff's Second Set of Interrogatories (Nos. 9-14, 16, 17, 19, 21), dated March 15, 2024, at 11-17. For example, Apple contends that, instead of using the '865 and '376 inventions in its accused products, it could avoid infringement by using "the power control functionality present in prior art WCDMA and 3G products, including at least (1) products incorporating the Qualcomm MSM6200 and MSM6250 processors known, used, or sold in the United States prior to the alleged invention date of the asserted patents or prior to December 1, 2004 and (2) products sold in the United States prior to the alleged invention date of the asserted patents or prior to December 1, 2004 incorporating examples of WCDMA and 3G power control functionality, including the Nokia 6651 or Motorola A845." *Id.* at 13. Apple also asserts as non-infringing alternatives "OLPC functionality carried out by non-Qualcomm chipsets, including but not limited to MediaTek chipsets," "the OLPC functionality identified during the depositions of the named inventors Alfonso Campo Camacho and Miguel Blanco Carmona . . . as allegedly different from the claimed OLPC functionality," and various other outer loop power control solutions that are alleged to be in the prior art. *Id.* at 13-17. And for the '376 patent, Apple also identifies Intel modems as a non-infringing alternative to the Qualcomm modems in its accused products. *Id.* at 16.

466. I note, however, that Apple has not presented any evidence of how these alternative OLPC solutions compare relative to the infringing OLPC functionality in the accused products in

terms of providing benefits such as increased network capacity. Indeed, Apple does not even explain how outer loop power control works in many of these alleged alternatives, such as the MSM6200 and MSM6250 processors, the Nokia 6651 and Motorola A845 products, and the MediaTek and Intel chipsets.

467. With respect to Intel modems and the '376 Patent, as I noted above, Bernd Adler, then Head of Wireless System Engineering at Intel Mobile Communications, reviewed the TOT patents and opined that they were directed to "solve one of the key CDMA problem ... slow outer power control convergence," referring to it as a "nice idea" that he wished he had "instead of [Intel's approach]." *See, e.g.*, Email from Bernd Adler re: Top optimized Technologies (3PS 1302 INTEL 000061). Mr. Adler also stated that the benefits claimed by TOT would be greater than those Intel had been able to reach with its approach. *Id.*; Bernd Adler Deposition (3/27/24) at 42:2-43:17. And again, Apple has made no attempt to show any relative benefit from Intel's, or any other approach.

468. As I discussed in the Section above, simulations and testing performed by TOT compared their solution to various prior known approaches and demonstrated significant performance benefits. I understand from my experience in the wireless communications industry that Apple's choice of baseband processor for each new cellular product is a highly competitive endeavor, in which network performance and capacity are key considerations. In my opinion, Apple would not find solutions based on older generations of modem chip to be technically acceptable.

469. In sum, even assuming that these alleged alternative OLPC solutions are non-infringing, I have seen no evidence that Apple or its customers would find these alternatives to be technically and commercially acceptable substitutes to the infringing OLPC functionality in its

accused products. I reserve the right to provide further opinions on this subject should Apple or its experts present any additional evidence, argument, or opinions regarding non-infringing alternatives.

C. TOT-Huawei Agreement

470. I have reviewed an agreement entitled "ToT OLPC Solution License And Related Services Agreement" between Huawei Technologies Co., Ltd. and ToT Power Control, S.L. (TOT00193758-778). The "RECITALS" section of that agreement lists the following patents and patent applications that pertain to the agreement:

Likewise, ToT has filed, amongst others, the following patents which protect the ToT OLPC Solution:

i) *International Application No.: PCT/ES2003/000630 "Method and Apparatus for the Outer Loop of the Power Control System of a Mobile Communication System".*

ii) *International Application No.: PCT/ES2006/000403 "Outer-Loop Power Control Method and Device for Wireless Communication Systems".*

iii) *International Application No.: PCT/ES2006/000402 "Outer-Loop Power Control Method and Device for Wireless Communication Systems".*

iv) *Spanish Patent published under record number ES2255887 and US Patent published under US number 2007218933 "Outer loop power control method and apparatus for wireless communication systems".*

Id. at TOT00193760.

