

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.,
Petitioner

v.

ASUS TECHNOLOGY LICENSING INC.,
Patent Owner.

IPR2024-01036
Patent No. 11,291,052

DECLARATION OF MICHAEL ALLAN MARTIN DAVIES

Table of Contents

I. Introduction	3
II. Qualifications	4
III. Scope of Opinion.....	9
IV. The '052 Patent.....	10
A. General Overview	10
B. Effective Filing Date.....	12
C. Prosecution History.....	13
D. The Challenged Claims.....	13
V. Person of Ordinary Skill in the Art ('POSITA')	13
VI. Legal Principles	17
VII. Claim Construction.....	19
A. "Start timing offset"	20
B. "a single (TB) transport block of Msg3 transmission to the network"	24
C. Specifying TTI duration and start timing offset in "time units"	27
VIII. Overview of the Prior Art References	29
A. Tang	29
B. Löhr.....	31
C. Tirronen	34
D. Applicant Admitted Prior Art ("AAPA")	36
IX. Specific Grounds of Challenge	38
X. Ground 1: Tang alone and/or Tang in view of Löhr	38
A. Scope, content, and rationale for combining prior art	38
XI. Ground 2: Tirronen	68
A. Scope and content of the prior art.....	68
B. Challenged Claims	70
XII. Conclusion	93

I. INTRODUCTION

1. My name is Michael Allan Martin Davies, and I have been retained by counsel (Greenberg Traurig, LLP) for Samsung Electronics Co., Ltd. (“Samsung”) as an expert witness in the *Inter Partes* Review of claims 1, 5, 7-8, 12, and 14 (the “Challenged Claims”) of U.S. Patent No. 11,291,052 (Ex-1001, the “’052 patent”).
2. I have also been retained to provide an analysis regarding the level of ordinary skill in the art at the time of the invention of the ’052 patent, and what a person of ordinary skill in the art would have understood at the time of the earliest application underlying the ’052 patent.
3. I have been informed that Asus Technology Licensing Inc. (hereinafter referred to as “the Patent Owner”) owns the ’052 patent. I have no financial interest in the Patent Owner of the ’052 patent, nor to my recollection have I had any contact with the Patent Owner for more than a decade, or the inventors of the ’052 patent. I also have no financial interest in Samsung.
4. All of the opinions stated in this declaration are based on my own expertise and professional judgement.
5. I am being compensated on an hourly basis for my work. My fee is not contingent on the outcome of any matter or on any of the technical positions explained or set forth in this declaration.
6. My opinions are based on my years of education, research and experience, as well as my investigation and study of relevant materials. The materials that I studied for this declaration include all the documents referenced in this declaration and the exhibits to Samsung’s

Petition for *Inter Partes* Review of U.S. Patent No. 11,291,052 (Ex-1001, the “’052 patent”).

7. I may rely upon these materials, my knowledge and experience, and/or additional materials to rebut arguments raised by the patent owner. Further, I may also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.
8. This declaration represents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information and on my continuing analysis of the materials produced in this proceeding.

II. QUALIFICATIONS

9. I am Chairman and Senior Partner of Endeavour Partners, LLC, a Senior Lecturer and erstwhile Principal Investigator at the Massachusetts Institute of Technology, a Guest Lecturer at London Business School, and the Co-Founder and Chief Executive Officer of WKD.SMRT, Inc.
10. I have spent more than thirty years working in telecommunications, electronics, and related industries. I worked first as an engineer, then as a manager and executive, and now as an academic, consultant, expert, entrepreneur, and advisor. I have worked for a wide variety of technology and manufacturing companies on issues relating to manufacturing, logistics, supply chain, research and development, product development, platform development, systems engineering, technology, strategy, software development and innovation. My work involves the connections amongst technology, innovation, new

products and services, adoption and diffusion, consumer choice and behavior, and systems, architecture, platforms, and the emergence and evolution of business ecosystems.

11. I received a Bachelor of Arts and a Master of Arts in Engineering and in Electrical Sciences from St. Catharine's College at the University of Cambridge; a Master of Engineering in Cybernetics, Robotics and Microelectronics from the University of Durham; and a Master of Business Administration from London Business School (with Distinction). My educational work focused on engineering and electrical sciences, including mathematics, physics and computer science; cybernetics and robotics; microelectronics including the design of microchips; and management science, with a particular focus on technology and innovation, business strategy and systems thinking. I have attached my curriculum vitae as Exhibit 1.
12. I am currently Chairman and Senior Partner of Endeavour Partners, LLC, a strategy consulting firm with expertise in mobile, wireless and digital technologies, systems and businesses. I work with companies that create these products and services and those that are impacted by the business and technology forces at play in the mobile and digital sectors to help them anticipate technological innovations, consumer needs, and the emergence and evolution of business ecosystems so that they are capable of navigating opportunities for innovation and growth.
13. I have experience working throughout the mobile, wireless and digital sectors, including the convergence of mobile, broadband, Internet, and digital technologies. My work in this area includes the communications sector, such as mobile devices including mobile phones (basic cellular

phones, feature phones, smartphones), tablets, services and networks (broadband and Internet), computers (servers, PCs, components, hardware, and software), electronic hardware (semiconductors and ICs, PCB design, and manufacturing), consumer electronics, content (video, audio, and applications), and electronic commerce.

14. I have also worked on business and technology strategy with many leading mobile device manufacturers (“MDMs”) including HTC, Samsung, Nokia, Motorola, Sony Ericsson, and Mitsubishi Electric; supply chain companies such as Qualcomm and Analog Devices; and many leading network operators and service providers, including AT&T, Verizon, Vodafone, Sprint Nextel, British Telecom (BT), Deutsche Telekom, Virgin Mobile, Optus, and Telecom New Zealand.
15. I have significant experience serving as an expert consultant in this field. I served as an industry expert for the Department of Justice in 2011 in the anti-trust investigation (Civil Action No. 11-01560 (ESH)) of the proposed AT&T and T-Mobile merger. In this role, I analyzed the impact of the proposed merger, in particular as it related to consumer choice and to the technology and the economics of mobile networks and mobile services.
16. I also served as an industry expert for the Department of Justice in 2019 in the anti-trust investigation of the proposed T-Mobile and Sprint merger. In this role, I again analyzed the impact of the proposed merger, in particular as it related to consumer choice and to technology and the economics of mobile networks and mobile services. Additionally, I am serving as a technical and industry expert for the Department of Justice

in the anti-trust investigation of Google, LLC (District Court for the District of Columbia Case No. 1:20-cv-03010-APM).

17. I also served as an industry expert for the Department of Justice, Anti-Trust Division, Media, Entertainment, and Communications Section in 2022 during a recent major global anti-trust investigation in the communications services sector. Internationally, I served as an industry expert on the public interest in 2022 for the Competition Bureau Canada during its assessment of the proposed acquisition of Shaw Communications by Rogers Communications.
18. I am a Senior Lecturer at the Massachusetts Institute of Technology (MIT) where I have held posts in both the School of Engineering (in Aero/Astro) and in the Sloan School of Management, where I have created and taught courses in fundamental and advanced topics in technology strategy, in systems engineering, in the leadership of high-tech businesses, and in integrated design and management. I have been responsible for creating, managing, and teaching two capstone leadership courses for postgraduate students, the Systems Leadership & Management Lab and Praxis programs, and for teaching the capstone leadership courses for undergraduates in the Gordon Engineering Leadership program. I teach topics including creative innovation, value creation, emerging technologies, product management, product marketing, basic finance and business models, pricing and marketing, competitive analysis, market opportunity identification, funding entrepreneurship, data-driven decision making and decision-making under uncertainty.

19. I have also been a Principal Investigator at MIT and have typically supervised the master's thesis work of several students each year, much of which also focuses on issues related to mobile and digital ecosystems and innovation. I also have supervised theses that have been the basis for being spun off as companies, and received funding from the National Science Foundation. I am the creator and co-leader of the program on Breakthrough Innovation, and I also teach multiple modules of the Technology Leadership Program, including a significant portion of the core course.
20. I have been responsible for organizing and teaching the New Technology Ventures program at London Business School, which is designed to enable would-be entrepreneurs to evaluate novel technologies and ideas, many of them in the mobile and digital industries, and turn them into new entrepreneurial ventures. Additionally, I am the creator and course Academic Director for the path-breaking course on The Business of AI.
21. I have held significant leadership roles in the industry. I was the New Zealand representative to the International Telecommunication Union Radiocommunication Sector (ITU-R), the international standards making body, including the ITU-R, Task Group 8/1. I was elected as a Vice-Chairman of the Global System for Mobile Communication Memorandum of Understanding (the largest group of mobile network operators worldwide, which is now the GSMA with nearly 800 members) and was a founder and Chairman of its 3rd Generation Interest Group and have also chaired government working parties on PCS Spectrum.

22. I have been the Chairman of the Massachusetts Technology Leadership Council Mobile Cluster, and served on the Board of Advisors for the Department of Systems Engineering at the U.S. Military Academy at West Point, on the Board of Directors of the Kendall Square Association. I am an advisor to WGBH, a public television station, public radio station and public media production house located in Boston, Massachusetts, and to PRX, the leading public audio podcasting business.

III. SCOPE OF OPINION

23. I have been asked to provide my opinions regarding whether claims 1, 5, 7-8, 12, and 14 (the “Challenged Claims”) of the ’052 patent are unpatentable pursuant to the following grounds:
- Whether claims 1, 5, 7-8, 12, and 14 are rendered obvious under AIA 35 U.S.C. §103 by U.S. Patent No. 2018/0343682 A1 to Tang et al. (“Tang”, Ex-1004) in view of U.S. Patent No. 2012/0147830 A1 to Löhr et al. (“Löhr”, Ex-1005).
 - Whether claims 1, 5, 7-8, 12, and 14 are rendered obvious under AIA 35 U.S.C. §103 by U.S. Patent No. 10,743,350 B2 to Tirronen (“Tirronen”, Ex-1006).
24. This Declaration, including the exhibits hereto, sets forth my opinion on these topics.

IV. THE '052 PATENT

A. General Overview

25. The '052 patent is directed toward a random access procedure for use in the context of 3GPP networks. (Ex-1001 at 1:42-54.) Such networks employ an “exemplary structure” like “E-UTRAN,” which comprises user equipment (“UEs”) such as mobile phones, network elements such as base stations (“BSs” or “eNBs”), and an air interface. (Ex-1001 at 1:32-40.) At the time of the disclosure of the '052 patent, the 3GPP standards organization was considering proposed changes to the previous generation of radio technology (i.e. 4G/LTE networks) in preparation for the next generation of such technology (i.e., 5G). (Ex-1001 at 1:32-40, 2:34-61.)

26. Random access procedures for user equipment (UEs) in a network were well known in the prior art. The '052 patent itself references LTE's contention-based random access procedure:

In LTE, there are two kinds of random access procedure, contention and non-contention. The contention random access procedure consists of 4 steps, including: Msg 1, Msg2, Msg3, and Msg4. FIG. 5 is an exemplary embodiment of the contention random access. (Ex-1001 at 8:31-35.)

27. FIG. 5 is reproduced below. Counsel have used, and I have adopted, yellow, pink, and blue highlighting to refer to the key messages involved in a random access procedure, that is Msg1 (random access preamble) transmitted by a mobile device, specifically the UE, seeking access to the network on the uplink, Msg2 (random access response (RAR)) from the network, specifically the eNB, on the downlink, and Msg3 (scheduled transmission) respectively, in order to facilitate

review of closely related disclosures and figures throughout this Declaration, including in FIG. 5 below:

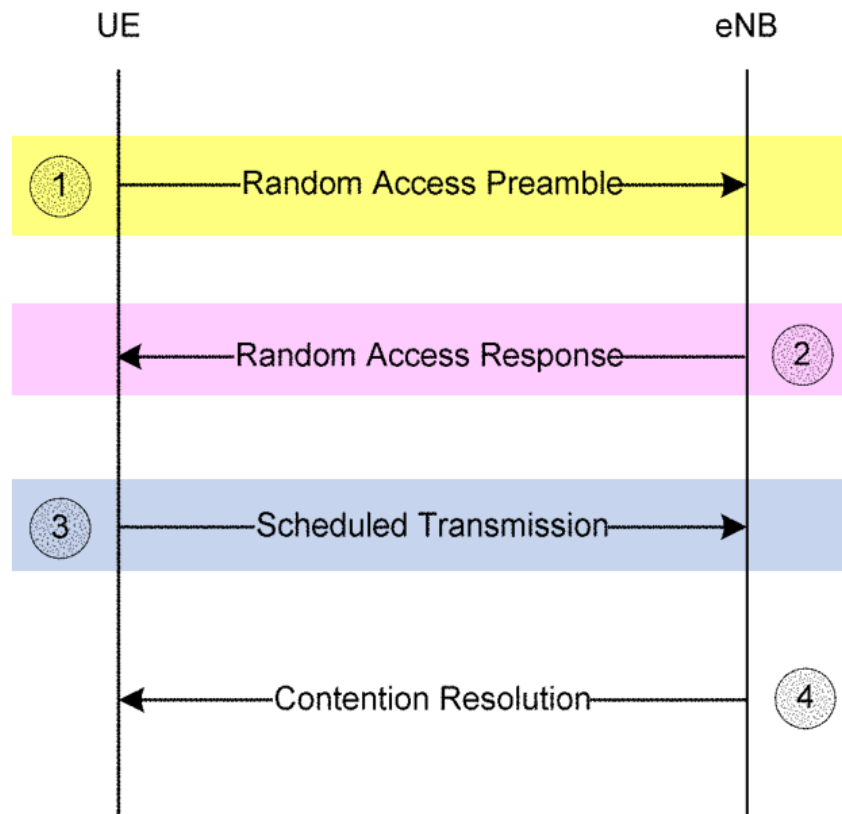


FIG. 5 (PRIOR ART)

Figure 1 *Contention-based Random Access Procedure for LTE disclosed as prior art in the '052 Patent (Ex-1001 at FIG. 5 (highlighting counsel's))*

28. The '052 patent expressly identified LTE's contention-based random access procedure as prior art. The same basic steps (as laid out in the prior art) formed the basis for the Challenged Claims of the '052 patent: a UE transmitting a Msg1 preamble to an eNB, followed by a UE receiving a Msg2 random access response (RAR) from the eNB, and finally the UE transmitting Msg3 to an eNB according to instructions from Msg2. (Ex-1001 at 8:31-35.)

29. The '052 patent further acknowledges that the 3GPP standards organization had proposed prior art contemplating how to use different transmission time intervals (TTIs), and specifically how to reduce latency for some communications (using short TTIs) while maintaining steady state transmissions for others (using long TTIs):

On the other hand, a dynamic TTI adjusting concept is discussed in 3GPP R2-163445, which proposes to set the TTI size per scheduling grant for optimizing TCP (Transmission Control Protocol) transmission case. In particular, short TTI can be used to accelerate TCP slow start process, and long TTI can be used in steady transmission rate state for reduc[ing] control signaling overhead. (Ex-1001 at 8:42-48.)

30. The premise of the '052 patent was to utilize the known variable TTI concept in a specific scenario, a mobile device seeking random access to the network, to accelerate this random access procedure:

The present application further discusses whether it can also be used to accelerate random access procedure and how to achieve dynamic TTI change in random access. The following discussion mainly focuses on the Msg3 transmission step in a random access procedure. (Ex-1001 at 8:49-54.)

31. The '052 patent requires that a TTI duration and a start timing offset be sent to the UE in the network's random access response (RAR)/Msg2, and further requires that a UE transmit a single TB as a Msg3 transmission rather than use TTI bundling. (*See* Ex-1001 at Claim 1.)

B. Effective Filing Date

32. The '052 patent claims priority to a provisional application filed July 28, 2016. (Ex-1001, (60).) I apply this date herein without taking a position on the entitlement of the '052 patent to the claimed effective filing date.

C. Prosecution History

33. I adopt counsel's discussion of the prosecution of four applications: (1) U.S. Patent Application Nos. 15/663,674 (Ex-1009, the "674FH"), (2) 16/052,505 (Ex-1002, the "052FH"), (3) 17/673,985 (Ex-1010, the "985FH"), and (4) European Patent App. No. EP17183827.9 (Ex-1008).

D. The Challenged Claims

34. This Declaration relates to Claims 1, 5, 7-8, 12, and 14, of which claims 1 and 8 are independent.

V. PERSON OF ORDINARY SKILL IN THE ART ('POSITA')

35. I understand that my assessment of the claims of the '052 patent must be undertaken from the perspective of what would have been known or understood by a person having ordinary skill in the art, reading the '052 patent on its priority date and in light of the specification and file history of the '052 patent. I may refer to such a person as a "POSITA."
36. I understand that my analysis and opinions expressed in this declaration must be rendered based on the perspective of a POSITA as of the priority date of the '052 patent. I also understand that a POSITA is a hypothetical person who is presumed to know the relevant art at the time of the alleged invention claimed in the '052 patent.
37. I further understand that in determining the level of ordinary skill in the art, I am to consider factors including:
- the type of problems encountered in the art or field of invention,
 - prior art solutions to those problems,

- the rapidity with which innovations are made,
 - sophistication of the technology, and
 - the educational level of active workers in the field.
38. I have been instructed to assume a person of ordinary skill in the art is not a specific real individual, but rather a hypothetical individual having the qualities reflected by the factors discussed above.
39. I understand that a POSITA is a person of ordinary creativity, but not an automaton, and that a POSITA can often fit multiple patents or prior art references together like pieces of a puzzle as a result of this ordinary creativity. I also understand that I may consider the inferences and creative steps that a POSITA would employ. In addition, I understand that a POSITA would necessarily have been capable of understanding the scientific and engineering principles applicable to the pertinent art. I also understand that when I consider what would have been obvious to a POSITA, I am not considering what would have been obvious to me at the time, nor to the inventors, judges, laymen, those skilled in other arts, or to geniuses in the art.
40. A POSITA in the field of the '052 patent, as of its provisional filing date¹ of July 28, 2016, would have had at least a bachelor's degree in electrical engineering, computer science, computer networking, or network engineering and familiarity with telecommunications. The POSITA would have also had some familiarity with the relevant 3GPP

¹ As explained previously, counsel does not concede the '052 patent is entitled to claim priority to its provisional application.

standards as of this time, as well as software for communications protocols, and at least two years of experience working in a field involving wireless communications. Additional education may serve as a substitute for a lack of experience and vice versa.

41. My opinion relies on various factors. For example, the “Field” of the ’052 patent indicates that the patent “generally relates to wireless communication networks, and more particularly, to a method and apparatus for improving Msg3 transmission of random access procedure in a wireless communication system.” (Ex-1001 at 1:15-20.) Wireless communication networks of the type discussed in the ’052 patent were generally standardized by 3GPP, including LTE and 5G. The people working in this field usually had an electrical engineering degree, computer science, computer networking, or network engineering, as I note below, and ordinary skill would require a couple of years of experience and some familiarity with the 3GPP family of standards as well.

42. Likewise, the “Background” section describes a rising demand for data-intensive communications to and from mobile devices. (*Id.* at 1:23-40.)

The “Background” states:

With the rapid rise in demand for communication of large amounts of data to and from mobile communication devices, traditional mobile voice communication networks are evolving into networks that communicate with Internet Protocol (IP) data packets. Such IP data packet communication can provide users of mobile communication devices with voice over IP, multimedia, multicast and on-demand communication services. An exemplary network structure is an Evolved Universal Terrestrial Radio Access Network (E-UTRAN). The E-UTRAN system can provide high data throughput in order to realize the above-noted voice over IP and multimedia services. A new radio technology for the next generation (e.g., 5G) is currently being discussed by the 3GPP standards organization. Accordingly, changes to the current body of 3GPP standard are currently being submitted and considered to evolve and finalize the 3GPP standard. (*Id.*)

43. E-UTRAN is often referred to as LTE and encompasses the LTE air interface as well as UEs, and BSs operating on the network. A POSITA would have been familiar with this background information, including the ongoing 3GPP standardization efforts as 3GPP standards evolved from LTE to 5G.
44. Additionally, various 3GPP technical specifications, proposals and related references are incorporated by reference in the ’052 patent, and large portions of the various 3GPP technical specifications were copied and summarized in the patent as well. (*See, e.g.*, Ex-1001 at 2:34-61 (citing and incorporating by reference); 5:27-7:59 (citing and pasting portions of 3GPP TS 36.300 v13.2.0 (Ex-1014 in this proceeding)).)