471. In my opinion, all of these listed patents and applications are technologically comparable to both the '865 and '376 Patents. As an initial matter, the titles of all of these patents and applications (as well as their content as discussed below) indicate that they relate to methods and devices for outer loop power control in wireless communication systems, which is the same technical subject matter as the '865 and '376 Patents.

472. In addition, item i) in this list, PCT/ES2003/000630, contains an Abstract stating: "The invention relates to a method and apparatus for the outer loop of the power control system of a mobile communication system, which form a cellular infrastructure and which can be used to meet a quality-of-service (QoS) specification determined with the minimum level of power necessary." WO 2004/057773, cover page. PCT/ES2003/000630 is therefore directed to the same general technical problem as the '865 and '376 Patents – improving outer loop power control in a wireless communications network so that devices can communicate in the network using the minimum level of power necessary. This further shows that PCT/ES2003/000630 is technologically comparable to the '865 and '376 Patents.

473. Item ii) in this list, International Application No. PCT/ES2006/000403, claims priority to a Spanish patent application 200502056 filed on August 17, 2005, which I note is the same foreign patent application to which the '376 Patent claims priority. *See* '376 Patent, cover page; TOT00152302-46 at TOT00152302. In addition, the Abstract of PCT/ES2006/000403 is substantially the same as the Abstract of the '376 Patent, referring to the invention as an "outage-based OLPC" method which "establishes that the desired signal-to-interference target (SIR_{target}) is given as the sum of two components, namely: a first component ($SIR_{outage\text{-}tgt}$) which is calculated using a dynamic adjustment function, e.g. a neural network, which matches a quality criterion based on cut-off probabilities with a quality criterion based on the target block error rate ($BLER_{target}$), taking as input the fading margins associated with the different cut-off probabilities considered; and a second component ($SIR_{BLER\text{-}tgt}$) . . . ." *Id.* PCT/ES2006/000403 is therefore related to the '376 Patent, further showing that it is technologically comparable to the '376 Patent.

474. Item iii) in this list, International Application No. PCT/ES2006/000402, claims priority to a Spanish patent application 200502057 filed on August 17, 2005, which I note is the

same foreign patent application to which the '865 Patent claims priority. *See* '865 Patent, cover page; WO 2007/020304, cover page. In addition, the Abstract of PCT/ES2006/000402 is substantially the same as the Abstract of the '865 Patent, referring to the invention as "a method and device for WCDMA-based wireless communication systems, which modify the desired signal-to-interference target (SIR_{target}) upon detection of the end of the wind-up mode . . . The invention consists in establishing a value for the desired signal-to-interference target (SIR_{target}) which is as close as possible to the value of same prior to the beginning of the wind-up phase such as to continue immediately thereafter with the correct variation determined for normal mode outer-loop power control." *Id.* PCT/ES2006/000402 is therefore related to the '865 Patent, further showing that it is technologically comparable to the '865 Patent.

475. Item iv) in this list, "ES2255887 and US Patent published under US number 200721893," apparently refers to U.S. Patent Application Publication No. 2007/0218933, which eventually issued as U.S. Patent No. 7,558,593. The Abstract of U.S. Patent Application Publication No. 2007/0218933 describes "a quick adjustment of the target signal to interference ratio (SIR_{target}) at the start of each transmission (N) using the method known as Outage-Based OLPC, which establishes said ratio (SIR_{target}) as the sum of two components, a first component ($SIR_{outage\text{-}tgt}$) that adjusts quickly to the conditions of the communications channel and a second component ($SIR_{BLER\text{-}tgt}$) adjustable according to a target block error rate ($BLER_{target}$) . . . ." Item iv) therefore relates to the outage-based OLPC method described in the '376 Patent, further showing that it is technologically comparable to the '376 Patent.

476. Also, "ANNEX I" in the agreement provides a high-level description of "the ToT OLPC Solution." TOT00193758-778 at TOT00193776. This description in ANNEX I matches

what is described as the inventions in the patents and patent applications listed as items i) through iv) in the "RECITALS" section of the agreement.

D. Apple License Agreements

477. I understand that Apple has produced nine license agreements in this case and that there is a question regarding the comparability of the agreements for purposes of damages. *See* Apple's Second Supplemental Responses and Objections to Plaintiff's Second Set of Interrogatories (Nos. 9-14, 16, 17, 19, 21), dated March 15, 2024, at 26-29. I also understand that Apple currently has not taken any definitive position as to whether any of these nine license agreements are comparable licenses. Instead, Apple merely states in is interrogatory responses that the agreements "may" be found by an expert to be "technically and/or economically comparable to the technology claimed in the Asserted Patents." *Id.* at 28. I also understand that Apple's Rule 30(b)(6) witness, Brian Ankenbrandt, testified in his deposition that he had no opinion as to whether any of these agreements were technologically comparable, and that he was also unaware of Apple having any opinion on this issue. *See* Brian Ankenbrandt Deposition (3/13/24) at 52:6-15, 59:7-20, 67:18-68:10, 75:14-76:1, 81:20-82:7, 85:15-86:4, 90:9-22, 99:7-17, 105:17-106:3.

478. While it is unclear at this point in time whether Apple intends to assert that any of the nine license agreements are comparable, I provide below some initial observations regarding these agreements.

1. SmartPhone Technologies LLC – Apple Settlement and License Agreement

479. Apple entered into a Settlement and License Agreement with SmartPhone Technologies LLC ("SPT") on March 21, 2013 (the "SPT-Apple Agreement"). *See* APL-

TOTDDE_00723725-37. Under this agreement, SPT granted a license to certain patents to Apple. *See id.* at APL-TOTDDE_00723727-28.

480. Apple's witness, Mr. Ankenbrandt, was unaware whether Apple considered any of the patents licensed in the SPT-Apple Agreement to be technologically comparable to the '865 or '376 Patents. *See* Brian Ankenbrandt Deposition (3/13/24) at 52:6-15.

481. In addition, I note that a number of the patents listed as the licensed patents in this agreement do not appear to be technologically comparable to the '865 or '376 Patents. *See* APL-TOTDDE_00723725-37 at APL-TOTDDE_00723736. For example, U.S. Patent No. 6,505,215 is entitled "Method and Apparatus for Synchronization of Two Computer Systems Supporting Multiple Synchronization Techniques by Using Synchronization Transport Modules," and the Abstract describes the patent as relating to "[a] method and system for synchronizing two computer systems supporting multiple synchronization techniques." The patent does not appear to have anything to do with outer loop power control, or even any form of power control, in a wireless communications system. In my opinion, this patent is therefore not technologically comparable to either the '865 or '376 Patents.

482. As another example, U.S. Patent No. 6,711,609 is entitled "Method and Apparatus for Synchronizing an Email Client on a Portable Computer System with an Email Client on a Desktop Computer," and the Abstract describes the patent as relating to "[a] fully integrated email system for a desktop computer with an associated palmtop computer." Again, the patent does not appear to have anything to do with outer loop power control, or even any form of power control, in a wireless communications system. In my opinion, this patent is therefore not technologically comparable to either the '865 or '376 Patents.

483. As another example, U.S. Patent No. 6,928,300 is entitled "Method and Apparatus for Automated Flexible Configuring of Notifications and Activation," and the Abstract describes the patent as relating to "[a] preferences option [that] maintains preferences for enabling and disabling notifications for device(s) of an electronic device." Again, the patent does not appear to have anything to do with outer loop power control, or even any form of power control, in a wireless communications system. In my opinion, this patent is therefore not technologically comparable to either the '865 or '376 Patents.

2. St. Clair Intellectual Property Consultants, Inc. - Apple Settlement and License Agreement

484. Apple entered into a Settlement and License Agreement with St. Clair Intellectual Property Consultants, Inc ("St. Clair") on October 28, 2013 (the "St. Clair-Apple Agreement"). *See* APL-TOTDDE_00723748-60. Under this agreement, St. Clair provided Apple with a license to certain patents. *See id.* at APL-TOTDDE_00723749.