45. In my own experience working in this field, experience with reviewing 3GPP standards including technical specifications and proposals was important for individuals working in the field. Such materials informed those working in the field how 3GPP standard networks functioned, including for well-known networks like LTE.
46. The educational level of active workers in the field of the invention also informs my opinion. Such individuals usually had at least a bachelor's degree in electrical engineering, computer science, computer networking or networking engineering or a related discipline and at least two years of experience working in the field of wireless communications networks or in academic research related thereto.
47. As of July 28, 2016, I had more than ordinary skill in the art. I am, however, familiar with the skills and knowledge possessed by those I would have considered to be of ordinary skill in the art as of that date. When I refer to the understanding of a POSITA, I am referring to the understanding of such a person as of July 28, 2016.

VI. LEGAL PRINCIPLES

48. I am not an attorney. I have been informed, however, about several principles and standards of patent law, which I have used in developing my opinions expressed herein.
49. For example, it is my understanding that there are two ways in which prior art may render a patent claim unpatentable. First, the prior art can be shown to “anticipate” the claim. Second, the prior art can be shown to have made the claim “obvious” to a POSITA.

50. It is my understanding that a patent claim is unpatentable as being anticipated if all the claim elements are found expressly or inherently within a prior art reference and arranged as in the claim. It is my understanding that a prior art disclosure can inherently anticipate claimed subject matter if the disclosure necessarily functions in accordance with, or includes, the claimed subject matter.
51. It is my understanding that a patent claim is unpatentable as being obvious in view of prior art if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the alleged invention was made to a POSITA to which said subject matter pertains. I further understand that an obviousness analysis takes into consideration factual inquiries such as the level of ordinary skill in the art, the scope and content of the prior art, and the differences between the prior art and the patent claim.
52. I understand that the U.S. Supreme Court has recognized several rationales for combining references and for modifying a reference as part of an obviousness analysis. These rationales include:
- combining prior art elements according to known methods to yield predictable results,
 - simple substitution of a known element for another to obtain predictable results,
 - a predictable use of prior art elements in accordance with their established functions,

- applying a known technique to improve a known device (or process) and yield predictable results,
 - choosing from a finite number of known predictable solutions with a reasonable expectation of success.
53. It is further my understanding that an obviousness analysis takes into consideration whether the prior art provides a teaching, suggestion, or motivation to combine teachings of multiple prior art references to arrive at the patent claim.
54. I also understand that the alleged priority date for the '052 patent is July 28, 2016. I have therefore analyzed obviousness as of that date or somewhat before that date.
55. Finally, several of the claims of the '052 patent disclose elements that in my opinion are nothing more than an obvious “design choice” (as detailed in my opinion below). It is my understanding that design choices are obvious because they are “nothing more than a predictable use of prior art elements...to address a known problem.” *PlaSmart, Inc. v. Kappos*, 482 Fed. Appx. 569, 573-74 (Fed. Cir. 2012). I further understand that design choices that “provide[] no novel or unexpected result” are obvious. In *re Kuhle*, 526 F.2d 553, 555 (C.C.P.A. 1975). As such, I have applied that understanding in my opinions that follow.

VII. CLAIM CONSTRUCTION

56. I adopt the petitioner’s argument that no claim constructions are required and I have interpreted the claims at issue in accordance with their ordinary and customary meanings. 37 C.F.R. §41.100(b).

57. The Challenged Claims include terms that were disputed during prosecution of the patent – “start timing offset” (limitations 1.2.2 and 8.2.2) and “the UE performs a single (TB) transport block of Msg3 transmission to the network” (limitations 1.3 and 8.3). Accordingly, I have provided a brief explanation regarding these terms below.
58. Another instance disputed during prosecution was “specifying TTI duration and start timing offset in ‘time units’” and while the ’052 patent does not explicitly require this, I have provided a brief explanation of what qualifies as “time units”.

A. “Start timing offset”

59. The term “start timing offset” appears in claims 1 and 8, where it is described as a part of Msg2 and pertains to the TTI information of Msg3. In the following excerpt from the ’052 patent, “start timing offset” appears to refer to a gap period (timing) between a UE’s reception of Msg2 and its transmission of Msg3:

Msg3 start timing offset—In LTE, there is a fixed gap period between Msg2 reception and Msg3 transmission. The fixed gap period is designed for covering UE’s Msg2/3 processing time (e.g., decode, (de-)multiplexing transport block). However, in NR, some possible methods can bring benefits to reduce such fixed gap period. For example, if short TTI is applied to both Msg2/Msg3 transmissions as FIG. 11, the minimum of the fixed gap between Msg2 and Msg3 can be set to short TTI. Otherwise, the minimum gap could only be set to normal sub-frame length like without short TTI case.

There are also many other ways to reduce processing time (e.g., provision TB size). These methods will bring some benefits, as well as some limitations and/or complexity. As a conclusion, we think that it could be beneficial for network be capable to decide the length of gap period. For achieving the concept, a UE will need to know the gap information (or called Msg3 start timing offset) by information provided from network. The possible solutions are listed below. (Ex-1001 at 13:60-14:10.)

60. The means of indicating the “start timing offset” is also described in the ’052 patent:

The Msg3 start timing offset can be indicated in TTI duration, numerology, symbol, slot, microsecond, millisecond or N times of periodicity of periodic behavior. N can be an integer or a decimal number. (Ex-1001 at 18:48-52.)

61. According to the definition above, “start timing offset” broadly refers to any fixed gap between the reception of Msg2 and transmission of Msg3. This gap can be indicated in many ways including a symbol, slot, numerology, or time at which the Msg3 transmission may begin.

62. It is worth noting in this context the prosecution history of the related European patent, wherein the European examiner argued, in an Office Action of January 7, 2020 that the “start-timing offset of Msg3” was trying to solve the problem of “how to implement a correct timing advance in a random access procedure” and both the problem and its solution were not novel:

Said problem is a known one in the art, and a skilled person would always be faced with such problem. The known solution to that problem is to send a timing advance indication (i.e. a timing offset) in the Msg2 of the random access procedure. As an example, document D7 (which is related to RA procedure in a network with short TTI, see section 2.3 Message 3, which discloses that “the size is dynamic due to the short TTI”) discloses that same subject matter, see section 2.2 Message 2, “The purpose of Message2 is to at least: [...] Conveys timing adjustment in order to prevent un-synchronized transmission over UL-SCH”. (Ex-1008-EPFH at 167.)

63. In response to the patent examiner’s Office Action of January 7, 2020, the applicant attempted to provide additional detail to disambiguate the terms “start timing offset” and “timing adjustment”:

Section 2.2 of D7 indeed mentions sending a timing adjustment for the UL-SCH transmission in the Msg2. However, said “timing adjustment” of D7 cannot be deemed the same as the “start timing offset” as claimed in the presently filed new claim 1 of the present application. The reason is that the “start timing offset” of the invention is used for the UE to know at which time unit (e.g. slot, symbol, etc.) the Msg3 should be started to send, whereas the “timing adjustment” mentioned in section 2.2 of D7 is used for the UE to know how much small/tiny adjustment at a specific known time unit should be done for sending the Msg3. (Ex-1008-EPFH at 172.)

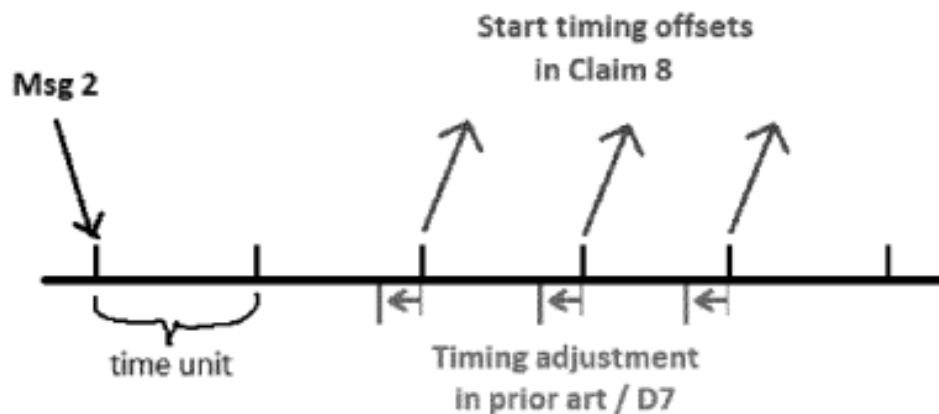


Figure 2 *The difference between start timing offset and timing adjustment proposed by the applicant of the '052 patent during the prosecution of a related European Patent (Ex-1008-EPFH at 172.)*

As shown in the above figure, the “start timing offset” as claimed in the invention is different from the “timing adjustment” as disclosed in section 2.2 of D7. Thus, from the teaching of D7 in respect to conveying a “timing adjustment” in the Msg2, the teaching of the invention in respect to including a “start timing offset” of the Msg3 in the Msg2 as claimed in the charactering part of the presently filed new claim 1 cannot unambiguously and doubtlessly be derived. Therefore, D7 is silent on the acknowledged differing feature of the invention as mentioned above. (Ex-1008-EPFH at 172.)

64. The applicant was ultimately unsuccessful in convincing the patent examiner of its position and chose to amend the claims in this regard. (Ex-1002-EPFH at 198-226.)
65. While the '052 patent defines “a start timing offset” as a fixed gap period between Msg2 reception and Msg3 transmission designed to cover the UE’s Msg2/Msg3 processing time (Ex-1001 at 13:60-64), the applicant narrowed this definition during the prosecution of a related European patent. In that prosecution, “a start timing offset” was

understood to refer to the time unit in which a Msg3 transmission may start (e.g., the time slot or symbol). (Ex-1008-EPFH at 172.)

B. “a single (TB) transport block of Msg3 transmission to the network”

66. The phrase “single transport block” appears in claims 1 and 8 of the ’052 patent. In both claims, the phrase is used to describe the Msg3 transmission to the network as defined by the TTI information of Msg2.
67. The specific qualification of a “single” TB was added during the ’052 patent prosecution to distinguish over TTI bundling. (Ex-1002-052FH at 149-154.) The applicant argued that TTI bundling disclosed in Mujtaba “teaches away from the intention of reducing transmitting delay for Msg3 and a start timing offset of the Msg3” because it involves sending the same packet in multiple consecutive transmissions. (Ex-1002-052FH at 153.) The applicant argued that this distinction is significant enough to justify the use of the phrase “single transport block”:

In contrast, as recited in claims 1 and 8, if a **single transport block (TB)** is used for Msg3 transmission, the average random access latency could be reduced due to early start to monitor Msg4. (Ex-1002-052FH at 153, emphasis applicant’s.)

68. In response to the examiner’s rejection of this argument, the applicant doubled down on the idea that the “single TB” phrase was added to distinguish from TTI bundling. In particular, the applicant highlighted the examiner’s reliance on Löhr as a reference, as Löhr disclosed TTI bundling. (Ex-1002-052FH at 200.) The applicant argued:

Notably, Löhr seems to be silent as to a UE performing **a single (TB) transport block of Msg3 transmission to a network according to TTI information of a Msg3.**

Rather, Löhr seems to provide for a TTI **bundling** mode via which **multiple redundant versions of a transport block** are transmitted. (Ex-1002-052FH at 200-201, emphasis applicant's.)

69. These statements mischaracterize Löhr, as they imply that the ability to send multiple redundant TBs excludes the ability to send a single (non-redundant) TB. As described below, Löhr explicitly discloses TTI bundling and single TB transmission modes, as the examiner recognized. (Ex-1005-Löhr at FIG. 10.) No reasonable person, let alone a person of ordinary skill in the art, could interpret Löhr as providing only a TTI bundling mode while being “silent” on a single TB mode.
70. Additionally, the '052 patent does not describe the “single transport block.” In fact, the word “single” only appears once outside of the claims 1 and 8, and there in reference to an antenna. (Ex-1001 at 3:24-28.) Despite the applicant's insistence on modifying the claims to include a “single transport block”, the specification is silent regarding concepts relating to sending a single transport block verses sending multiple transport blocks (non-bundling verses TTI bundling).
71. The applicant used FIG. 7 and paragraph 51 of the patent application (which became 9:9-18 of the '052 patent) (reproduced below) to

support its addition of the “single transport block” phrase during patent prosecution.

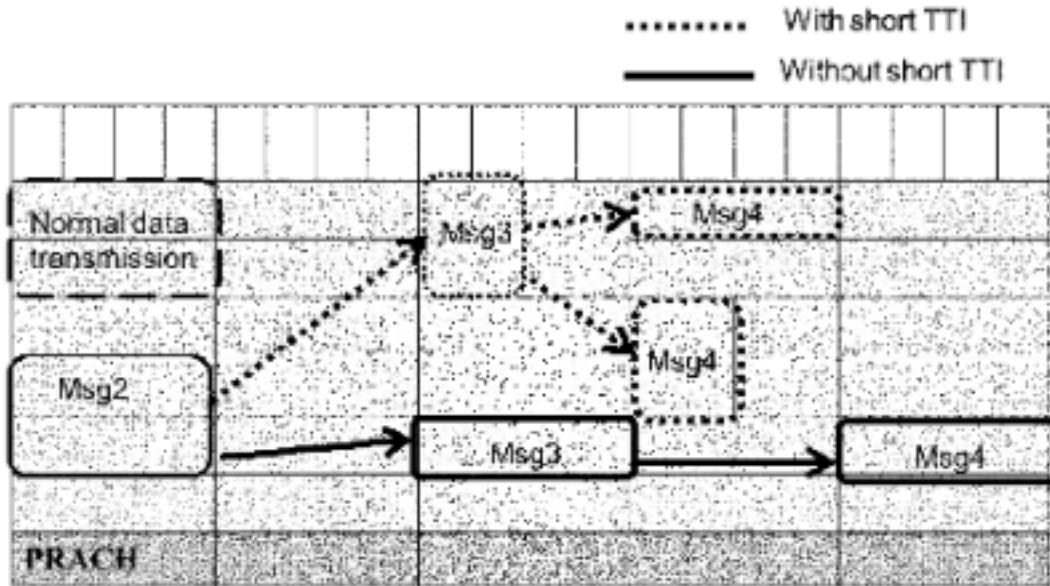


FIG. 7

Figure 3 Depiction showing how random access latency could be reduced if short TTI were applied to Msg3 transmission (Ex-1001 FIG. 7.)

If short TTI applies to Msg3 transmission, the average random access latency could be reduced due to early start to monitor Msg4. A possible case for such benefit is shown in FIG. 7. As shown in FIG.7, although the processing delay is a fixed period, the UE could start to receive Msg4 earlier owing to early Msg3 transmission. Moreover, two possibilities for monitoring Msg4 are shown in FIG. 7. The UE may expect either TTI format if the TTI length information is not be carried in scheduling control signal. Otherwise, the UE may expect multiple possibilities of TTI length. (Ex-1001 at 9:9-18.)

72. Neither FIG. 7 nor the excerpt from the '052 patent specification (Ex-1001 at 9:9-18) appear to provide any support for the use of “single TB” in the claims. FIG.7 and the excerpt from the '052 patent specification (Ex-1001 at 9:9-18), appear to favor the use of a short TTI for Msg3

transmission as it could reduce the random access latency by enabling monitoring for Msg4 to start early. The applicant made no connection between short TTI and a “single TB”.

C. Specifying TTI duration and start timing offset in “time units”

73. As Petitioner explains in the Petition, during prosecution at the EPO the applicant argued:

[T]he inventive concept of the present invention is explicitly including the TTI duration of the Msg3, which is a first number of time units, and the gap period between Msg2 reception and Msg3 transmission, which is a second number of time units, in the Msg2. (Ex-1008-EPFH at 201.)

[A]ccording to the present invention, two numeric values of time durations are directly indicated in the TTI information. (Ex-1008-EPFH at 218.)

74. The TTI information set forth in the claims was clarified in amendments so as to refer to this time unit concept (Ex-1008-EPFH at 226), as shown below:

“...the TTI information of the Msg3 includes a first number of time units and a second number of time units for indicating a TTI duration of the Msg3 and a start timing offset of the Msg3 gap period between Msg2 reception and Msg3 transmission, respectively.

75. The claims in the '052 patent do not use the same claim language. Even if the claims in the '052 patent require specifying TTI duration and start timing offset in terms of time units, that would not distinguish the claims from the prior art. In particular, a POSITA would understand that time units include units defined in terms of seconds (e.g., 1 millisecond), symbols, and subframes. (Ex-1004-Tang at [0228], [0258-59]; Ex-1006-Tirronen at 2:39-47, 11:20-34; Ex-1023-36.211 at

page 69, §6.2.) In LTE, downlink and uplink transmissions are organized into 10 ms radio frames each of which are subdivided into ten 1ms subframes.² Each subframe is further subdivided into two 0.5 ms slots, and each slot consists of seven 66.7 μ s symbols.³

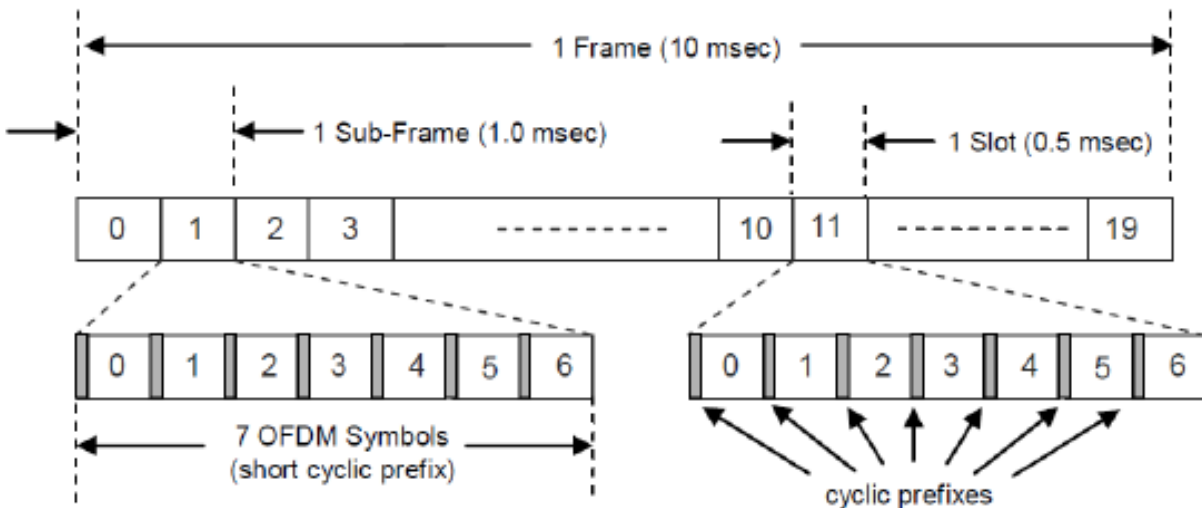


Figure 4 *One frame of FDD LTE in the time domain, illustrating how a frame is broken down into sub-frames and symbols⁴*

76. Given the frame structure associated with LTE one of ordinary skill in the art would have understood that subframes and symbols are units of time.

²

https://www.sharetechnote.com/html/FrameStructure_DL.html#:~:text=Each%20of%20the%20frame%20consists,of%20which%20is%2066.7%20us.

³

https://www.sharetechnote.com/html/FrameStructure_DL.html#:~:text=Each%20of%20the%20frame%20consists,of%20which%20is%2066.7%20us.

⁴

https://www.sharetechnote.com/html/FrameStructure_DL.html#:~:text=Each%20of%20the%20frame%20consists,of%20which%20is%2066.7%20us.

VIII. OVERVIEW OF THE PRIOR ART REFERENCES

A. Tang

77. Tang is U.S. Patent App. Pub. 2018/0343682, filed August 2, 2018.
78. I understand from counsel that Tang is a continuation of PCT/CN2016/073234 (“Tang-PCT”), filed on February 2, 2016, and that Tang is prior art. Because Tang-PCT is in Chinese, Ex-1020 comprises the Tang-PCT and a certified translation of the same, and Ex-1021 is a comparison between the certified translation and Tang itself. These references confirm that the subject matter I rely on was described in the priority application, as required. I also cite to both Tang and the corresponding citation in the certified translation herein.
79. Tang discloses a random access procedure in FIG. 3, reproduced below. (*See* Ex-1004-Tang at [0244]-[0271]; Ex-1020 at 24:29-28:19.)