485. Apple's witness, Mr. Ankenbrandt, was unaware whether Apple considered any of the patents licensed in the St. Clair-Apple Agreement to be technologically comparable to the '865 or '376 Patents. *See* Brian Ankenbrandt Deposition (3/13/24) at 59:7-20.

486. In addition, I note that a number of the patents listed as the licensed patents in this agreement do not appear to be technologically comparable to the '865 or '376 Patents. *See* APL-TOTDDE_00723748-60 at APL-TOTDDE_00723759-60. For example, U.S. Patent No. 5,337,408 is entitled "Multi-Level Display Controller," and the Abstract describes the patent as relating to "a computer having a display controller for controlling a display where the display provides an image with different selectable gray scale levels." The patent does not appear to have anything to do with outer loop power control, or even any form of power control, in a wireless

communications system. In my opinion, this patent is therefore not technologically comparable to either the '865 or '376 Patents.

487. As another example, U.S. Patent No. 5,630,163 is entitled "Computer Having a Single Bus Supporting Multiple Bus Architectures Operating with Different Bus Parameters," and the Abstract describes the patent as relating to "[a] data processing system including a central processing unit and control circuitry on a single chip connected by a common bus to two or more bus devices having different sets of bus parameters." Again, the patent does not appear to have anything to do with outer loop power control, or even any form of power control, in a wireless communications system. In my opinion, this patent is therefore not technologically comparable to either the '865 or '376 Patents.

3. IPCom GmbH & Co. KG – Apple Settlement, License and Transfer Agreement

488. Apple entered into a Settlement, License and Transfer Agreement with iIPCom GmbH & Co. KG ("IPCom") on December 9, 2021 (the "IPCom-Apple Agreement"). *See* APL-TOTDDE_00723529-658. Under this agreement, IPCom licensed and/or transferred a number of patents and patent applications to Apple. *See* APL-TOTDDE_00723529-658 at APL-TOTDDE_00723534, APL-TOTDDE_00723538.

489. There appear to be well over a thousand patents and patent applications that were either licensed or transferred to Apple in the IPCom-Apple Agreement. *See id.* at APL-TOTDDE_00723554-643. Apple's witness, Mr. Ankenbrandt, was unaware whether Apple considered any of the patents licensed in the IPCom-Apple Agreement to be technologically comparable to the '865 or '376 Patents. *See* Brian Ankenbrandt Deposition (3/13/24) at 67:18-68:10.

4. Digcom Inc. – Apple License Agreement

490. Apple entered into a Settlement and License Agreement with two parties, Digcom Inc. and Dr. Kamilo Feher ("Digcom"), on April 15, 2010 (the "Digcom-Apple Agreement"). *See* APL-TOTDDE_00723761-77. Under this agreement, Digcom licensed a number of patents and applications to Apple. *See id.* at APL-TOTDDE_00723762.

491. There appear to be over 60 patents and patent applications that were licensed to Apple in the Digcom-Apple Agreement. *See id.* at APL-TOTDDE_00723770-76. Apple's witness, Mr. Ankenbrandt, was unaware whether Apple considered any of the patents licensed in the Digcom-Apple Agreement to be technologically comparable to the '865 or '376 Patents. *See* Brian Ankenbrandt Deposition (3/13/24) at 75:14-76:1.

5. Power Management Solutions LLC - Apple License Agreement

492. Apple entered into a Settlement and License Agreement with Power Management Solutions LLC ("PMS"), on March 29, 2013 (the "PMS-Apple Agreement"). *See* APL-TOTDDE_00723738-47. Under, this agreement, PMS provided Apple with a license to two patents. *See id.* at APL-TOTDDE_00723739, APL-TOTDDE_00723747.

493. Apple's witness, Mr. Ankenbrandt, was unaware whether Apple considered any of the patents licensed in the PMS-Apple Agreement to be technologically comparable to the '865 or '376 Patents. *See* Brian Ankenbrandt Deposition (3/13/24) at 81:20-82:7.

494. In addition, it is my opinion that neither of the patents listed as the licensed patents in this agreement are technologically comparable to the '865 or '376 Patents. *See* APL-TOTDDE_00723738-47 at APL-TOTDDE_00723747. The first licensed patent, U.S. Patent No. 5,504,909 is entitled "Power Management Apparatus Collocated on the Same Integrated Circuit as the Functional Unit that It Manages," and the Abstract describes the patent as relating to "[a] power management apparatus that controls the use of power within an integrated circuit. A first

embodiment gates integrated circuit power on or off concurrently with switches inserted between the co-resident functional circuit I/O nets and the integrated circuit I/O pads. A second embodiment instantiates the power management apparatus on an integrated circuit by itself for connection to external integrated circuits. Buffering or sequencing is provided for both embodiments." The patent does not appear to have anything to do with outer loop power control, nor does it appear to relate to the field of wireless communications systems. In my opinion, this patent is therefore not technologically comparable to either the '865 or '376 Patents.

495. The second licensed patent, U.S. Patent No. 6,195,755 is entitled "Nonvolatile Power Management Apparatus for Integrated Circuit Application," and the Abstract describes the patent as relating to "[a] nonvolatile power management apparatus that controls the use of power within an integrated circuit. The embodiment varies the power applied to a functional circuit within the integrated circuit. At nominal power, the functional circuit operates normally per nominal operational specifications. Under reduced power, the integrated circuit retains all of its internal states, but has its I/O nets isolated from external circuitry. This prevents latch-up of the functional circuit operating from reduced power (low power input voltage) and prevents external circuitry connected to the integrated circuit from being overloaded." Again, the patent does not appear to have anything to do with outer loop power control, nor does it appear to relate to the field of wireless communications systems. In my opinion, this patent is therefore not technologically comparable to either the '865 or '376 Patents.

6. Haystack Alley, LLC – Apple Patent License Agreement

496. Apple entered into a Patent License Agreement with Haystack Alley, LLC ("Haystack Alley"), on February 19, 2010 (the "Haystack Alley-Apple Agreement"). *See* APL-TOTDDE_00723701-11. Under this agreement, Haystack Alley provided Apple with a license to a number of patents. *See id.* at APL-TOTDDE_00723702, APL-TOTDDE_00723711.

497. Apple's witness, Mr. Ankenbrandt, was unaware whether Apple considered any of the patents licensed in the Haystack Alley-Apple Agreement to be technologically comparable to the '865 or '376 Patents. *See* Brian Ankenbrandt Deposition (3/13/24) at 85:15-86:4.

498. In addition, I note that a number of the patents listed as the licensed patents in this agreement do not appear to be technologically comparable to the '865 or '376 Patents. *See* APL-TOTDDE_00723701-11 at APL-TOTDDE_00723711. For example, U.S. Patent No. 5,454,107 is entitled "Cache Memory Support in an Integrated Memory System," and the Abstract describes the patent as relating to "[a] low-cost, moderate performance small computer system is provided by allowing a single sharable block of memory to be independently accessible as graphics or main store memory. Allocation of the memory selected programmably, eliminating the need to have the maximum memory size for each block simultaneously." The patent does not appear to have anything to do with outer loop power control, or even any form of power control, in a wireless communications system. In my opinion, this patent is therefore not technologically comparable to either the '865 or '376 Patents.

499. As another example, U.S. Patent No. 6,393,572 is entitled "Sleepmode Activation in a Slave Device," and the Abstract describes the invention of the patent as follows: "In a master-slave configuration wherein a sleepmode activation is effected by the cessation of a clocking signal, the need for an analog device or auxiliary clock for detecting the cessation of the clocking signal is obviated by anticipating the cessation of the clock signal. Upon anticipating the cessation of the clock signal, the remaining clock signaling before cessation is used as required to effect a controlled power-down of the slave device. By eliminating the need for an analog clock cessation detector, the process tolerance constraints associated with analog circuitry can be avoided, the reliability and robustness of the design is improved, and the required testing is simplified, thereby

reducing the cost of the device." The patent does not appear to have anything to do with outer loop power control, nor does it appear to relate to the field of wireless communications systems. In my opinion, this patent is therefore not technologically comparable to either the '865 or '376 Patents.