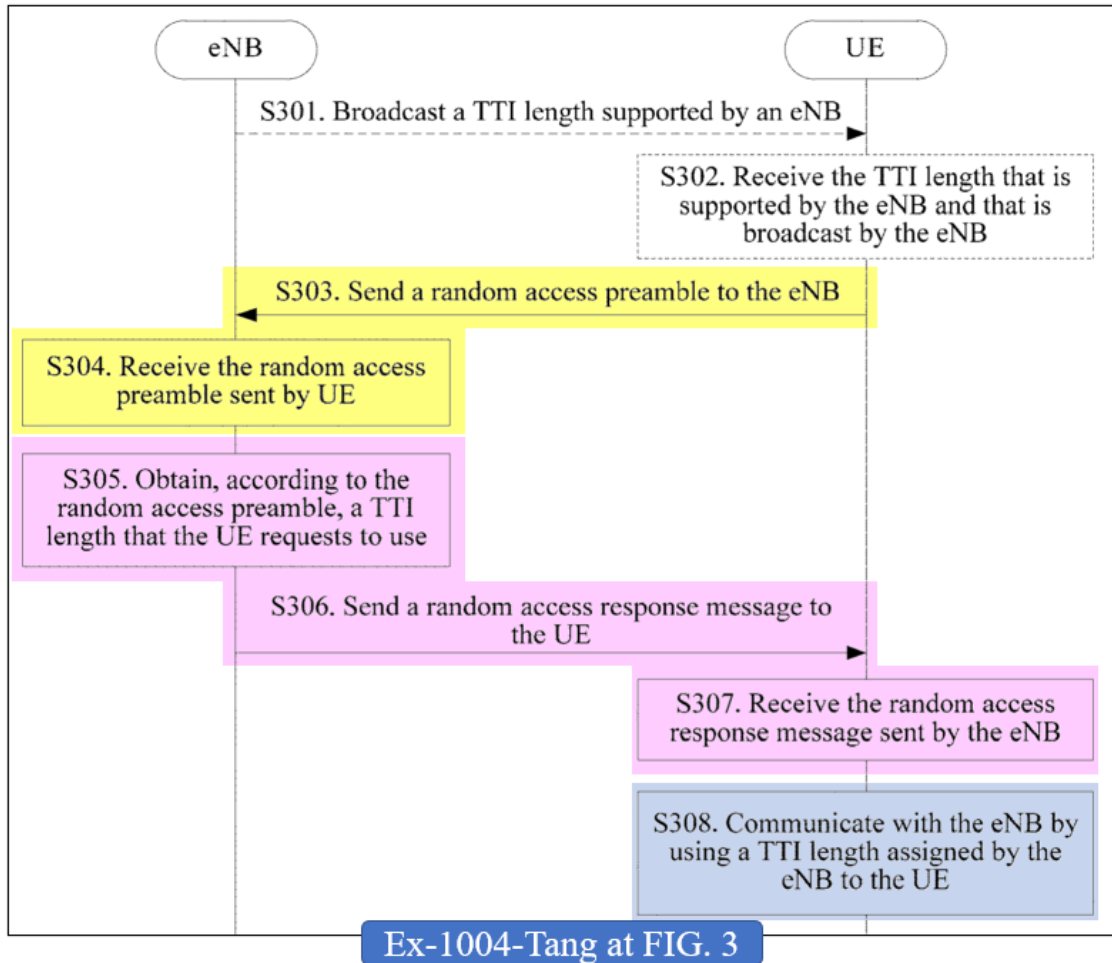


Figure 5 *The random access procedure depicted in Tang FIG. 3 (Ex-1004-Tang at FIG. 3 (highlighting counsel's))*

80. FIG. 3 of Tang illustrates a UE transmitting a random access preamble to an eNB (Step S303, highlighted in yellow), receiving a random access response (RAR) message with TTI indication information that includes a TTI length (Ex-1004-Tang at [0242]-[0259]; Ex-1020 at 24:11-27:3) and subframe start location information, where the subframe start location information includes a start subframe number and a symbol index in a subframe (Ex-1004-Tang at [0242]-[0259]; Ex-1020 at 24:11-27:3) (including Steps 305-307, highlighted in pink). Then the UE begins to communicate with the eNB at an effective

moment and/or start symbol location with the TTI length assigned to UE by the eNB (Ex-1004-Tang at [0271]; Ex-1020 at 28:18-19) (Step 308, highlighted in blue).

B. Löhr

81. Löhr is U.S. Patent App. Pub. 2012/0147830, filed June 15, 2010 and published June 14, 2012. According to counsel, Löhr is prior art.
82. Löhr relates to the contention-based random access procedure for LTE as set forth in 3GPP TS 36.321 v8.5.0 (Ex-1012), which involves the four conventional random access steps: 1. UE sending an eNB a random access preamble (Msg1) (highlighted in yellow), 2. UE receiving from an eNB a Random Access Response (RAR) in response (Msg2) (highlighted in pink), 3. UE sending an eNB a scheduled transmission according to the RAR (Msg3) (highlighted in blue), and 4. UE receiving from an eNB a contention resolution (Msg4). (Ex-1005-Löhr at FIG. 5, [0032]-[0048].)

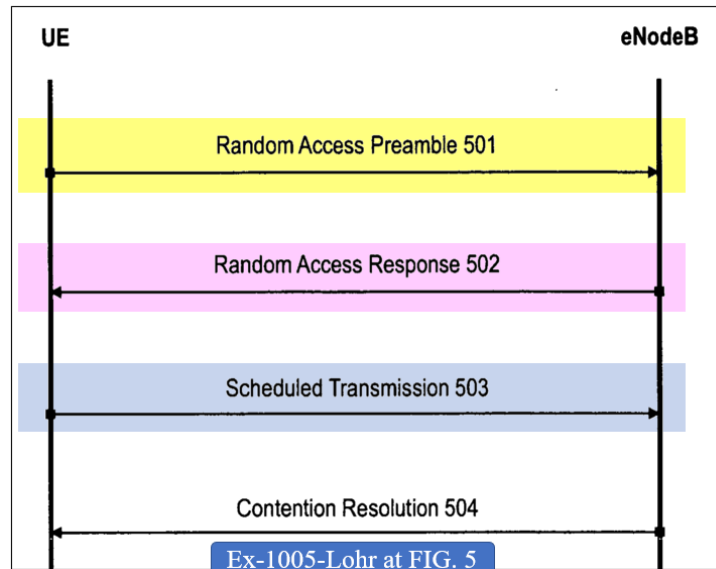


Figure 6 *Contention-Based Random Access Procedure (Ex-1005-Löhr at FIG. 5)*

83. In the random access procedure described in Löhr, the random access response (RAR)/Msg2 from the eNB indicates to the UE whether or not to use TTI bundling based on a transmission mode indicator. (Ex-1005-Löhr at [0112] and [0175].)

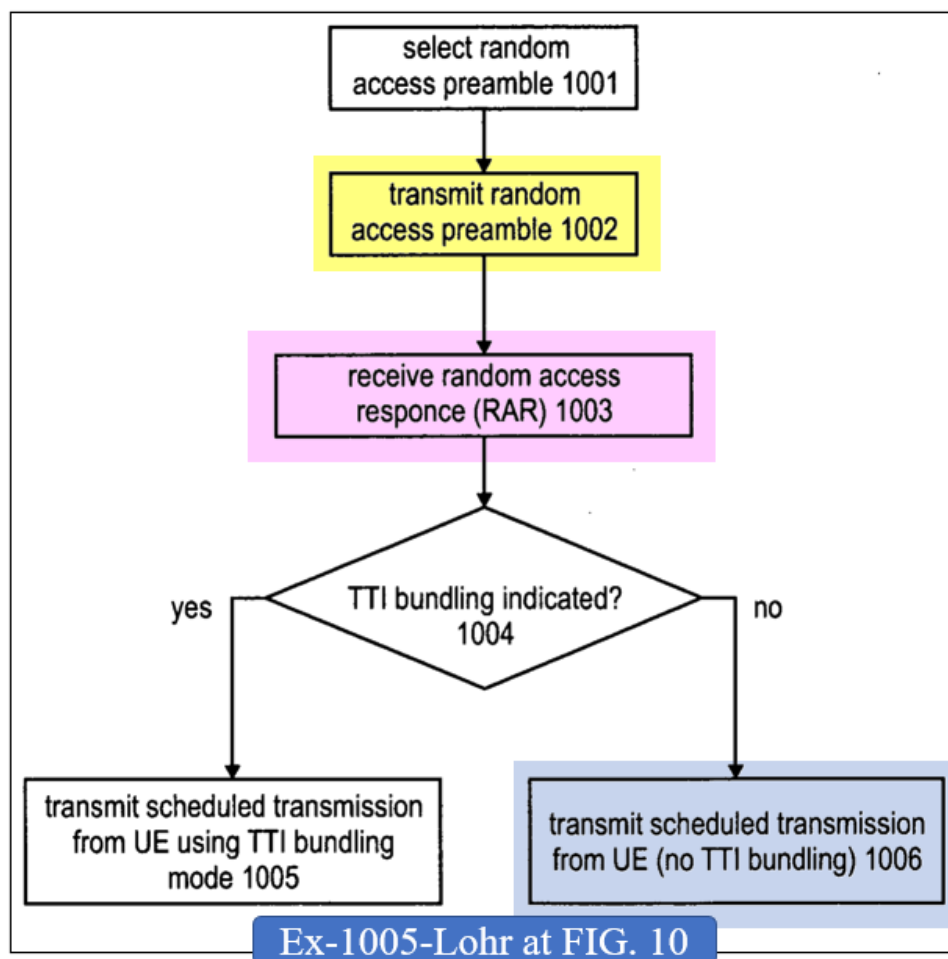


Figure 7 *Löhr's contention based random access procedure where the random access response indicates (via a transmission mode indicator) whether or not TTI bundling should be used for Msg3 transmission. (Ex-1005-Löhr at FIG. 10 and [0112] and [0175] (highlighting counsel's))*

84. When the transmission mode indicator indicates that TTI bundling is not necessary (i.e. no TTI bundling), Msg3 is transmitted from the UE to the network without TTI bundling (i.e. as a single TTI, shown as the blue highlighted box in FIG. 10 of Löhr). (Ex-1005-Löhr at [0175]).
85. During the patent prosecution for the '052 patent, the patent examiner repeatedly cited Löhr in response to the applicant's claim amendments requiring the "single TB" limitation. (Ex-1002-052FH at 149-54, 167, 194-203, 211-221, 235-259, 532-534.) Throughout the '052 patent

prosecution and even in the Notice of Allowance, the patent examiner maintained that Löhr (including FIG. 10) disclosed the “single TB” limitation added by the applicant. (*E.g.*, Ex-1002-052FH at 533, the Notice of Allowance stated “Löhr discloses (Figs. 7-15) perform(ing) a single (TB) transport block of Msg transmission to the network according to the TTI information of the Msg [0164, 0120, 0183, 0187],”; the claims were ultimately allowed based on other grounds.)

C. Tirronen

86. Tirronen is U.S. Patent 10,743,350, filed September 8, 2016.
87. Tirronen is entitled to and claims priority to Provisional App. 62/232,743 (“Tirronen-Prov”), filed September 25, 2015. (*See* Ex-1022 (chart comparing Tirronen disclosures with corresponding Tirronen-Prov disclosures).) I understand from counsel that Tirronen is prior art. I cite to both Tirronen and the corresponding citation in the Tirronen-Prov herein.
88. Tirronen discloses a random access procedure for conventional UEs (like legacy LTE UEs) as well as low complexity UEs (like MTC UEs) and UEs requiring/using coverage enhancements. (Ex-1006-Tirronen at 9:37-54, 10:14-25; Ex-1007 at 3:40-4:9, 4:28-35.) For low complexity UEs/UEs with coverage enhancements the random access procedure may be modified by repeating the Transmission Time Interval (TTI) in Msg3. (Ex-1006-Tirronen at 10:14-39; Ex-1007 at 4:28-5:2).

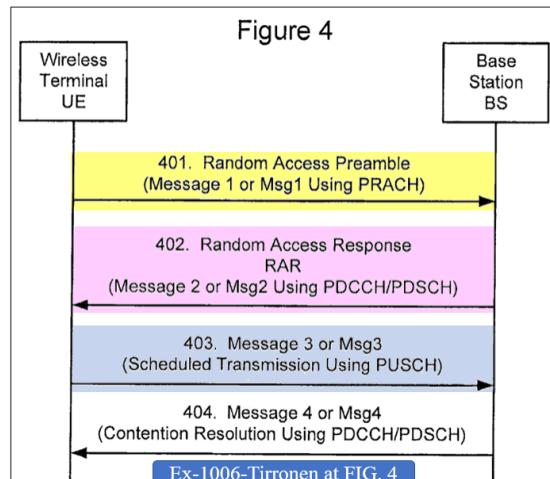


Figure 8 *LTE random access procedure described in Tirronen and extended for low complexity UEs/UEs with coverage enhancements (Ex-1006-Tirronen at FIG. 4, 9:37-54, 10:14-25; Ex-1007 at 3:40-4:9, 4:28-35.)*

89. Tirronen's process reflects the LTE random access procedure, where a UE transmits a preamble to the eNB (Msg1) (highlighted in yellow), the UE then receives a Random Access Response (RAR) containing an Uplink grant from the eNB in response (Msg2) (highlighted pink), and UE transmits a scheduled transmission to the eNB in accordance with the UL Grant (Msg3) (highlighted blue). (Ex-1006-Tirronen at FIG. 4, 8:58-62; Ex-1007 at 3:12-14.)
90. Tirronen provides for the possibility of TTI with or without extension (i.e. TTI or extended TTI), in much the same way as Löhr provides for the possibility of TTI with or without TTI bundling. The TTI field used in Tirronen to indicate whether the TTI is extended (bundled) or not is analogous to the transmission mode indicator used in Löhr to disclose whether the TTI is bundled or not. Low complexity UEs (such as MTC UEs) and UEs requiring/using coverage enhancements require extended TTI. Conventional UEs (like legacy LTE UEs) do not require

extended TTI, and use a single TTI instead. (Ex-1006-Tirronen at 11:20-34; Ex-1007 at 5:33-41.)

91. Tirronen discloses that the random access response message contains a time domain configuration (i.e. TTI information) that includes TTI duration and a time location in a subframe for a Msg3 transmission. (Ex-1006-Tirronen at 2:39-47, 13:19-35; Ex-1007 at 13:20-27, 7:36-8:3.)

D. Applicant Admitted Prior Art (“AAPA”)

92. There is no dispute that prior art LTE specifications disclose a contention-based random access procedure. In particular, the Patentee admitted that this procedure is outlined in figure 10.1.5.1-1 of 3GPP TS 36.300 v13.2.0 (Ex-1014), which is reproduced as FIG. 5 and labeled prior art in the ’052 patent:

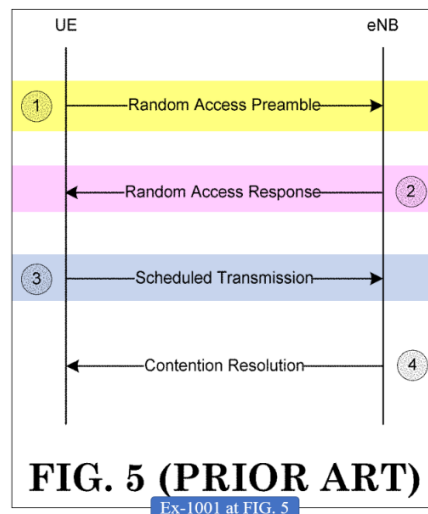


Figure 9 *Contention Based Random Access Procedure (Ex-1001 at FIG. 5 (highlighting counsel’s); see Ex-1001 at 2:1-2 (“FIG. 5 is a reproduction of FIG. 10.1.5.1-1 of 3GPP TS 36.300 v13.2.0.”))*

93. The figure above uses the same highlighting scheme counsel applied to similar figures disclosed in Tang, Löhr, and Tirronen. The '052 patent describes these prior art steps as follows:

“The four steps of the contention based random access procedures are:

1) Random Access Preamble on RACH in uplink:...

2) Random Access Response generated by MAC on DL-SCH:...

3) First scheduled UL transmission on UL-SCH:

Uses HARQ;

Size of the transport blocks depends on the UL grant conveyed in step 2. ...

4) Contention Resolution on DL....” (Ex-1001 at 6:13-7:10.)

94. The messages associated with each step 1-4 (labeled in the excerpt above and in FIG. 5) are also conventionally called “Msg1, Msg2, Msg3, and Msg4” in LTE. (Ex-1001 at 8:31-41.) As shown in FIG. 5 and described in the excerpt above, the preamble/Msg1 transmission is an uplink transmission from the UE to the network; the RAR/Msg2 transmission is a downlink transmission from the network to the UE; and the Msg3 transmission is an uplink transmission from the UE to the network. A POSITA would have known this by convention (e.g., “uplink” transmissions in this context refer to transmissions sent “up” from a UE to a network element like a base station, while “downlink” transmissions go in the opposite direction from the network element/base station “down” to a UE). It is also shown expressly in the AAPA description above, because the preamble is on RACH “in

uplink,” RAR/Msg2 is sent on “DL-SCH” where “DL” refers to downlink, and Msg3 is sent on “UL-SCH” where “UL” refers to uplink.

95. As explained herein, the ’052 patent’s claims are generally directed to the conventional random access procedure outlined above with three already known modifications: (1) the RAR/Msg2 includes a TTI duration, (2) the RAR/Msg2 contains a start timing offset, and (3) the UE must only perform “a single (TB) transport block of Msg3 transmission.” (*E.g.*, Ex-1001 at claim 1.)

IX. SPECIFIC GROUNDS OF CHALLENGE

96. The specific grounds of the challenge are:

- Ground 1: Tang alone and/or Tang in view of Löhr
- Ground 2: Tirronen alone

X. GROUND 1: TANG ALONE AND/OR TANG IN VIEW OF LÖHR

A. Scope, content, and rationale for combining prior art

97. Ground 1 relies on Tang alone and/or Tang in view of Löhr.
98. Tang is titled “TTI Configuration Method, Device, and System” and discloses the ability to configure different TTI lengths for communication between a UE and an eNB, including for random access procedures. (Ex-1004-Tang at [0001]-[0006], FIG. 3; Ex-1020 at FIG. 3, 1:2-28.)
99. More specifically, Tang discloses a random access procedure (see FIG. 3) in which a UE transmits a random access preamble to an eNB (Msg1) (highlighted in yellow), receives a random access response (RAR) comprising TTI information from the eNB (Msg2) (highlighted in

pink), and then sends a scheduled transmission as permitted by the information in the RAR/Msg 2 from the UE to the eNB (Msg3) (highlighted in blue).

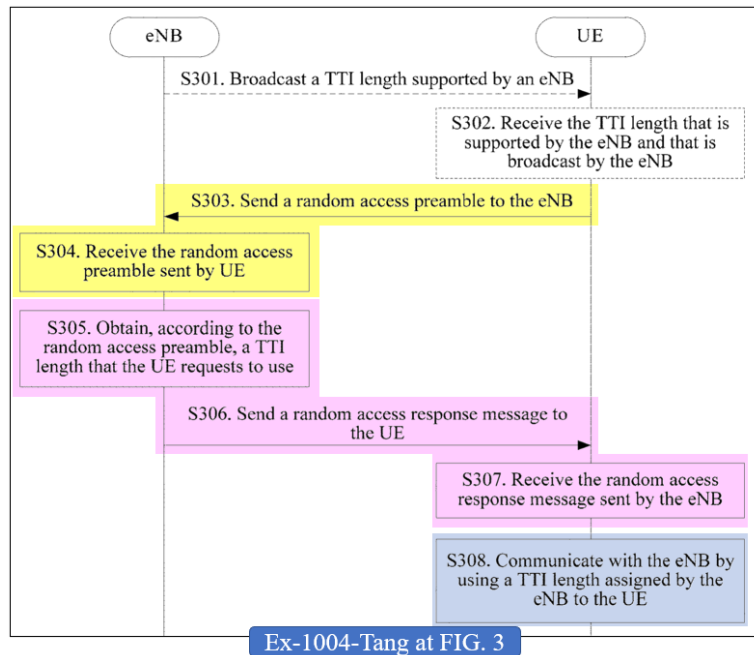


Figure 10 *The Random Access Procedure described in Tang (Ex-1004-Tang at FIG. 3 (highlighting counsel's); Ex-1020 at FIG. 3)*

100. Step 308 (S308 in FIG. 3) in Tang discloses that the UE uses a TTI length assigned by the eNB to transmit the Msg3 uplink transmission to the eNB. (See also Ex-1004-Tang at [0001]-[0006], [0012], [0228]-[0271]; Ex-1020 at 1:2-28, 2:10-24, 22:16-28:19.)
101. Tang does not expressly state whether the UE would use a feature called “TTI bundling” for this transmission. Tang’s silence on TTI bundling teaches and suggests that Tang did not use TTI bundling, because TTI bundling is more typically associated with low complexity UE or UEs requiring/using coverage enhancements. (See, e.g., Ex-1006-Tirronen at 10:14-25 (as discussed with respect to Ground 2).) For example, the

standard random access procedure described in Release 13 of the 3GPP standard for LTE expressly notes that “TTI bundling does not apply”:

“For transmission of Msg3 during Random Access (see subclause 5.1.5) TTI bundling does not apply. For BL UEs or UEs in enhanced coverage, uplink repetition bundling is used for transmission of Msg3” (Ex-1011-36.321 at page 30, §5.4.2.1; *see also* Ex-1019-36.321-v13.1.0 at page 32 §5.4.2.1 (disclosing the same); Ex-1001 at 2:46-61 (incorporating Ex-1019 by reference in its entirety).)

102. In other words, the default random access procedure for LTE UEs did not use TTI bundling, but some low complexity UEs or UEs requiring or using coverage enhancements could use TTI bundling if desired or required. One of ordinary skill in the art would infer from Tang’s silence on the use of TTI bundling that Tang’s Msg3 transmission was comprised of a single transport block rather than a bundle of redundant transmissions sent over two or more consecutive Transmission Time Intervals.
103. It was also obvious to implement Tang’s devices in view of Löhr’s teachings regarding TTI bundling. In particular, Löhr describes the

conventional contention based random access procedure used in standard LTE networks in FIG. 5:

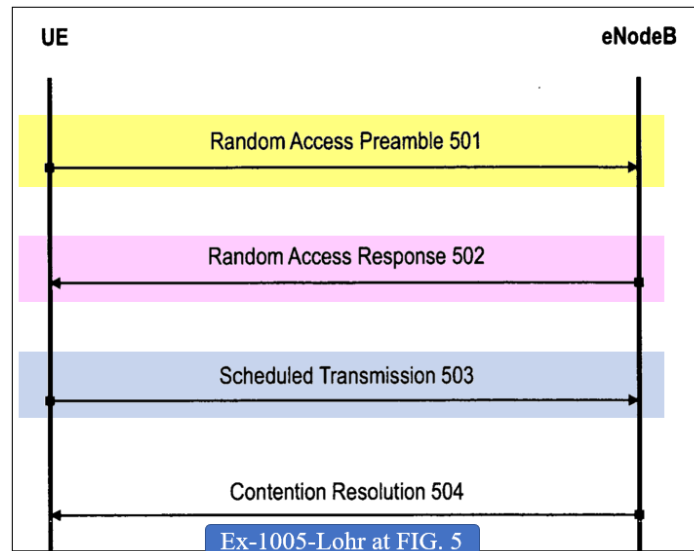


Figure 11 *The standard LTE contention based random access procedure described in Löhr (Ex-1005-Löhr at FIG. 5 (highlighting counsel's), [0041] (noting that a detailed description of LTE's random access process is found in 3GPP TS 36.321 v8.5.0 (Ex-1012)); see also [0041] (noting that "Scheduled Transmission 503" is typically called Msg3 in 3GPP TS 36.321).)*

104. Löhr also indicates that “the operation of a mobile terminal and a base station using an improved random access procedure as described herein will be described in further detail with respect to FIG.10 and FIG.11” (Ex-1005-Löhr at [0174].) In FIG. 10, in particular, Löhr facilitates a more flexible random access procedure by including a transmission mode indicator in Msg2 that instructs the UE whether its Msg3 transmission should use TTI bundling or not:

FIG. 10 shows a flow chart of the exemplary operation of a mobile terminal in a contention based random access procedure according to an embodiment of the invention. [T]he mobile terminal sends 1002 the selected random access preamble to the eNodeB to trigger a random access response message from the eNodeB which is received 1003 by the mobile terminal. The random access response message is containing inter alia a resource grant for the first scheduled uplink transmission of the mobile terminal as well as a transmission mode indicator...In this exemplary embodiment, the transmission mode indicator is a flag (one bit) that -when set (for example flag =1) – that the mobile terminal should send the scheduled uplink transmission using TTI bundling as described with respect to FIG. 12 previously herein. If the transmission mode indicator is not set (for example flag = 0), the mobile terminal is instructed to send the first scheduled transmission without TTI bundling, i.e. as a transmission in a single TTI. (Ex-1005-Löhr at [0175].)

105. Accordingly, when the first scheduled transmission (i.e., Msg3) is sent without TTI bundling, it is sent as a transmission as a single TB and that is sent within a single TTI.

106. The flow chart in FIG. 10 is shown below using the same highlighting scheme as used above relative to Tang:

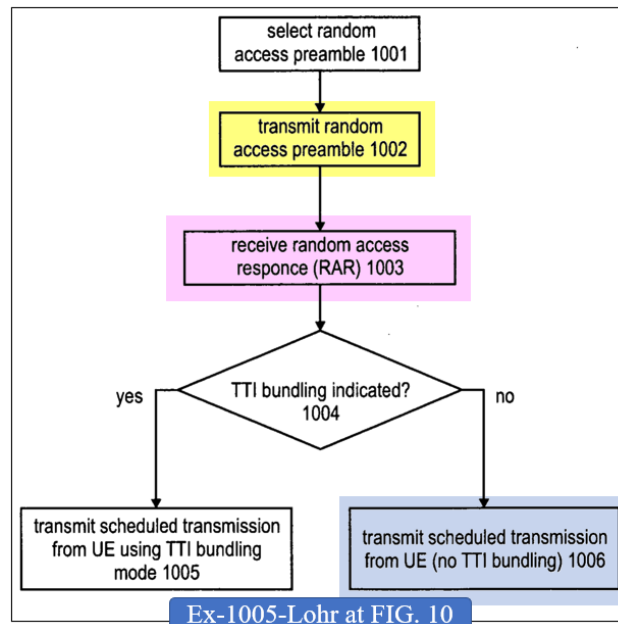


Figure 12 *The decision tree used to determine if TTI bundling should be used to transmit Msg3 from the UE, where TTI bundling is indicated through a transmission mode indicator flag (Ex-1005-Löhr at FIG. 10 (highlighting counsel's))*

107. As shown, Löhr discloses using a RAR/Msg2 transmission to indicate to the UE whether Msg3 should be transmitted with or without TTI bundling. (Ex-1005-Löhr at [0174]-[0175], FIG. 10, [0177]-[0178].)
108. One of ordinary skill in the art would have been motivated and found it obvious to include Löhr's TTI bundling indicator in Tang's RAR/Msg2 transmission. In particular, Löhr's transmission mode indicator offered desirable flexibility in a communications network. Indeed, the 3GPP standard disclosed that while TTI bundling was not used for general LTE random access, it could be used for low capability UEs (e.g. bandwidth limited or enhanced coverage UEs) as noted above.

109. Löhr also expressly discloses that TTI bundling was useful in some circumstances:

In the TTI bundling mode, the mobile terminal may for example send multiple redundancy versions of the same transport block within a number of consecutive transmission time intervals on the granted resources. As a ‘bundle’ of transmission is sent in consecutive transmission time intervals (TTIs), the combining gain achieved by combining the individual transmissions of the (redundancy versions of the) transport block in the decoding process allows to significantly increase the probability of successful decoding while further reducing the retransmission delay when utilizing HARQ for the scheduled transmission. (Ex-1005-Löhr at [0112].)

110. Although TTI bundling requires additional transmission efforts from the UE, in some circumstances bundling could increase the probability of successful decoding while reducing the need for HARQ retransmissions. (Ex-1005-Löhr at [0112].) One of ordinary skill in the art would have been familiar with the tradeoffs between bundling and non-bundling as they were well documented. For instance fewer HARQ processes may be required when using TTI bundling, at the expense of increased round trip transmission time (Ex-1005-Löhr at [0164]-[0165].) Moreover the fact that TTI bundling could be initiated with a transmission mode indicator flag made it very flexible. A UE could be instructed to use TTI bundling at the cell edge where successful decoding is less likely, and instructed to forgo TTI bundling at the center of a cell where successful decoding is more likely. (Ex-1005-Löhr at [0169].) Furthermore, UEs that were not capable of using TTI bundling would default to conventional 3GPP LTE random access even when the transmission mode indicator flag specified TTI bundling. (Ex-1005-Löhr at [0195].)

111. One of ordinary skill in the art would have expected to succeed in implementing Löhr's TTI bundling indicator. There were UEs that were already capable of utilizing TTI bundling in some circumstances, and it would have been trivial to include Löhr's simple indicator for instructing these UEs on which mode to use:

[T]he transmission mode indicator is a flag (one bit) that – when set (for example flag = 1) – that the mobile terminal should send the scheduled uplink transmission using TTI bundling as described with respect to FIG. 12 previously herein. If the transmission mode indicator is not set (for example flag = 0), the mobile terminal is instructed to send the first scheduled transmission without TTI bundling, i.e. as a transmission in a single TTI. (Ex-1005-Löhr at [0175].)

112. One of ordinary skill in the art would have been well versed in adding an indicator to an Uplink grant and applying that knowledge toward enabling an eNB to indicate to a UE which mode to use would have been easy. Enabling a transmission mode indicator flag in Tang would merely require updating the eNBs to send and the UEs to interpret a simple flag (e.g. 0 or 1), and would have resulted, predictably, in the UE sending a single Msg3 transport block when bundling was not indicated and sending a bundled Msg3 when bundling was indicated.
113. One of ordinary skill in the art would have understood that while Tang's UE did not normally use TTI bundling for random access communication, they would have been motivated to, and found it obvious to, modify Tang in view of Löhr so that Tang would include the ability to transmit either non-bundled or bundled Msg 3 transmissions during random access.

1. [1.0] A method of a UE (User Equipment) for performing random access procedure, comprising:

114. Tang discloses a random access procedure conducted by a UE. In Tang, the user equipment (UE) transmits a random access preamble containing a TTI length (Msg1) and the eNB issues a response to this preamble including the TTI length in the form of a random access response (RAR) message (Msg2). The UE then uses the TTI length assigned in the RAR to communicate with eNB (Msg3). (Ex-1004-Tang at [0026], [0244]-[0271], FIG. 3; Ex-1020 at 3:19-23, 24:29-28:19, FIG. 3.)

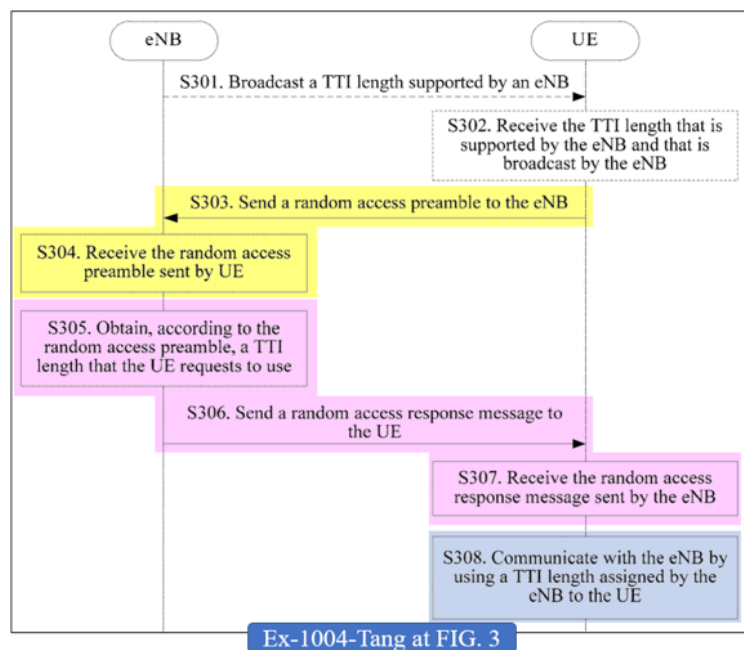


Figure 13 *Configuring TTI using a random access procedure performed by a UE (Ex-1004-Tang at FIG. 3 (highlighting counsel's); see id.at [0244]-[0271]; Ex-1020 at 24:29-28:19.)*

2. [1.1] the UE transmits a preamble to a network;

115. Tang discloses a UE transmitting a preamble to a network. FIG. 3 of Tang at S303. (shown highlighted in yellow above) shows the UE transmitting a random access preamble to the eNB. (Ex-1004-Tang at FIG. 3; Ex-1020 at FIG. 3.) Tang provides the following description of this step:

S303. The UE sends a random access preamble to the eNB, where the random access preamble indicates a TTI length that the UE requests to use. (Ex-1004-Tang at [0248]; Ex-1020 at 25:5-6.)

116. One of ordinary skill in the art would certainly have understood that an eNB is also known as an evolved NodeB (eNodeB). Further, one of ordinary skill in the art would have understood that the eNB (evolved NodeB, eNodeB) is a type of base station used in Long-Term Evolution (LTE) cellular networks, thereby indicating that the UE transmits a preamble to the network.⁵

⁵ https://www.3gpp.org/images/PDF/lte_advanced_SAI_paper.pdf

3. [1.2] the UE receives a Msg2 containing a TTI (Transmission Timer Interval) information of a Msg3, associated with uplink, from the network in response to the preamble,

117. Tang discloses a UE receiving a Msg2 containing TTI information associated with the uplink for Msg3 from the network in response to the preamble. FIG.3 in Tang shows a UE receiving a random access response (RAR) (Msg2) containing information (including a TTI length) to be used in communicating with the eNB (Msg3). (Ex-1004-Tang at FIG. 3; Ex-1020 at FIG. 3.) Tang describes this process in the detailed description of FIG. 3:

S305. The eNB obtains, according to the random access preamble, the TTI length that the UE requests to use. For a specific method in which the eNB performs mapping according to the random access preamble to obtain the UE requests to use, refer to step S303 S306. The eNB sends a random access response message (RAR) to the UE, where the random access response message includes TTI indication information.... (Ex-1004-Tang at [0253]-[0255]; Ex-1020 at 26:6-14.)

S307. The UE receives the random access response message sent by the eNB.... (Ex-1004-Tang at [0270]; Ex-1020 at 28:11-17.)

S308. The UE begins to communicate with the eNB at an effective moment and/or start symbol location by using the TTI length assigned by the eNB to the UE. (Ex-1004-Tang at [0271]; Ex-1020 at 28:18-19.)

118. One of ordinary skill in the art would have understood that in the random access procedure Msg2 relates to the eNB sending the UE a RAR, and Msg3 relates to the UE communicating with the eNB according to the RAR. One of ordinary skill in the art would have understood the TTI information associated with the RAR (Msg2) would be used to prescribe the timing of the uplink transmission of Msg3.

Tang discloses a UE receiving a Msg2 containing TTI information associated with the uplink for Msg3 from the network in response to the preamble.

4. [1.2.1] wherein the TTI information, contained in Msg2, of the Msg3, associated with uplink, includes a TTI duration of the Msg3, associated with uplink, and

119. Tang discloses that Msg2 contains TTI information associated with the uplink transmission of Msg3, in particular the TTI duration for Msg3. This allows Tang to use shorter TTIs in some instances, in order to reduce round trip and transmission delays, among other benefits. (*See* Ex-1004-Tang at [0004]-[0005]; Ex-1020 at 1:9-24.)
120. Tang describes the UE receiving the random access response (Msg2) which contains TTI information including TTI length:

S307. The UE receives the random access response message sent by the eNB, where the random access response message includes the TTI indication information, and the TTI indication information includes at least one of the following information: a TTI length assigned by the eNB to the UE.... (Ex-1004-Tang at [0270]; Ex-1020 at 28:11-17; *see also* Ex-1004-Tang at [0258]; Ex-1020 at 26:27-32.)

121. Tang further describes the UE using the TTI length from the RAR (Msg2) to prescribe the duration of the uplink transmission of Msg3:

To be compatible with a TTI of 1 ms and a short TTI, in the embodiments of the present disclosure, indications are performed by using different TTI lengths. A symbol number may be used as a unit of a TTI length. For example, a TTI of 1 ms is divided into two slots, each slot includes seven symbols (ordinary cyclic prefix) or six symbols (extended cyclic prefix). Therefore, a TTI length of the TTI of 1 ms has a symbol number of 12 or 14, and correspondingly, a TTI length of a short TTI may have a symbol number of two, seven, or the like. A time length may also be used as a unit of a TTI length. For example, the TTI length of the TTI of 1 ms may be 1 ms, and the TTI length of the short TTI may be 0.1 ms, 0.5 ms, or the like. (Ex-1004-Tang at [0228]; Ex-1020 at 22:16-24.)

In a system supporting different TTI lengths, a related indication needs to be added to the random access response message, and the related indication may include, but is not limited to, TTI enabling information, a TTI length, and subframe start location information, where the subframe start location information includes a start subframe number and a symbol index in a subframe. For example, the TTI enabling information occupies 1 bit, the TTI length occupies 3 bits (for example, there are eight TTI lengths, and optionally, values 1 to 7 respectively correspond to TTIs of lengths of one to seven symbols), and the subframe start location information occupies 4 bits (optionally, used to indicate a start symbol location at which the UE begins to perform data transmission by using an assigned TTI length). Therefore, compared with a random access response message of a TTI of 1 ms in the prior art, there is totally one more byte. (Ex-1004-Tang at [0258]-[0259]; Ex-1020 at 26:27-27:3.)

S308. The UE begins to communicate with the eNB at an effective moment and/or a start symbol location by using the TTI length assigned by the eNB to the UE. (Ex-1004-Tang at [0271]; Ex-1020 at 28:18-19.)

122. Tang describes what a TTI length is in:

To be compatible with a TTI of 1 ms and a short TTI, in the embodiments of the present disclosure, indications are performed by using different TTI lengths. A symbol number may be used as a unit of a TTI length. For example, a TTI of 1 ms is divided into two slots, each slot includes seven symbols (ordinary cyclic prefix) or six symbols (extended cyclic prefix). Therefore, a TTI length of the TTI of 1 ms has a symbol number of 12 or 14, and correspondingly, a TTI length of a short TTI may have a symbol number of two, seven, or the like. A time length may also be used as a unit of a TTI length. For example, the TTI length of the TTI of 1 ms may be 1 ms, and the TTI length of the short TTI may be 0.1 ms, 0.5 ms, or the like. (Ex-1004-Tang at [0228]; Ex-1020 at 22:16-24; *see also* Ex-1004-Tang at [0012], [0228], [0239]-[0242], [0252]-[0255]; Ex-1020 at 2:10-24, 22:16-24, 23:30-24:27, 26:5-14.)

123. Tang also establishes that TTI length is not distinct to his invention, as the background section explains:

In a conventional Long Term Evolution (LTE) communication protocol, a transmission time interval (TTI) is a basic time unit in time domain of LTE radio resources, and has a standard time length that is 1 ms (briefly referred to as a TTI of 1 ms below). (Ex-1004-Tang at [0003]-[0005]; Ex-1020 at 1:6-24.)

124. One of ordinary skill in the art would understand that a TTI length can be measured in time (i.e. a length of time) and therefore is synonymous with a TTI duration. As such, Tang discloses that Msg2 contains TTI duration associated with the uplink transmission of Msg3.

5. [1.2.2] [wherein the TTI information, contained in Msg2, of the Msg3, associated with uplink, includes...] a start timing offset of the Msg3, associated with uplink; and

125. Tang discloses that Msg2 contains TTI information associated with the uplink transmission of Msg3, in particular the start timing offset for Msg3.
126. Tang describes the UE receiving the random access response (Msg2) which contains TTI information including starting subframe/symbol location:

In a system supporting different TTI lengths, a related indication needs to be added to the random access response message, and the related indication may include, but is not limited to, TTI enabling information, a TTI length, and subframe start location information, where the subframe start location information includes a start subframe number and a symbol index in a subframe. ... the subframe start location information occupies 4 bits (optionally, used to indicate a start symbol location at which the UE begins to perform data transmission by using an assigned TTI length). (Ex-1004-Tang at [0258]-[0259]; Ex-1020 at 26:27-27:3.)