7. Freescale Semiconductor – Apple License Agreement

500. Apple entered into License Agreement with Freescale Semiconductor, Inc. and Freescale Semiconductor, Ltd. (collectively "Freescale") on May 30, 2012 (the "Freescale-Apple Agreement"). *See* APL-TOTDDE_00723712-24. Under this agreement, Freescale granted a license to a number of patents and patent applications to Apple. *See id.* at APL-TOTDDE_00723714.

501. Apple's witness, Mr. Ankenbrandt, was unaware whether Apple considered any of the patents licensed in the Freescale-Apple Agreement to be technologically comparable to the '865 or '376 Patents. *See* Brian Ankenbrandt Deposition (3/13/24) at 90:9-22. In addition, I note that the Freescale-Apple Agreement does not specifically list out what patents and patent applications are licensed under the agreement. Instead, the agreement simply states that the "Freescale Patents" are licensed. *See* APL-TOTDDE_00723712-24 at *See* APL-TOTDDE_00723714. "Freescale Patents" is defined in the agreement as "all patents and patent applications (together with patents issuing thereon) in all jurisdictions worldwide that are, as of the Effective Date or at any time during the Term of this Agreement, acquired by, assigned to, owned by or controlled by Freescale or any of its Affiliates or to which Freescale or any of its Affiliates has, at any time during the Term of this Agreement, a right to assert a claim of infringement or to grant any license," as well as any related patents. *See id.* at APL-TOTDDE_00723713.

8. Bell Northern Research, LLC-RPX Corporation Patent License and Option Agreement

502. Bell Northern Research, LLC ("BNR") entered into a Patent License and Option Agreement with RPX Corporation ("RPX") on December 13, 2021 (the "BNR-RPX Agreement"). *See* APL-TOTDDE_00723659-700. Under this agreement, BNR provided RPX with a license to a number of patents and patent applications. *See id.* at APL-TOTDDE_00723661-63, APL-TOTDDE_00723673-88. Apple's witness, Mr. Ankenbrandt, testified that Apple also has a license to the patents licensed in the BNR-RPX Agreement. *See* Brian Ankenbrandt Deposition (3/13/24) at 98:7-22.

503. There appear to be hundreds of patents and patent applications that were licensed in the BNR-RPX Agreement. *See id.* at APL-TOTDDE_00723673-88. Mr. Ankenbrandt was unaware whether Apple considered any of the patents licensed in the BNR-RPX Agreement to be technologically comparable to the '865 or '376 Patents. *See* Brian Ankenbrandt Deposition (3/13/24) at 99:7-17.

9. 2BCom LLC-RPX Corporation Patent License and License Option Agreement

504. RPX entered into a Patent License and License Option Agreement with 2BCom, LLC ("2BCom") on October 15, 20221, 2003 (the "2BCom-RPX Agreement"). *See* APL-TOTDDE_00723778-97. Under this agreement, 2BCom provided RPX with a license to a number of patents and patent applications. *See id.* at APL-TOTDDE_00723779-80, APL-TOTDDE_00723784-97. Apple's witness, Mr. Ankenbrandt, testified that Apple also has a license to the patents licensed in the 2BCom-RPX Agreement. *See* Brian Ankenbrandt Deposition (3/13/24) at 103:4-20.

505. There appear to be close to a hundred patents and patent applications that were licensed in the 2BCom-RPX Agreement. *See id.* at APL-TOTDDE_00723673-88. Mr.

Ankenbrandt was unaware whether Apple considered any of the patents licensed in the 2BCom-RPX Agreement to be technologically comparable to the '865 or '376 Patents. *See* Brian Ankenbrandt Deposition (3/13/24) at 105:17-106:3.

506. I reserve the right to provide further analysis and opinions regarding the license agreements produced by Apple to the extent that Apple or its experts later contend that any of the agreements are comparable licenses.