S307. The UE receives the random access response message sent by the eNB, where the random access response message includes the TTI indication information, and the TTI indication information includes at least one of the following information: a TTI length assigned by the eNB to the UE, effective moment information, start symbol location information, and enabling confirm information of the TTI length, where the subframe start location information includes a start subframe number and a symbol index in a subframe. (Ex-1004-Tang at [0270]; Ex-1020 at 28:11-17.)

127. Tang also describes a UE using the start symbol location from the RAR (Msg2) to prescribe when to start the uplink transmission of Msg3:

S308. The UE begins to communicate with the eNB at an effective moment and/or a start symbol location by using the TTI length assigned by the eNB to the UE. (Ex-1004-Tang at [0271]; Ex-1020 at 28:18-19.)

128. The patentee, in its January 7, 2020 Office Action for a European patent application (EP17183827.9) related to the '052 patent defined a start timing offset as:

the 'start timing offset' of the invention is used for the UE to know at which time unit (e.g. slot, symbol, etc.) the Msg3 should be started to send. (Ex-1008-EPFH at 172.)

129. One of ordinary skill in the art would appreciate that the start symbol location described in Tang was designed to indicate to the UE which symbol it should use to start sending Msg3. One of ordinary skill in the art would also recognize that the start symbol/subframe location in Tang had the same meaning as the 'start timing offset' in the '052 patent. Tang discloses Msg2 containing a start timing offset associated with the uplink transmission of Msg3.

6. [1.3] the UE performs a single TB (Transport Block) of Msg3 transmission to the network according to the TTI information of the Msg 3

130. Tang alone discloses a UE transmitting a single TB (Transport Block) of Msg3 according to TTI information. Tang describes a UE receiving a random access response message (Msg2) with TTI information and using that TTI information to transmit a Msg3 to the network:

S307. The UE receives the random access response message sent by the eNB, where the random access response message includes the TTI indication information, and the TTI indication information includes at least one of the following information: a TTI length assigned by the eNB to the UE, effective moment information, start symbol location information, and enabling confirm information of the TTI length, where the subframe start location information includes a start subframe number and a symbol index in a subframe.

S308. The UE begins to communicate with the eNB at an effective moment and/or start symbol location by using the TTI length assigned by the eNB to the UE. (Ex-1004-Tang at [0270]-[0271]; Ex-1020 at 28:11-19.)

131. While Tang does not explicitly indicate that a single transport block of Msg3 is transmitted from the UE to the network, one of ordinary skill in the art would have inferred from the fact that at most one transport block can be transmitted over a radio interface during a transmission time interval (TTI) that Tang involved transmitting a single transport block of Msg3. Thus, Tang discloses a UE transmitting a single TB (Transport block) of Msg3 according to TTI information. Moreover, limiting the transmission of Msg3 according to TTI information to one transport block is not a novel concept introduced by the patentee in

limitation 1.3, rather it is a long established element of the LTE standard.

132. Tang is also silent on and does not indicate that TTI bundling should be used. According to the 3rd Generation Partnership Project (3GPP) Evolved Universal Terrestrial Radio Access (E-UTRA) Medium Access Control (MAC) protocol specification for LTE advanced, TTI bundling is rarely used in contention based random access, rather it is reserved primarily for use with less capable UEs:

For transmission of Msg3 during Random Access (see subclause 5.1.5) TTI bundling does not apply. For NB-IoT, BL UEs or UEs in enhanced coverage, uplink repetition bundling is used for transmission of Msg3. (Ex-1011-36.321 at §5.4.2.1, page 32.)

133. One of ordinary skill in the art would infer from the fact that TTI bundling is largely reserved for less capable UEs, that more capable UEs, like conventional smartphones do not use TTI bundling, or the uplink repetition associated with it and thus transmit only a single transport block (TB) as claimed. One of ordinary skill in the art would understand that Tang's step S308, where a UE transmits a scheduled Msg3 transmission according to a designated start symbol location and TTI length assigned by the eNB, would normally not include TTI bundling. Therefore Tang discloses a UE transmitting a single TB (Transport block) of Msg3 according to TTI information.
134. Tang in view of Löhr discloses a UE transmitting a single TB (Transport block) of Msg3 according to TTI information. As explained in Petitioner's discussion of the patent prosecution of the '052 patent, the "single (TB) transport block" aspect of limitation 1.3 was added during prosecution to allegedly distinguish over the prior art that

involved TTI bundling. (Ex-1002-052FH at 149-54.) The patent examiner was not persuaded by this amendment, and in the first office action response addressing this amendment to the claim language, the examiner relied on Löhr (specifically, Löhr at FIGs.7-15 and related paragraphs). Despite the applicant incorrectly stating that Löhr was directed solely toward TTI bundling (Ex-1002-052FH at 201), the patent examiner maintained that Löhr disclosed transmitting a single TB transport block of Msg3 throughout the prosecution and in the Notice of Allowance for the '052 patent. (Ex-1002-052FH at 532-534.)

135. In fact, the Notice of Allowance stated:

Löhr discloses (FIGs. 7-15) [sic] perform a single (TB) transport block of Msg transmission to the network according to the TTI information of the Msg [0164, 0120, 0183, 0187]. (Ex-1002-052FH at 533.)⁶

136. The examiner was correct to assert and maintain that Löhr discloses the “single TB” limitation. Löhr describes a UE using TTI information and

⁶ Notably, the examiner granted the case after stating “all cited prior arts of record fail to disclose in claims 1, [sic] and 8 the rationale and reasoning stated in Applicant’s Arguments/Remarks filed on 08/04/2020 and 11/03/2021.” (Ex-1002-052FH at 533.) Neither of the filed remarks addresses Löhr or the “single (TB) transport block” limitation.

a transmission mode indicator to 1. Determine transmission mode (TTI bundling or without TTI bundling) 2. Transmit a Msg3 to the network:

[I]n another embodiment of the invention, the random access procedure further comprises transmitting a scheduled uplink transmission from the mobile station to the base station (i.e. Msg3) according to the transmission mode indicated in the random access response message. In this exemplary embodiment, the transmission mode may be for example a TTI bundling mode. The mobile terminal is therefore transmitting different redundancy versions of the same transport block within a number of consecutive transmission time intervals on the resources granted in the random access response message. (Ex-1005-Löhr at [0119]-[0120].)

137. Löhr describes multiple different redundancy versions of the same transport block being used to consecutively transmit Msg3 from the UE to the eNB according to TTI bundling. However, if the transmission mode is not set (i.e. it is indicating transmission without bundling), then the UE transmits a single transport block of Msg3 according to TTI information.

If the transmission mode indicator is not set, the mobile terminal transmits 1006 transmits the first transmission as scheduled by the grant within the random access without TTI bundling. Accordingly, the mobile terminal builds a transport block and is coding same to obtain one or more redundancy versions of the transport block. Subsequently, the mobile terminal transmits one (advantageously self-decodable) redundancy version of the transport block within the transmission time interval as allocated by the grant within the random access response message. (Ex-1005-Löhr at [0178]; *see id.* at [0175]-[0177].)

138. One of ordinary skill in the art would have understood that transmitting one transport block redundancy version is equivalent to transmitting a single transport block. Therefore, without TTI bundling, Löhr discloses

a UE transmitting a single TB (Transport Block) of Msg3 according to TTI information to the eNB (i.e. limitation 1.3). As mentioned above, one of ordinary skill in the art would have found it obvious to combine Tang with Löhr as Tang could benefit from incorporating optional TTI bundling and the use of a simple indicator to tell the UE whether to use TTI bundling or not.

139. Thus, Tang in view of Löhr discloses this limitation and thereby renders obvious claim 1.

7. [Claim 5] The method of claim 1, wherein the TTI information of the Msg3 is included in a RAR (Random Access Response) for responding [sic] the preamble.⁷

140. Tang in view of Löhr disclose this limitation for the reasons described above relative to limitation 1.2. Specifically, Tang discloses that the eNB responds to the UE's preamble (Msg1) with a RAR message (Msg2) that includes TTI information. (Ex-1004-Tang at FIG. 3 & [0255]-[0270]; Ex-1020 at 26:10-28:19.)

141. Indeed this was conventional in LTE's random access procedure. (Ex-1005-Löhr at FIG. 5, [0041].)

142. Thus, Tang in view of Löhr renders obvious claim 5.

⁷ I assume for the purposes of this Declaration only that this claim should read "...for responding to the preamble."

8. [Claim 7] The method of claim 1, wherein the Msg2 is a random access response.

143. Tang in view of Löhr disclose this limitation for the reasons described above relative to limitation 1.2. Specifically, Tang discloses that the eNB responds to the UE's preamble (Msg1) with a RAR message (Msg2) that includes TTI information. (Ex-1004-Tang at FIG. 3 & [0255]-[0270]; Ex-1020 at 26:10-28:19.)

144. This was conventional in LTE. (Ex-1005-Löhr at FIG. 5, [0041].)

145. Thus, Tang in view of Löhr renders obvious claim 7.

9. [8.0] A UE (User Equipment), comprising:

146. Tang discloses a UE (User Equipment). In Tang, User Equipment is described as follows:

[T]he user equipment may be configured to communicate with (for example, be in D2D communication with) one or more user equipments, or may be configured to communicate with one or more base stations. User equipment may further be referred to as a user terminal, and may include some or all of the functions of a system, a user unit, a user station, a mobile station, a mobile wireless terminal, a mobile device, a node, a device, a remote station, a remote terminal, a terminal, a wireless communication device, a wireless communication apparatus, or a user agent. The user equipment may be a cellular phone, a cordless telephone set, a session initiation protocol (SIP) phone, a smartphone, a wireless local loop (WLL) station, a personal digital assistant (PDA), a laptop computer, a handheld communications device, a handheld computing device, a satellite radio device, a wireless modem card and/or another processing device configured to communicate on a wireless system. (Ex-1004-Tang at [0221]; Ex-1020 at 20:26-21:17; *see also* Ex-1004-Tang at FIG. 18, [0417]-[0421]; Ex-1020 at FIG. 18, 47:7-48:1.)

147. The UE in Tang is used in conjunction with a random access procedure as demonstrated in FIG. 3:

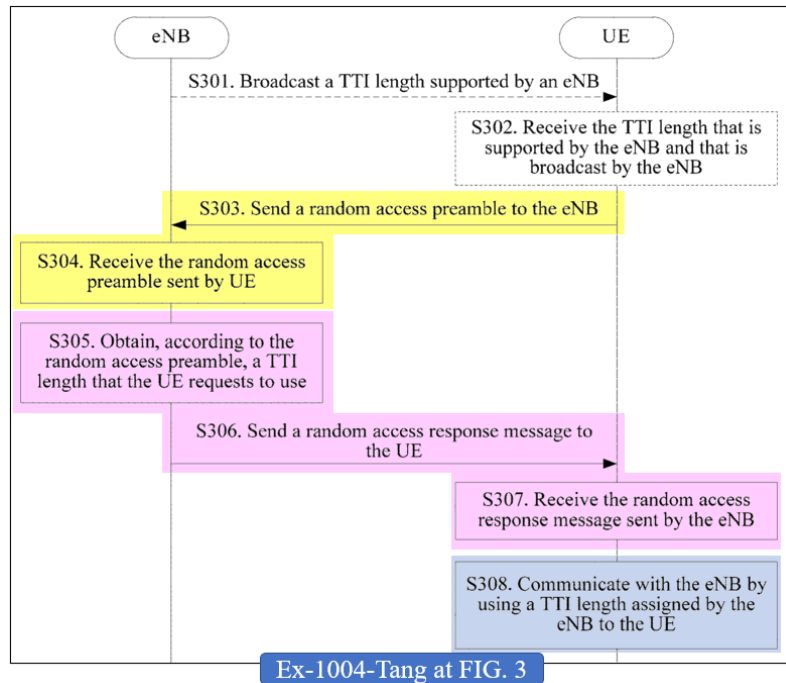


Figure 14 *Random Access Procedure (Ex-1004-Tang at FIG. 3 (highlighting counsel's); [0244]-[0271]; Ex-1020 at 24:29-28:19.)*

148. As shown, Tang discloses a UE (User Equipment).

10.[8.0.1] a control circuit;

149. Tang discloses a control circuit. In FIG. 18 and its description, Tang discusses the components of a UE and how they are arranged to perform the TTI configuration method.

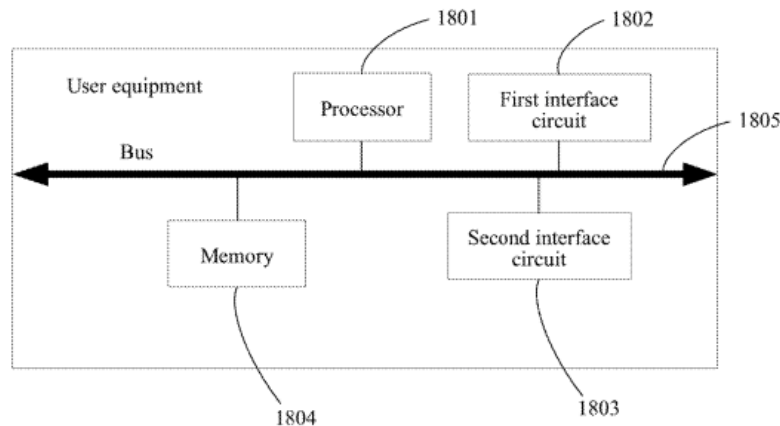


Figure 15 *The components of the User Equipment (UE) and how they are arranged to perform the TTI configuration method, of particular interest here is the bus (Ex-1004-Tang at FIG. 18; Ex-1020 at FIG. 18.)*

150. Tang describes the bus in FIG. 18 as:

The bus 1805 may be an industry standard architecture (ISA) bus, a peripheral component interconnect (PCI) bus, an extended industry standard architecture (EISA) bus, or the like. The bus 1805 may be classified into an address bus, a data bus, a control bus, and the like. For convenience of representation, only one bold line is configured for representation in FIG. 18, but it does not indicate that there is only one bus or one type of bus. (Ex-1004-Tang at [0420]; Ex-1020 at 47:26-31.)

151. One of ordinary skill in the art would understand that the user equipment contained a control bus. One of ordinary skill in the art would have also understood that the control bus enables the processor to conduct bi-directional communication with other components,

transferring control signals to coordinate and regulate their actions.⁸ One of ordinary skill in the art would have understood that a circuit, used in its ordinary definition, refers to a two-way communication path between components in a computer.⁹ One of ordinary skill in the art would have understood that a control bus discloses a control circuit, in that both provide a bi-directional path for control communications between the components of a UE. Tang discloses a control circuit.

11.[8.0.2] a processor installed in the control circuit; and

152. Tang discloses a processor. Tang shows the processor in FIG. 18.

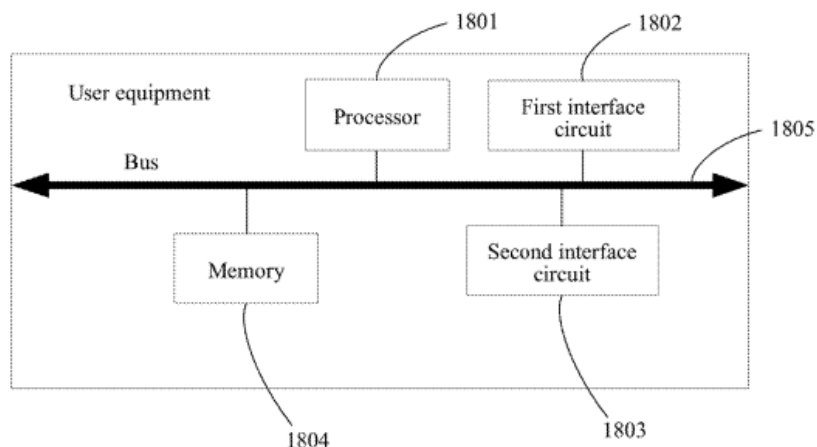


Figure 16 *The components of the User Equipment (UE) and how they are arranged to perform the TTI configuration method, of particular interest here is the processor (Ex-1004-Tang at FIG. 18; Ex-1020 at FIG. 18.)*

⁸ <https://nordvpn.com/cybersecurity/glossary/control-bus/>

⁹ <https://www.merriam-webster.com/dictionary/circuit> (definition 4c).

153. Tang describes the processor as being connected by the bus as follows:

The processor 1801, the first interface circuit 1802, a second interface circuit 1803, and the memory 1804, are connected by using the bus 1805 and communicate with each other. It should be noticed that the processor 1801 herein may be one processor, or may be a general term of a plurality of processing elements. For example, the processor may be a central processing unit (CPU), may be an application specific integrated circuit (ASIC), or may be one or more integrated circuits configured to implement this embodiment of the present disclosure, for example one or more microprocessors (DSP), or one or more field programmable gate arrays (FPGA). (Ex-1004-Tang at [0418]-[0419]; Ex-1020 at 47:13-25.)

154. One of ordinary skill in the art would have understood that a processor connected to other components of the UE system via a “control” bus discloses a processor installed in the control circuit. One of ordinary skill in the art would have understood that the control bus enables the processor to conduct bi-directional communication with other components, transferring control signals to coordinate and regulate their actions.¹⁰ One of ordinary skill in the art would have understood that a circuit, used in its ordinary definition, refers to a two-way communication path between components in a computer.¹¹ Tang discloses the processor installed in the control circuit.

¹⁰ <https://nordvpn.com/cybersecurity/glossary/control-bus/#:~:text=The%20control%20bus%20manages%20the,and%20at%20the%20right%20time.>

¹¹ <https://www.merriam-webster.com/dictionary/circuit> (definition 4c).

12.[8.0.3] a memory installed in the control circuit and operatively coupled to the processor

155. Tang discloses a memory installed in the control circuit and operatively coupled to the processor. Tang shows the memory on the control bus coupled to the processor:

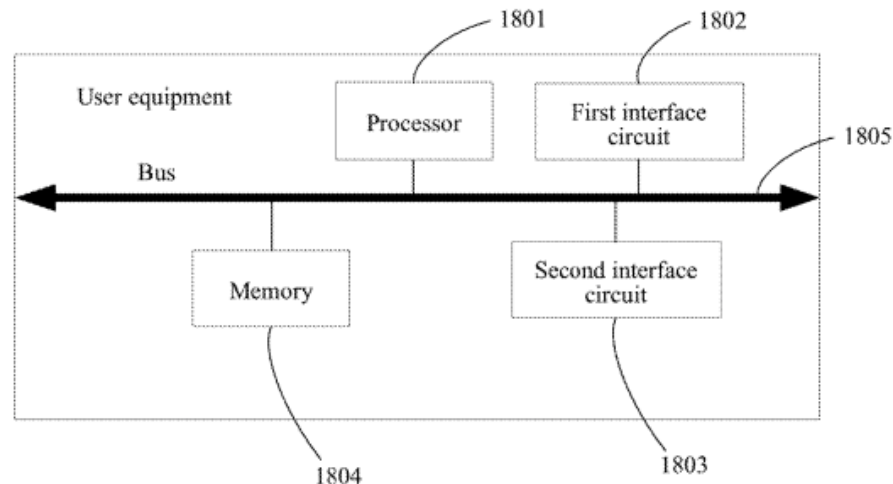


Figure 17 *The components of the User Equipment (UE) and how they are arranged to perform the TTI configuration method, of particular interest here is the memory (Ex-1004-Tang at FIG. 18; Ex-1020 at FIG. 18.)*

156. Tang describes the memory as:

The memory 1804 may be one storage apparatus, or may be a general term of a plurality of storage elements, and is configured to store executable program code or parameters, data, and the like required for running of an access network management device. Moreover, the memory 1804 may include a random access memory (RAM), and may also include a non-volatile memory (NVRAM) such as a magnetic disk storage or a flash memory. (Ex-1004-Tang at [0419]; Ex-1020 at 47:20-25.)

157. Tang also describes that the memory is installed on the control circuit and operatively coupled to the processor:

The processor 1801, the first interface circuit 1802, the second interface circuit 1803, and the memory 1804 are connected by using the bus 1805 and communicate with each other.” (Ex-1004-Tang at [0417]; Ex-1020 at 47:7-12.)

158. As described in Tang, the memory is communicatively coupled to the processor via the control bus. One of ordinary skill in the art would have understood that a memory connected to a processor via a “control” bus discloses a memory installed on the control circuit. One of ordinary skill in the art would have understood that the control bus enables the memory to conduct bi-directional communication with the processor, transferring control signals to coordinate and regulate their actions.¹² One of ordinary skill in the art would have understood that a circuit, used in its ordinary definition, refers to a two-way communication path between components in a computer.¹³ One of ordinary skill in the art would have understood that a control bus is synonymous with a control circuit, in that both provide a bi-directional path for control communications between the components of a UE. One of ordinary skill in the art would have understood that the memory was operatively coupled (via bi-directional path for control communications or the control circuit) to the processor. Tang discloses a memory installed on the control circuit and operatively coupled to the processor.

¹² <https://nordvpn.com/cybersecurity/glossary/control-bus/>

¹³ <https://www.merriam-webster.com/dictionary/circuit> (definition 4c).

13.[8.0.4] wherein the processor is configured to execute a program code stored in the memory to:

159. Tang discloses a processor that is configured to execute a program code stored in the memory. Tang describes a processor that is configured to execute a program saved in the memory:

The processor 1801 is configured to execute a program in the memory, so as to perform the method provided in the foregoing method embodiment with reference to the first interface circuit 1802 and the second interface circuit 1803.

Specifically, the processor 1801 is configured to execute a program in the memory to perform a function of the processing unit of the eNB in the foregoing embodiment. (Ex-1004-Tang at [0421]-[0422]; Ex-1020 at 47:32-48:3.)

160. One of ordinary skill in the art would have understood that the words “program code” and “program” can be and often are used interchangeably. As shown in these excerpts from Tang, Tang discloses the processor configured to execute a program stored in memory.

14.[8.1] transmit a preamble to a network

161. Tang in view of Löhr renders obvious limitation 8.1 for the reasons provided above regarding claim 1.1.

15.[8.2] receive a Msg2 containing a TTI (Transmission Time Interval) information of a Msg3, associated with uplink, from the network in response to the preamble, wherein the TTI information, contained in Msg2, of the Msg3, associated with uplink includes

16.[8.2.1] a TTI duration of the Msg3, associated with the uplink, and

**17.[8.2.2] a start timing offset of the Msg3, associated with the uplink;
and**

162. Tang in view of Löhr renders obvious limitations 8.2, 8.2.1, and 8.2.2 for the reasons provided above regarding limitations 1.2, 1.2.1, and 1.2.2.

18.[8.3] perform a single TB (Transport Block) of Msg3 transmission to the network according to the TTI information of the Msg3.

163. Tang in view of Löhr renders obvious limitation 8.3 for the reasons provided above regarding limitation 1.3.

164. Thus, Tang in view of Löhr renders obvious claim 8.

19.[Claim 12] The UE of claim 8, wherein the TTI information of the Msg3 is included in a RAR (Random Access Response) for responding to the preamble.

165. Tang in view of Löhr renders obvious claim 12 for the reasons provided above regarding claim 5.

20.[Claim 14] The UE of claim 8, wherein the Msg2 is a random access response.

166. Tang in view of Löhr renders obvious claim 14 for the reasons provided above regarding claim 7.

XI. GROUND 2: TIRRONEN

A. Scope and content of the prior art

167. Ground 2 relies on Tirronen. Tirronen claims priority to a provisional patent application as discussed above. I provide dual citations to Tirronen (Ex-1006) and to the corresponding disclosures in the provisional (Ex-1007).

168. Tirronen explains that Msg2 contains a time domain configuration of the Uplink grant for Msg3 uplink communication. Tirronen further explains that this time domain configuration may include TTI information for Msg3 uplink communication. According to Tirronen, this TTI information for Msg3 uplink communication may contain a TTI field:

The time domain configuration may further include a transmission time interval (TTI) field for Message 3 transmission on the uplink. The TTI field contains information about the number of UL subframes that a set of code bits of a TB is mapped to. In one alternative (as in legacy LTE system) a TTI is one subframe, i.e. 1 millisecond. In another alternative (as in narrowband IOT system), a TTI (i.e., an extended TTI) is composed of multiple subframes. A typical value in an extended TTI may be composed of six subframes. If only two possible TTIs are defined in the system, then the TTI field can be 1 bit, for example, TTI field-0 indicates TTI of one subframe, TTI field-1 indicates TTI of six subframes. In general, if Q possible TTIs are defined in the system, then the TTI field is composed of $\text{ceil}(\log_2(Q))$ bits. (Ex-1006-Tirronen at 11:20-34; Ex-1007 at pg. 5.)

169. The TTI field contains information on how many UL subframes will be used to transmit a set of Msg3 code bits (TTI information) on a transport block. If a legacy LTE UE is in use, the one bit TTI field is set to 0 and

1 subframe will be used to transmit the set of Msg3 code bits (TTI information) on a transport block. In the instance a NB IoT UE is in use, extended TTI is required, as its Msg3 code bits (TTI information) consists of multiple subframes. If a NB IoT UE is in use, the one bit TTI field will be set to 1 indicating multiple subframes will be used to transmit the set of Msg3 code bits (TTI information) on a transport block. One of ordinary skill in the art would have understood that Tirronen transmits Msg3 with or without extension (i.e., TTI or extended TTI) in much the same way as Löhr (discussed in detail above relative to Ground 1) provides for the possibility of Msg3 transmission with or without TTI bundling. In the same way as Löhr's indicator, it was obvious and one of ordinary skill in the art would have understood that the TTI field used in Tirronen indicates whether TTI is extended (bundled) or not. When not using a TTI extension (i.e. TTI field = 0, as in a legacy LTE system), the Msg3 transmission occupies one subframe on a transport block (i.e. 1 millisecond).

B. Challenged Claims

1. [1.0] A method of a UE (User Equipment) for performing random access procedure, comprising:

170. Tirronen discloses the method of a UE (User Equipment) for performing random access procedure. First Tirronen establishes the use of a UE (User Equipment):

As used herein, a legacy or non-legacy wireless terminal (also referred to as a UE, user equipment node, mobile terminal, etc.) can include any device that receives data from and/or transmits data to a communication network, and may include, but is not limited to, a mobile telephone (“cellular” telephone), laptop/portable computer, pocket computer, hand-held computer, and/or desktop computer. (Ex-1006-Tirronen at 7:35-42; Ex-1007 at 1:29-34.)

171. Some of the disclosures in Tirronen are offered in the context of a particular type of UE, specifically MTC UEs. For instance:

In examples discussed below, base station BS-a may provide wireless communications for wireless terminals UE-a, UE-b, and UE-g, wireless terminals UE-a and UE-g may be [an] MTC wireless terminals, and wireless terminal UE-b may be a conventional wireless terminal. Accordingly, random access procedures for wireless terminals UE-a and UE-g may be different than random access procedures for wireless terminal UE-b. (Ex-1006-Tirronen at 9:55-62; Ex-1007 at 4:10-14.)

172. This has implications as low complexity UEs and UEs requiring coverage enhancements require changes to the random access

procedure (such as the inclusion of extended TTI discussed below in limitation 1.2.1):

In 3GPP Rel-13 for MTC (Machine-Type Communications) wireless devices UEs, random access procedures may be specified for low complexity wireless terminals UEs and wireless terminals UEs requiring/using coverage enhancements (e.g. in situations where the UEs are in deep coverage in basements, etc.). Different methods may be used to obtain coverage enhancements, where an effect on current LTE procedures may come from time repetitions of various channels. Stated in other words, the data included in one TTI (Transmission Time Interval) may be repeated in time so the recipient(s) can accumulate energy over longer time periods to enhance the coverage of the transmission. (Ex-1006-Tirronen at 10:14-25; Ex-1007 at 4:28-35.)

173. The claims of the '052 patent are agnostic about the type of UE used, and the '052 patent expressly applies to MTC UEs:

One of the general objectives of the present application is to study the frame structure user in New RAT (NR) for 5G, to accommodate various type of requirement (discussed in 3GPP TR 38.913) for time and frequency resource, e.g., from ultra-low latency (~0.5 ms) to expected longer TTI (Transmission Time Interval) for MTC (Machine Type Communication), from high peak rate for eMBB (enhanced Mobile Broadband) to very low data rate for MTC. An important focus is low latency aspect, while other aspect of mixing/adapting different TTIs can also be considered in the study. (Ex-1001 at 5:13-20.)

In LTE, there could be three different random access configurations in LTE system. The first configuration is generally for normal UEs with enough RF/Baseband capability to monitor whole system bandwidth (e.g. cell phones, high-end MTC devices). The second configuration is generally for low-end MTC devices and normal UEs with enough RF/Baseband capability but worked in power limited condition. The third configuration is generally for NB-IoT (Narrow-Band Internet of Things) UE which pool RF/Baseband capability and can only perform transmission/reception on a narrow band (e.g. 1.4MHz). The last configuration is generally defined as a new RAT (Radio Access Technology). Normally, low-end MTC devices will only worked on the second configuration, and NB-IoT devices will work only on the third configuration. For a normal UE with enough RF/Baseband capability, the UE will only change RA configuration when it enters the power limited state (e.g., cell edge or even far away). (Ex-1001 at 8:58-9:8.)

174. Since the '052 patent is agnostic to the type of UE, the fact that some of Tirronen's embodiments are described in the context of a particular type of UE does not distinguish Tirronen from the claims of the '052 patent.

175. Tirronen also establishes that the UE performs a random access procedure as illustrated in FIG. 4 of Tirronen:

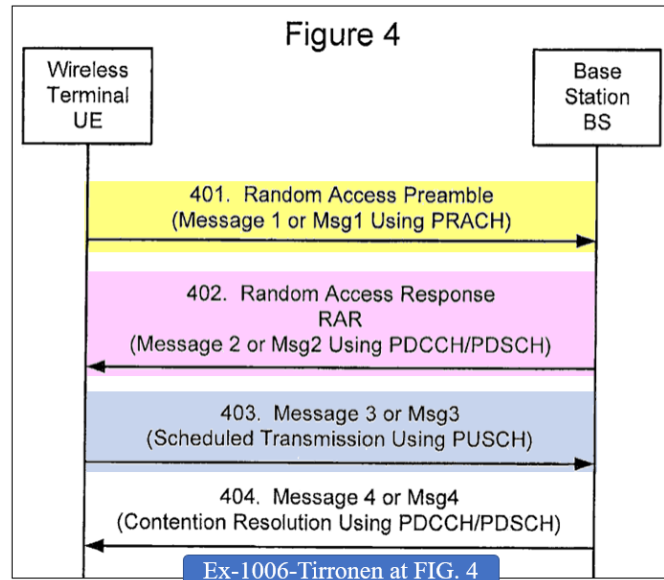


Figure 18 *Random Access Procedure disclosed in Tirronen as FIG. 4 (Ex-1006-Tirronen at FIG. 4; Ex-1007 at FIG. 4)*

176. Tirronen discusses a wireless terminal (UE) performing a random access procedure with a node (base station) of a random access network:

A method of operating a wireless terminal may include transmitting a random access preamble of a random access procedure from the wireless terminal to a node of a radio access network. (Ex-1006-Tirronen at Abstract; Ex-1007 at 11:11-21.)

177. One of ordinary skill in the art would appreciate that a wireless terminal is equivalent to user equipment (UE). One of ordinary skill in the art would also understand that a base station or eNB is a node of a radio access network. Tirronen discloses the method of a UE performing a random access procedure.

2. [1.1] the UE transmits a preamble to a network;

178. Tirronen discloses the UE transmitting a preamble to the network. Specifically, the yellow highlighted portion of FIG.4 illustrates a UE transmitting a preamble to a network (“Base Station BS”):

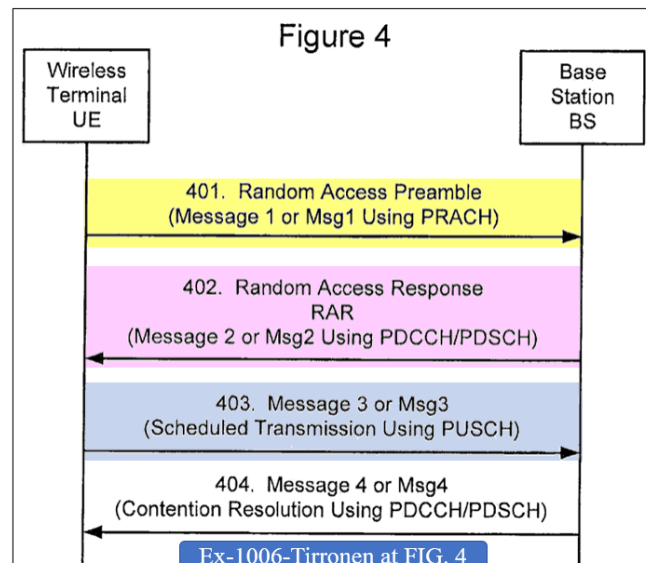


Figure 19 *Random access procedure with random access preamble highlighted in yellow (highlighting counsel's) (Ex-1006-Tirronen at FIG. 4; Ex-1007 at FIG. 4.)*

179. Tirronen's first embodiment further confirms that a UE transmits a preamble to the eNB:

A method of operating a wireless terminal (UE-a), the method comprising, transmitting a random access preamble of a random access procedure from the wireless terminal (UE-a) to a node (BS-a) of the radio access network, RAN;.... (Ex-1006-Tirronen at Embodiment 1 (20:22-26); Ex-1007 at Embodiment 1, pg. 11; *see also* Ex-1006-Tirronen at 8:64-9:5; Ex-1007 at 3:15-20.)

180. One of ordinary skill in the art would appreciate that a wireless terminal is equivalent to user equipment (UE). One of ordinary skill in the art would also understand that a base station or eNB is a node of a radio

access network. Tirronen discloses the UE transmitting a random access preamble to a network.

3. [1.2] the UE receives a Msg2 containing a TTI (Transmission Timer Interval) information of a Msg3, associated with uplink, from the network in response to the preamble,

181. Tirronen discloses a UE receiving a Msg2 from the network in response to the preamble, with the Msg2 containing TTI (Transmission Timer Interval) information for the uplink transmission of Msg3. In FIG. 4 Tirronen illustrates that the UE receives a Msg2 random access response/RAR (highlighted in blue) from the network:

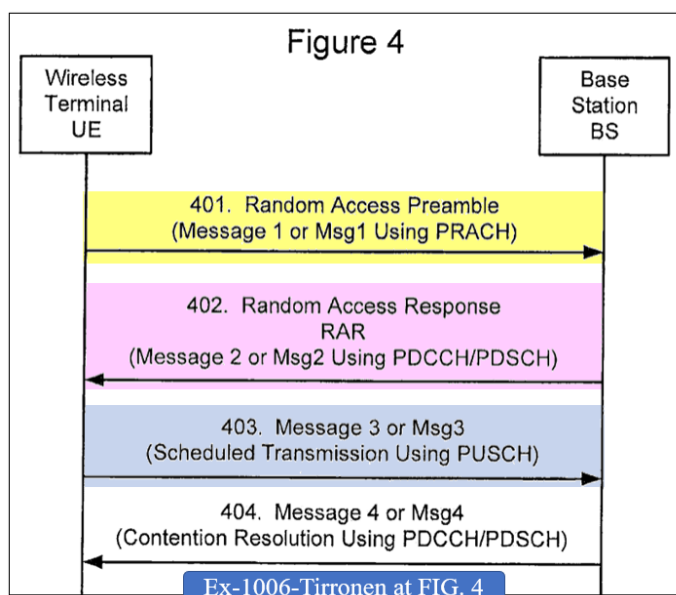


Figure 20 *The random access procedure with the Random Access Response/RAR/Msg2 highlighted in blue (highlighting counsel's) (Ex-1006-Tirronen FIG.4; Ex-1007 at FIG. 4.)*

182. Tirronen's UE also receives a random access response (RAR/Msg2) from the network which includes TTI information associated with the uplink transmission of Msg3:

[B]ase station BS processor 203 may transmit a Random Access Response RAR (Msg2) through transceiver 201 at operation 402. More particularly, the Random Access Response RAR may include an uplink grant for a subsequent Message 3 to be transmitted by wireless terminal UE. Responsive to receiving Message [2]¹⁴ of operation 402 through transceiver 301, wireless terminal UE processor 303 may transmit Message 3 (e.g., an RRC connection request) through transceiver 301 at operation 403 using the uplink grant indicated in the RAR of operation 402. ... [A] format of the RAR of operation 402 may be different for different types of wireless terminals. For a conventional mobile wireless terminal UE (e.g., a cellular radiotelephone, a smartphone, a tablet computer, a laptop computer, etc.), the RAR of operation 402 may include uplink grant information for the subsequent uplink Message 3 of operation 403 without including repetition information for uplink Message 3 of operation 403 and/or without including information regarding the downlink Message 4 of operation 404. (Ex-1006-Tirronen at 9:6-31; Ex-1007 at 3:22-36.)

¹⁴ Tirronen and the Tirronen-Prov contain an obvious typographical error, referring to "Message 4" instead of "Message 2"/"Msg2" when discussing step 402. As FIG. 4 shows, this error was obvious to a POSITA because step 402 of FIG. 4 and the surrounding context of the disclosure indicate that the text should refer to "Message 2"/"Msg2."

183. “[T]ime domain configuration” information comprising “Transmission Time Interval information for the Message 3 uplink communication” is included in the RAR/Msg2:

After transmitting the random access preamble, a random access response [RAR] of the random access procedure may be received from the node of the radio access network, with the random access response including an Uplink grant for a Message 3 uplink communication of the random access procedure. The UL grant may include **a time domain configuration** associated with the Message 3 uplink communication. The time domain configuration may include a...Transmission Time Interval information for the Message 3 uplink communication. (Ex-1006-Tirronen at 1:63-2:7; *see id.* at 3:39-44, 5:1-9, 5:23-31, 5:41-49, 6:11-20, 6:29-37, 11:3-12 (disclosing the inclusion of TTI information in the RAR message); Ex-1007 at 11:13-21; *see id.* at 15:14-18.)

...

[A] wireless terminal may be adapted to transmit a random access preamble (Msg1) of a random access procedure from the wireless terminal to a node of a radio access network. The wireless terminal may also be adapted to receive a random access response (Msg2) of the random access procedure from the node of the radio access network after transmitting the random access preamble. The random access response may include an Uplink grant for a Message 3 (Msg3) uplink communication of the random access procedure. The UL grant include a time domain configuration associate with the Message 3 uplink communication, and the time domain configuration may include a repetition factor that defines a number of repetitions across subframes for the Message 3 uplink communication; and/or Transmission Time Interval information for the Message 3 uplink communication. (Ex-1006-Tirronen at 4:62-5:9; Ex-1007 at 14:38-15:6.)

184. Accordingly, the RAR/Msg2 includes a UL grant for Msg3 uplink communication. One of ordinary skill in the art would have understood

that the UL grant contained a time domain configuration, which included Transmission Time Interval (TTI) information for Msg3 uplink communication. Tirronen discloses a UE, in response to sending a preamble to the network, receiving from the network a RAR (Msg2) with TTI information for the Msg 3 uplink communication, as indicated in this limitation.

4. [1.2.1] wherein the TTI information, contained in Msg2, of the Msg3, associated with uplink, includes a TTI duration of the Msg3, associated with uplink, and

185. Tirronen discloses a TTI duration within the TTI information contained in Msg2 for application to the uplink communication of Msg3. As established above for limitation 1.2, Msg2 contains TTI information for the uplink communication of Msg3. (E.g., Ex-1006-Tirronen at 4:62-5:9; Ex-1007 at 14:38-15:6.) Tirronen explains that Msg 2 contains a time domain configuration of the Uplink grant for Msg3 uplink communication. Tirronen further explains that this time domain configuration may include TTI information for Msg3 uplink communication. According to Tirronen, this TTI information for Msg3 uplink communication may contain information about TTI duration:

The time domain configuration may further include a transmission time interval (TTI) field for Message 3 transmission on the uplink. The TTI field contains information about the number of UL subframes that a set of code bits of a TB is mapped to. In one alternative (as in legacy LTE system) a TTI is one subframe, i.e. 1 millisecond. In another alternative (as in narrowband IOT system), a TTI (i.e., an extended TTI) is composed of multiple subframes. A typical value in an extended TTI may be composed of six subframes. If only two possible TTIs are defined in the system, then the TTI field can be 1 bit, for example, TTI field-0 indicates TTI of one subframe, TTI field-1 indicates TTI of six subframes. In general, if Q possible TTIs are defined in the system, then the TTI field is composed of $\text{ceil}(\log_2(Q))$ bits. (Ex-1006-Tirronen at 11:20-34; Ex-1007 at 5:33-41; see Ex-1006-Tirronen at 12:4-14, 13:19-35; Ex-1007 at 6:24-32, 7:36-8:3.)

186. Tirronen defines the TTI duration for Msg3 as the number of UL subframes that TTI information occupies on a transport block. One of ordinary skill in the art would have understood that Tirronen provides

for the possibility of TTI with or without extension (i.e. TTI or extended TTI), in much the same way as Löhr provides for the possibility of TTI with or without TTI bundling. One of ordinary skill in the art would have also understood that the TTI field used in Tirronen indicates whether the TTI is extended (bundled) or not. Low complexity UEs (such as MTC UEs) and UEs requiring/using coverage enhancements require extended TTI. Conventional UEs (like legacy LTE UEs) do not require extended TTI and use a single TTI instead. Tirronen describes the TTI information in the scenario without TTI extension (as in a legacy LTE system) as occupying a TTI duration of one subframe on a transport block (i.e. 1 millisecond). Tirronen further describes the TTI information in the scenario with TTI extension (as in low complexity UEs (MTC UEs) and UEs requiring/using coverage enhancements) as occupying a TTI duration of six subframes (i.e. 6 milliseconds).

187. Tirronen provides a formula for calculating TTI duration. First, element 1 is the time domain configuration for transmitting Msg3.

[T]he following information elements may be included in the UL grant in RAR for an MTC wireless terminal: Element 1. Time domain configuration for PUSCH carrying Msg3....” (Ex-1006-Tirronen at 12:4-8; Ex-1007 at 6:24-26.)

188. Then Tirronen defines the contents of the time domain configuration (in “Option 3 for Element 1”, see Ex-1006-Tirronen 13:19-35; Ex-1007 at 7:36-8:3.) which include (1) an R number of repetitions and (2) a Q

number of subframes and provides a formula for calculating TTI duration ($\text{TTI duration} = Q \cdot R$).

Element 1 may further contain a transmission time interval (TTI) field for Message3 transmission on the uplink. If the PUSCH Message 3 is configured with $\text{TTI} = Q$ subframes and R repetitions, then one transmission of PUSCH Message 3 takes $Q \cdot R$ subframes. (Ex-1006-Tirronen at 13:31-35; Ex-1007 at 8:1-3.)

189. Thus, Tirronen discloses a TTI duration within the TTI information contained in Msg2 for application to the uplink communication of Msg3.

5. [1.2.2] [wherein the TTI information, contained in Msg2, of the Msg3, associated with uplink, includes...] a start timing offset of the Msg3, associated with uplink; and

190. Tirronen discloses a start timing offset within the TTI information contained in Msg2 for use in the uplink communication of Msg3. Tirronen describes a time location indicating the starting subframe among a set of subframes that carries the Msg3 uplink communication:

According to some embodiments, the random access response of block 603 may include information defining a time and/or frequency location associated with the Message 3 uplink communication at block 605 based on the information defining the time and/or frequency location from the random access response. Information defining the time and/or frequency location may define a time and/or frequency location in a subframe for the Message 3 uplink communication. The information defining the time and/or frequency location may define one or more of: a starting subframe among a set of subframes that carries the Message 3 uplink transmission; a number of repetitions across subframes for carrying the Message 3 uplink transmission; a frequency location in a subframe for the Message 3 uplink transmission, where the frequency location is provided by a narrow band index or a PRB pair index; a number of PRB pairs occupied by the Message 3 uplink transmission; a resource block allocation information of the Message 3 uplink transmission; and/or a frequency hopping configuration of the Message 3 uplink transmission. (Ex-1006-Tirronen at 17:4-25; Ex-1007 at 13:20-38.)

191. In fact, Tirronen repeatedly explains that a RAR/Msg2 includes information defining the time when Msg3 transmission may begin. (See, e.g., Ex-1006-Tirronen at 2:39-47 (“The [RAR] may include information defining a time and/or frequency location associated with the [Msg3] uplink communication. ... Information defining the time and/or frequency location may define a time and/or frequency location

in a subframe for the [Msg3] uplink communication”); *see id.* at 2:48-59, 4:1-13, 6:38-45, 10:45-58, 11:42-51, 17:4-25, 18:64-19:17, 21:65-22:21, 24:51-25:7; Ex-1007 at 13:28-38, 17:4-17, 5:15-27, 5:6-14, 6:6-11, 13:20-38, 17:4-22, 13:20-38, 17:4-22.)

192. In the '052 patent, a start timing offset is defined as a fixed gap period between Msg2 reception and Msg3 transmission, designed to cover the UE's Msg2/Msg3 processing time. (Ex-1001 at 13:60-64.). In the patent prosecution of European patent application EP17183827.9, the applicant further explained that the start timing offset refers to the time unit in which a Msg3 transmission should start (e.g. the slot or symbol). (Ex-1008-EPFH at 172.) One of ordinary skill in the art would appreciate that the time location described in Tirronen indicated to the UE which subframe it should use to start sending Msg3.
193. Additionally, in “Option 3 for Element 1” discussed in Tirronen (Ex-1006-Tirronen at 13:19-35; Ex-1007 at 7:36-8:3), Tirronen explains one of the contents of the time domain configuration (Element 1) is a starting subframe.

Element 1 may further contain a starting subframe among the set of UL subframes that carry the PUSCH. (Ex-1006-Tirronen at 13:29-30; Ex-1007 at 7:42-43.)

194. One of ordinary skill in the art would have recognized that this starting subframe also discloses a start timing offset because it specifies a starting subframe, which discloses a time unit in which a Msg3 transmission should start.
195. Tirronen discloses Msg2 containing a start timing offset associated with the uplink transmission of Msg3.

6. [1.3] the UE performs a single TB (Transport Block) of Msg3 transmission to the network according to the TTI information of the Msg 3

196. Tirronen discloses the UE transmitting, according to the TTI information of Msg3, a single TB (Transport Block) of Msg3 to the network. In a random access procedure, the RAR/Msg2 typically includes the Uplink grant (which includes the TTI information) for the Msg3 uplink communication:

[A] format of the RAR of operation 402 may be different for different types of wireless terminals. For a conventional mobile wireless terminal UE (e.g. a cellular radiotelephone, a smartphone, a tablet computer, a laptop computer, etc.), the RAR of operation 402 may include Uplink grant information for the subsequent uplink Message 3 of operation 403 without including repetition information for uplink Message 3 of operation 403...In contrast, an RAR of operation 402 for a MTC (machine-type communication) wireless terminal UE may include repetition information for uplink message 3 of operation 403.... (Ex-1006-Tirronen at 9:22-36; Ex-1007 at 3:31-39.)

The random access response may include an Uplink grant for a Message3 uplink communication of the random access procedure. The UL grant may include a time domain configuration associated with the Message 3 uplink communication, and the time domain configuration may include: a repetition factor that defines a number of repetitions across subframes for the Message 3 UL communication; or Transmission Time Interval information for the Message 3 UL communication. (Ex-1006-Tirronen at 5:56-64; Ex-1007 at 15:7-18.)

197. The time domain configuration contained within the Uplink grant may include repetition information:

The time domain configuration may further include a transmission time interval (TTI) field for Message 3 transmission on the uplink. The TTI field contains information about the number of UL subframes that a set of code bits of a TB is mapped to. In one alternative (as in legacy LTE system) a TTI is one subframe, i.e. 1 millisecond. In another alternative (as in narrowband IOT system), a TTI (i.e., an extended TTI) is composed of multiple subframes. A typical value in an extended TTI may be composed of six subframes. If only two possible TTIs are defined in the system, then the TTI field can be 1 bit, for example, TTI field-0 indicates TTI of one subframe, TTI field-1 indicates TTI of six subframes. In general, if Q possible TTIs are defined in the system, then the TTI field is composed of $\text{ceil}(\log_2(Q))$ bits. (Ex-1006-Tirronen at 11:20-34; Ex-1007 at 5:33-41.)

198. As the excerpt above shows, a one-bit TTI field is used to signal whether a single TB Msg3 is transmitted in one subframe. When the TTI field is set to 1, the TTI is composed of multiple subframes (i.e. repetitions). On the other hand if the TTI field is set to 0, as in the instance of a conventional UE, TTI is one subframe. Thus, when the TTI field is set to 0, Tirronen's UE transmits a single Msg3 transport block to the network according to the TTI information provided in Msg2.

199. One of ordinary skill in the art would have understood that Tirronen provides for the possibility of TTI with or without extension (i.e., TTI or extended TTI) in much the same way as Löhrr provides for the possibility of TTI with or without TTI bundling. One of ordinary skill in the art would have also understood that the TTI field used in Tirronen to indicate whether TTI is extended (bundled) or not is analogous to the

transmission mode indicator used in Löhr to disclose whether the TTI is bundled or not. Tirronen describes the TTI information in the scenario without TTI extension (i.e. TTI field = 0, as in a legacy LTE system) as occupying one subframe on a transport block (i.e. 1 millisecond).

7. [Claim 5] The method of claim 1, wherein the TTI information of the Msg3 is included in a RAR (Random Access Response) for responding [sic] the preamble.¹⁵

200. Tirronen discloses that the TTI information of Msg3 is included in a RAR responding to the preamble. Tirronen describes the random access procedure as follows:

According to some embodiments of inventive concepts, a method of operating a node of a radio access network may include receiving a random access preamble of a random access procedure from the wireless terminal. Responsive to receiving the random access preamble, a random access response of the random access procedure may be transmitted to the wireless terminal, the random access response may include an Uplink grant for a Message 3 uplink communication of the random access procedure. The UL grant may include a time domain configuration associated with the Message 3 uplink communication, and the time domain configuration may include: a repetition factor that defines a number of repetitions across subframes for the Message 3 UL communication; or Transmission Time Interval information for the Message 3 UL communication. (Ex-1006-Tirronen at 3:30-44; Ex-1007 at 15:7-18.)

201. Tirronen describes the Random Access Response including a UL grant for Msg3 uplink communication. One of ordinary skill in the art would

¹⁵ I assume for the purposes of this Declaration only that this claim should read “...for responding to the preamble.”

have understood that the UL grant contained a time domain configuration which included Transmission Time Interval (TTI) information for Msg3 uplink communication. Tirronen discloses that TTI information of Msg3 is included in a RAR responding to the preamble.

8. [Claim 7] The method of claim 1, wherein the Msg2 is a random access response.

202. Tirronen discloses that Msg2 is a random access response (RAR) for the reasons described above relative to limitation 1.2. Specifically, FIG.4 of Tirronen shows that Msg2 and the Random Access Response are synonymous.

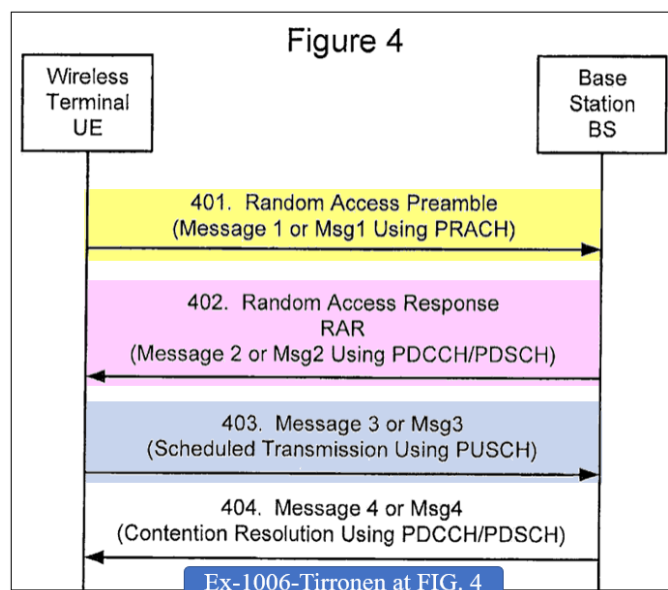


Figure 21 *The contention based random access procedure shown in FIG. 4 of Tirronen (highlight is counsel's) (Ex-1006-Tirronen at FIG. 4; Ex-1007 at FIG. 4.)*

203. Tirronen discloses that Msg 2 is a random access response.

9. [8.0] A UE (User Equipment), comprising:

204. Tirronen discloses a UE (User Equipment) for the reasons provided above regarding preamble 1.0.

10.[8.0.1] a control circuit;

205. Tirronen discloses a control circuit. FIG 3 of Tirronen shows a block diagram of a UE:

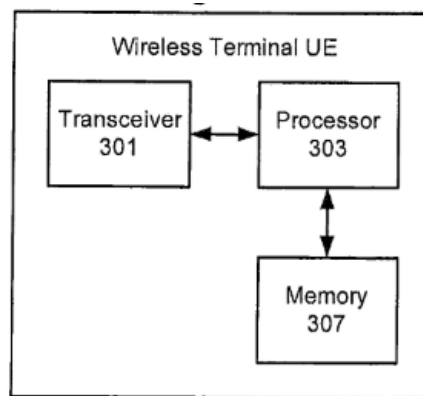


Figure 22 *A block diagram of a UE used in Tirronen (Ex-1006-Tirronen FIG. 3; Ex-1007 at FIG. 3.)*

206. The corresponding description of FIG. 3 discloses:

FIG. 3 is a block diagram illustrating elements of a wireless terminal UE (also referred to as a mobile terminal, mobile station, a UE, a user equipment, a user equipment node, etc.) of FIG. 1. As shown, a wireless terminal UE may include a transceiver circuit 301 (also referred to as a transceiver) configured to provide radio communications with a base station BS, a processor circuit 303 (also referred to as a processor) coupled to the transceiver circuit, and a memory circuit 307 coupled to the processor circuit. The memory circuit 307 may include computer readable program code that when executed by the processor circuit 403 causes the processor circuit to perform operations according to embodiments disclosed herein. According to other embodiments, processor circuit 303 may be defined to include memory so that a memory circuit is not separately provided. (Ex-1006-Tirronen at FIG. 3, 8:36-50; Ex-1007 at FIG. 3, 2:39-3:6.)

207. Thus, Tirronen's UE comprises a control circuit as claimed—namely, the control circuit includes at least the circuits identified in the excerpt above, including the transceiver circuit, processor circuit, and memory circuit.

11.[8.0.2] a processor installed in the control circuit; and

208. Tirronen discloses a processor installed in the control circuit. FIG 3 of Tirronen shows a block diagram of a UE:

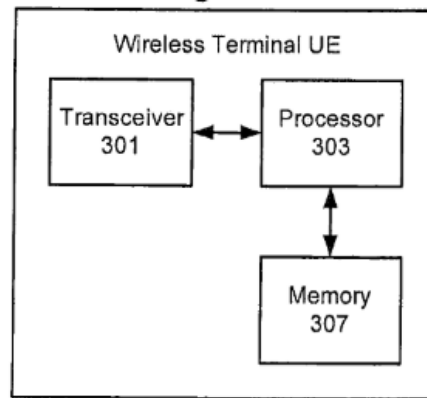


Figure 23 *A block diagram of a UE used in Tirronen (Ex-1006-Tirronen FIG. 3; Ex-1007 at FIG. 3.)*

209. Tirronen discloses a processor installed in the control circuit.

12.[8.0.3] a memory installed in the control circuit and operatively coupled to the processor

210. Tirronen discloses a memory installed in the control circuit and operatively coupled to the processor. Tirronen describes two potential scenarios: 1. a memory circuit separate but coupled to a processor circuit and 2. a processor circuit containing the memory:

“a memory circuit 307 coupled to the processor circuit. The memory circuit 307 may include computer readable program code that when executed by the processor circuit 403 causes the processor circuit to perform operations according to embodiments disclosed herein. According to other embodiments, processor circuit 303 may be defined to include memory so that a memory circuit is not separately provided.” (Ex-1006-Tirronen 8:43-50; Ex-1007 at 3:1-11.)

211. Tirronen discloses a memory installed in the control circuit and operatively coupled to the processor.

13.[8.0.4] wherein the processor is configured to execute a program code stored in the memory to:

212. Tirronen discloses a processor configured to execute a program code stored in the memory. Tirronen describes a processor executing a program in the memory to perform the embodiments of the invention:

“The memory circuit 307 may include computer readable program code that when executed by the processor circuit 403 causes the processor circuit to perform operations according to embodiments disclosed herein.” (Ex-1006-Tirronen at 8:44-48; Ex-1007 at 3:2-4.)

213. Tirronen discloses a processor configured to execute a program code stored in the memory.

14.[8.1] transmit a preamble to a network

214. Tirronen discloses limitation 8.1 for the reasons provided above regarding claim 1.1.

15.[8.2] receive a Msg2 containing a TTI (Transmission Time Interval) information of a Msg3, associated with uplink, from the network in response to the preamble, wherein the TTI information, contained in Msg2, of the Msg3, associated with uplink includes

16.[8.2.1] a TTI duration of the Msg3, associated with the uplink, and

17.[8.2.2] a start timing offset of the Msg3, associated with the uplink; and

215. Tirronen discloses limitations 8.2, 8.2.1, and 8.2.2 for the reasons provided above regarding limitations 1.2, 1.2.1, and 1.2.2.

18.[8.3] perform a single TB (Transport Block) of Msg3 transmission to the network according to the TTI information of the Msg3.

216. Tirronen discloses limitation 8.3 for the reasons provided above regarding limitation 1.3.

217. Thus, Tirronen discloses claim 8.

19.[Claim 12] The UE of claim 8, wherein the TTI information of the Msg3 is included in a RAR (Random Access Response) for responding to the preamble.

218. Tirronen discloses claim 12 for the reasons provided above regarding claim 5.

20.[Claim 14] The UE of claim 8, wherein the Msg2 is a random access response.

219. Tirronen discloses claim 14 for the reasons provided above regarding claim 7.

XII. CONCLUSION

220. I hereby declare that all statements made herein are of my own knowledge and are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed on this 25th day of June, at Cambridge, Massachusetts.



Michael Allan Martin Davies

Michael A M Davies

Chairman and Senior Partner, Endeavour.Partners

Senior Lecturer, Massachusetts Institute of Technology

Guest Lecturer, London Business School

Co-founder and CEO, WKD.SMRT, Inc.

Co-founder and former Chairman, Silverthread Inc.

Expertise

Michael Davies' specialist expertise and relevant experience cover the technical, business, strategic, economic, and broad policy issues involved in deep high tech and throughout the high-tech sector—in particular mobile devices and services—and wireless (cellular and satellite) and broadband networks, consumer electronics, the Internet of Things (IoT), electronic components, and semiconductors.

- the architecture and economics of communication services networks and computing services, in particular broadband cellular, fiber infrastructure, packet networks, cloud services, computing services, 'edge computing' services, satellite networks, video codecs, robotics, payment systems, IoT, and smart home technologies
- the architecture and economics of state-of-the art electro-mechanical devices, systems, and components that combine hardware and software, in particular mobile devices and systems, consumer electronics, personal computing and cloud computing, hardware manufacturing, semiconductors, and the related supply chains
- creative business models, co-opetition, and building business ecosystems, including open innovation, open source, shared infrastructure, and other ground-breaking approaches
- the economics of systems, platforms, architecture, modularity, and bottlenecks, in particular as this relates to complex products and services that combine software, computing, and communications
- consumer behavior and segmentation and the adoption and diffusion for high-tech that are novel products
- strategy and management for R&D, product creation, and technological innovation; knowledge-intensive technical teams, such as R&D staff; effective work practices; and the economics of innovation and intellectual property (trade secrets, patents, and licensing strategies)
- harnessing digital technologies knowledge and the challenges associated with innovation and how to address them

Michael has several areas of specialist expertise relevant to these challenges:

- consumers' purchase preferences and buying behaviors as well as projects adoption and diffusion of new technologies;
- anticipates the future by developing insight into the co-evolution of technological innovation and technology architecture, the potential demand opportunity, and platforms and business ecosystems;
- develops creative and robust business strategies by identifying opportunities and options for initiatives, investments, and novel business models that create and capture value; and
- provides effective leadership through decision-making under uncertainty, agile methods, and building resilience

Experience

Michael has worked for more than forty years in high tech telecommunications and mobile devices.

His experience spans the design, development, and deployment of mechanical, electrical, electronic, and high-tech products; manufacturing; software coding; video; supply chain management; research and development; technology; product creation; and business strategy.

Endeavour.Partners provides services to:

- delivers expert witness testimony on matters related to public policy, intellectual property, and commercial relationships within the mobile, wireless, and digital sectors
- provides consulting services on business strategy to companies throughout the mobile and wireless industry, including cellular infrastructure providers, mobile device manufacturers, and mobile network operators; companies involved in the broadband, fiber and satellite sectors
- provides consulting services on business strategy to industrial companies that are being impacted by digital and other deep technology

As a Senior Lecturer at MIT, Michael:

- created and taught courses in fundamental and advanced topics in technology strategy, systems engineering, leadership of high-tech businesses, and integrated design and product development process in both the School of Engineering (in Aero/Astro) and in the Sloan School of Management
- teaches creative innovation, value creation, emerging technologies, product management, product marketing, basic finance and business models, pricing and marketing, competitive analysis, market opportunity identification, funding entrepreneurship, data-driven decision-making, and decision-making under uncertainty
- created and leads, with colleague Blade Kotelly, Breakthrough Innovation: Creating Value in Times of Uncertainty

As a Guest Lecturer at the London Business School, Michael:

- created and for more than a decade has taught the New Technology Ventures program, which enables emerging entrepreneurs to evaluate novel ideas and inventions and turn them into new technology ventures
- created and serves as course Academic Director for the path-breaking course on The Business of AI.

As the Founder of WKD.SMRT, Michael:

- leads a company that is accelerating innovation in healthcare by provide superior real-life data for clinical trials, through a turnkey solution that combines state-of-the-art technologies in sensing, machine learning, and computer processing

As the Founder of Silverthread Inc, Michael:

- founded a company that helps clients diagnose and improve the economics of maintaining, evolving, and developing very large-scale software systems

Education

London Business School

1989–1991

Master of Business Administration (With Distinction)

- Specialized in Business Strategy, Technology Management, and Decision Sciences
- Participated in the PhD Program on Systems Dynamics

University of Durham, UK

1982–1984

Master of Engineering

- Microelectronics
- Cybernetics and Robotics
- Management Science

St Catharine's College, University of Cambridge

1979–1987

Bachelor of Arts (1982) and Master of Arts (1987)

- Electrical Sciences Tripos (Computer Science, Mathematics, Engineering, and Physics)
- Engineering Part I and Part II

Harvard Business School

Post-graduate study in Innovation & Organizations

Expert Reports and Testimony Experience

United States of America et al v AT&T Inc et al.

- Department of Justice anti-trust investigation, Civil Action No. 11-01560 (ESH)
- Industry Expert: Antitrust
- Expert Report (2011)

Apple Inc v Samsung Electronics America Inc, Samsung Telecommunications America LLC, and Samsung Electronics Co Ltd

- International Trade Commission Investigation No. 337-TA-796
- Industry Expert: Public Interest
- Expert Declaration (2013)

Ericsson Inc and Telefonaktiebolaget LM Ericsson v Samsung Electronics America Inc, Samsung Telecommunications America LLC, and Samsung Electronics Co Ltd

- International Trade Commission Investigation No. 337-TA-862
- Industry Expert: Public Interest
- Expert Report, Rebuttal Expert Report, Deposition Testimony, Hearing Testimony (2013)

Samsung Electronics Co Ltd and Samsung Telecommunications America LLC v Ericsson Inc and Telefonaktiebolaget LM Ericsson

- International Trade Commission Investigation No. 337-TA-866
- Industry Expert: Public Interest
- Expert Report, Rebuttal Expert Report, Deposition Testimony, Hearing Testimony (2013)

InterDigital Communications Inc, InterDigital Technology Corporation IPR Licensing Inc, and InterDigital Holdings v Samsung Electronics America Inc and Samsung Telecom America LLC

- International Trade Commission Investigation No. 337-TA-868
- Industry Expert: Public Interest
- Expert Report, Rebuttal Expert Report, Deposition Testimony, Hearing Testimony (2013)

Sasken Communication Technologies Limited v Spreadtrum Communications Inc and Spreadtrum Communications USA

- American Arbitration Association, International Centre for Dispute Resolution No. 50-117-T-0092-12
- Technical Expert and Industry Expert: Arbitration
- Expert Report, Deposition Testimony, Hearing Testimony (2013)

On Track Innovations LTD v T-Mobile USA Inc

- United States District Court, Southern District of New York No. 12-cv.02224-AJN-JCF
- Technical Expert
- Expert Report, Deposition Testimony (2013-2014)

Hand Held Products Inc v Amazon.com Inc et al.

- United States District Court, District of Delaware No. 1:12-CV-00768-RGA-MPT
- Technical Expert
- Expert Report, Code Analysis (2014)

Enterprise Systems Technologies SARL v Samsung Electronics America Inc, Samsung Electronics Co Ltd, and Samsung Telecommunications America LLC

- International Trade Commission Investigation No. 337-TA-925
- Industry Expert: Public Interest
- Expert Report, Deposition Testimony (2015)

NVIDIA Corporation v Samsung Electronics America Inc, Samsung Electronics Co Ltd, and Samsung Telecommunications America LLC

- International Trade Commission Investigation No. 337-TA-932
- Industry Expert: Public Interest
- Expert Report, Deposition Testimony, Hearing Testimony (2015)

Nokia Corporation v Samsung Electronics Co Ltd

- Arbitration, International Chamber of Commerce No. 19602/AGF/RD (c.19638/AGF)
- Industry Expert and Technology Expert: intellectual property, patent royalties
- Expert Report, Deposition Testimony, Hearing Testimony (2015)

Ericsson Inc and Telefonaktiebolaget LM Ericsson v Apple Inc

- International Trade Commission Investigation No. 337-TA-952
- Industry Expert: Public Interest
- Expert Report, Deposition Testimony, Hearing Testimony (2015)

Core Wireless Licensing SARL v LG Electronics Inc and LG Electronics Mobilecomm USA Inc

- United States District Court, Eastern District of Texas No. 2-14-cv-00911-JRG-RSP
- Technical Expert
- Expert Declaration, Expert Report, Deposition Testimony (2015)

St. Lawrence Communications v ZTE Corporation

- United States District Court, Eastern District of Texas No. 2:15-cv-394-JRG and 2:15-cv-00351-JRG
- Technical Expert
- Preliminary work performed; case settled (2016)

ParkerVision Inc v Apple Inc, Samsung Electronics Co Ltd, Samsung Electronics Inc, LG Electronics Inc, LG Electronics Mobilecomm USA Inc, and Qualcomm Inc

- International Trade Commission Investigation No. 337-TA-982
- Industry Expert: Public Interest
- Expert Report, Deposition Testimony (2016)

T-Mobile USA Inc v Huawei Device USA Inc and Huawei Technologies Co Ltd

- United States District Court, Western District of Washington No. 14-cv-01351-RAJ
- Industry Expert: Trade Secrets
- Expert Report, Deposition Testimony (2016), Declarations, Trial Testimony (2017)

Immersion Corporation v Apple Inc and AT&T Mobility LLC

- International Trade Commission Investigation No. 337-TA-1004/990
- Industry Expert: Public Interest
- Expert Report (2016), Deposition Testimony, Hearing Testimony (2017)

Netlist Inc v SK hynix America Inc, SK hynix Inc, SK hynix memory solutions Inc

- International Trade Commission Investigation No. 337-TA-1023
- Industry Expert: Public Interest
- Expert Report, Deposition Testimony, Hearing Testimony (2017)

Andrea Electronics Corporation v Samsung Electronics America Inc and Samsung Electronics Co Ltd

- International Trade Commission Investigation No. 337-TA-1026
- Industry Expert: Public Interest
- Expert Report, Deposition Testimony (2017)

Motorola Solutions Inc v Hytera America Inc and Hytera Communications America (West) Inc

- International Trade Commission Investigation No. 337-TA-1053
- Technical Expert
- Inter Partes Review, Expert Report, Rebuttal Report, Deposition Testimony (2017)

WiLAN v LG Electronics Inc

- United States District Court, Southern District of California No. 3:17-cv-00358-BEN-BGS
- Technical Expert
- Preliminary work performed; case settled (2017)

Huawei Technologies Co Ltd et al. v Samsung Electronics Co Ltd et al.

- United States District Court, Northern District of California No. 16-cv-02787-WHO
- Technical Expert: Standards Essential Patents
- Expert Report (2018)

Seven Networks Inc v Google LLC

- United States District Court, Eastern District of Texas No. 2:17-CV-00442-JRG
- Technical Expert
- Expert Report (2018)

BiTMICRO LLC v Samsung Electronics America Inc, Samsung Electronics Co Ltd, SK Hynix America Inc, and SK Hynix Inc

- International Trade Commission Investigation No. 337-TA-1097
- Industry Expert: Public Interest
- Expert Report, Deposition Testimony (2018)

United States of America et al. in the matter of T-Mobile USA Inc and Sprint Corporation

- United States District Court, District of Columbia No. 1:19-cv-02232-TJK
- Technical Expert and Industry Expert: industry background, anti-trust, economics
- Expert Report, Model (2018)

EVS Codec Technologies and St Lawrence Communications v Sony Mobile Communications Inc

- United States District Court, Southern District of New York No. 1:18-cv-09518-JSR
- Technical Expert and Industry Expert: intellectual property, patent royalties
- Expert Declarations, Expert Report (2019)

Peloton Interactive Inc v Flywheel Sports Inc

- United States District Court, Eastern District of Texas 2:2018-cv-00390-RWS-RSP and 2:19-cv-00317-JRG-RSP
- Industry Expert: Trade Secrets, Intellectual Property, Inter Partes Review, Indicia of Non-obviousness
- Expert Reports (2020)

Neodron Limited v Samsung Electronics Co Ltd, Amazon.com Inc, Motorola Mobility LLC, Microsoft Corp, and Apple Inc

- International Trade Commission Investigation No. 337-TA-1162 and No. 337-TA-1193
- Industry Expert: Public Interest
- Expert Report (2020)

Helios Towers plc v Orange SA

- Arbitration, International Chamber of Commerce No. 25115/dda
- Technical Industry Expert: Arbitration
- Expert Report (2020)

United States of America v Huawei Technologies Co Ltd

- Western District of Washington Docket No. CR19-010-RSM
- Eastern District of New York Docket No. 18-CR-457 (AMD)
- Industry Expert: Theft of trade secrets, and conspiracy to steal trade secrets, violating the Racketeer Influenced and Corrupt Organizations (RICO) Act
- Advisory capacity (2020)

RED v CloudMinds Inc

- JAMS Arbitration No. 1220062943
- Technical Expert and Industry Expert: Arbitration
- Expert Report, Deposition Testimony, Hearing Testimony (2020)

Nokia Corporation v Lenovo Group Limited

- International Trade Commission Investigation No. 337-TA-1208
- Industry Expert: Public Interest, Domestic Industry, Bonding
- Expert Report, Deposition Testimony (2020)

Evolved Wireless LLC v Samsung Electronics Co Ltd and others

- International Trade Commission Investigation No. 337-TA-1253
- Industry Expert: Public Interest
- Expert Report, Deposition Testimony (2021)

Competition Bureau of Canada in the matter of Rogers Communication and Shaw Communication

- Assessment of the proposed acquisition by Rogers Communication of Shaw Communication
- Industry Expert: Public Interest
- Expert Report for §104 Injunction
- Expert Report for §92 Hearing
- Testimony at Competition Tribunal
- Affidavit for Stay and Injunction for Appeals Court Canada (2021)

Sonrai Memory Limited v Intel Corp (on behalf of Dell Technologies Inc, Lenovo Group Limited, and LG Electronics Inc), Samsung Electronics Co Ltd, and Samsung Electronics America

- International Trade Commission Investigation No. 337-TA-1280
- Industry Expert: Public Interest
- Expert Report, Rebuttal Expert Report, Deposition Testimony (2021)

Ericsson Inc v Apple Inc

- International Trade Commission Investigation No. 337-TA-1299
- Industry Expert: Public Interest
- Expert Report, Rebuttal Expert Report, Deposition Testimony, Hearing Testimony (2022)

Ericsson Inc v Apple Inc

- International Trade Commission Investigation No. 337-TA-1300
- Industry Expert: Public Interest
- Expert Report, Rebuttal Expert Report, Deposition Testimony, Hearing Testimony (2022)

Ericsson Inc v Apple Inc

- International Trade Commission Investigation No. 337-TA-1301
- Industry Expert: Public Interest
- Expert Report, Rebuttal Expert Report, Deposition Testimony, Hearing Testimony (2022)

AliveCor Inc v Apple Inc

- International Trade Commission Investigation No. 337-TA-1266
- Industry Expert: Public Interest
- Declaration on Public Interest (2022)

Arigna Technology Limited v Apple Inc

- International Trade Commission Investigation No. 337-TA-1308
- Industry Expert: Public Interest
- Expert Report, Rebuttal Report, Deposition Testimony (2022), Hearing Testimony (2023)

United States of America v Google LLC

- United States District Court, District of Columbia No. 1:20-cv-03010-APM
- Technical Expert and Industry Expert: industry background, anti-trust
- Expert Report, Reply Report, Deposition Testimony (2020)

Department of Justice, Anti-Trust Division, Media, Entertainment and Communications Section

- Anti-trust investigation in the communications services sector
- Industry Expert and Technical Expert: Anti-trust
- Advisory capacity (2022)

Daedalus Prime LLC v Samsung Electronics Co Ltd, Samsung Telecommunications America LLC, and Qualcomm Incorporated

- International Trade Commission Investigation No. 337-TA-1335
- Industry Expert: Public Interest
- Expert Report (2022)

Daedalus Prime LLC v Samsung Electronics Co Ltd, Samsung Electronics America Inc, Taiwan Semiconductor Manufacturing Company Limited, and TSMC North America

- International Trade Commission Investigation No. 337-TA-1336
- Industry Expert: Public Interest
- Expert Report. (2022)

Masimo Corporation v Apple Inc

- International Trade Commission Investigation No. 337-TA-1276
- Industry Expert: Public Interest
- Declaration on Public Interest (2023)

PayRange Inc v KioSoft Technologies LLC

- United States District Court, Southern District of Florida No. 1:20-CV-24342-RNS
- Technical Expert and Industry Expert: intellectual property, damages estimation
- Expert Report, Rebuttal Report, Deposition (2023)

Interdigital Inc v Samsung Electronics Co Ltd

- Arbitration, International Chamber of Commerce No. 27699/PDP
- Industry Expert: Arbitration
- Expert Report (2023), Rebuttal Report (2024)

ASUS Inc v Samsung Electronics Co Ltd

- Technical legal case No. 2:23-CV-00409-JRG-RSP
- Technical Expert
- Inter Partes Review

Telefonaktiebolaget LM Ericsson v Lenovo (United States)

- International Trade Commission Investigation No. 337-TA-1387
- Industry Expert: Public Interest
- Expert Report

Professional Experience

Endeavour.Partners

Founder and Chairman

2003–Present

Endeavour.Partners is a boutique consulting firm that empowers business leaders to create a future that is more prosperous and more humane, equitable, sustainable, and resilient by harnessing digital technologies—and other deep technologies—to create new value and accelerate growth both in leading technology and for other global leaders worldwide in many diverse sectors to harness digital and deep technology.

Endeavour.Partners leverages its deep and broad expertise in technology to help achieve positive outcomes for people and the planet in vital and critical areas, such as anti-trust and the public interest, which encompasses, for example, public health and welfare, competitive conditions, and outcomes for consumers.

Michael and his team have experience working throughout the digital ecosystem: across mobile, cellular, satellite, Internet, and digital convergence and commerce. This includes extensive work in communications, in particular mobile devices (feature phones, smartphones, tablets, cameras, connected homes, smart homes), services (video/PnP, data, messaging, mobile payment, codecs, Bluetooth), components (processor, memory, sensors), cellular and satellite networks (network infrastructure and equipment), broadband and Internet, computing (from semiconductors through personal computing to software services), consumer electronics, content (video, audio, gaming), commerce, and convergence of these domains.

The firm specializes in technological innovation, the adoption and diffusion of new products, and the emergence and evolution of business ecosystems from a systems point of view. This expertise encompasses the key digital technologies redefining business, the economy, and society: smartphones, cloud services, the Internet of things (IoT), Artificial Intelligence (AI), and robotics.

The firm is headquartered in Cambridge, MA, with a presence in Seattle, WA, and in London, United Kingdom.

Clients

Endeavour.Partners clients include:

- most of the leading mobile device and connected consumer electronics vendors, including HTC, Samsung, Apple, Nokia, LG, Sony Ericsson, and Motorola
- leading network operators and service providers, such as Verizon Wireless, AT&T, Sprint, T-Mobile, Deutsche Telekom, Vodafone, BT, Optus, and Virgin Mobile
- network infrastructure owners and providers, such as Crown Castle, Samsung, and Lucent
- other firms throughout the high-technology supply chain, including semiconductor companies such as Intel, SK Hynix, Qualcomm, and Analog Devices
- leading global businesses in diverse sectors harnessing digital and other deep technologies, including Thomson Reuters, Swiss Re, Husqvarna, Arla, TetraPak, TechnipFMC, and A.C. Milan
- innovative new technology ventures, such as PowerByProxi, Soul Machines, and zero360
- leading public sector organizations, including public broadcaster WGBH and the American Archive of Public Broadcasting (AAPB)

Scope of Work

Michael's work through Endeavour.Partners exemplifies his wide-ranging expertise in business strategy, technology strategy, technology innovation, product creation, supply chain, and public policy issues. He has provided industry expertise in patent and antitrust litigations on behalf of:

- U.S. Department of Justice—anti-trust case over the proposed AT&T and T-Mobile merger (2011)
- Commercial Arbitration participants—industry and technical expert providing multi-billion-dollar patent arbitrations concerning both Standard Essential Patents (SEPs) and non-SEPs on mobile connectivity and mobile services
- ITC complainants and respondents—industry expert opining on the public interest for litigation focused on wireless infrastructure and networks, mobile devices, wearables, smart home devices, semiconductors, software applications, and digital ecosystems
- United States District Court plaintiffs and defendants—technical expert opining on the (in)validity and (non)infringement related to several technologies involved in mobile devices and wireless networks, including the capture and decoding of real-time video signals, communication on smartphones, and audio codecs

Endeavour.Partners has also worked in strategy projects on behalf of:

- wireless carriers—video/PnP, 4G and LTE technologies, Bluetooth and data/messaging, particularly around innovative business models
- one of the world's largest and most successful network operators and service providers—video and media platform strategy
- a major wireless carrier—strategies in NFC technology and mobile payments, including a deep technical analysis of competing solutions, as well as assessment on the surrounding business ecosystem, viable business models, and drivers of consumer adoption patterns
- R&D department (~20,000 people) of one of the world's largest software development organizations—renewal of product creation
- world's number one mobile device vendor—"R&D University" for top management team (in collaboration with the world's top academics)
- world's number one consumer electronics business—the future of the consumer electronics, connected home devices, computing business ecosystem, and communications business ecosystem
- a multi-billion-dollar diversified global technology business—renewal of their technology management, from semiconductors through software platforms to devices and complete solutions
- top-tier service providers and network operators, such as BT and Deutsche Telekom—corporate and business strategy for communications services, software businesses, innovative start-ups, and infrastructure vendors
- world's number one device vendor—platform strategy for its flagship product line
- innovation leader in mobile devices—a family of modular products
- world's number one global provider of subsea robotics—new networking approaches for robust, high-bandwidth, multi-model subsea communications systems

Endeavour.Partners has also provided broad industry expertise in regard to:

- business strategies on Internet and mobile advertising, including market sizing, opportunity assessment, and business model deployment for various service providers
- business strategies on machine learning as a service, disease management, green hydrogen, carbon nanotubes, and sensors
- comprehensive projection of the medium- and long-term demand for all digital services and devices, and the related attributes driving consumer choice and preference, including projected market share for major players under a variety of alternative scenarios and the implications thereof
- analysis of the full spectrum of the communications sector, from underlying physical infrastructure, through cellular networks, fiber networks, and satellite networks
- standards for smart home products and connectivity

WKD.SMRT, Inc.

Co-founder and Chief Executive Officer

2019–present

WKD.SMRT delivers superior real-life data for clinical trials in the home. Its solution makes clinical trials faster, easier, lower cost, and lower risk by combining state-of-the-art sensing, machine learning, and computing technologies to deliver data that is more precise, more complete, more objective, and more real-life.

It is partnering with the world's leading pharma company focused on neurodegenerative diseases, the world's number one academic neurology department, and the world's leading research group focused on the medical aspects of activities of daily living and quality of life.

Silverthread, Inc.

Co-founder, former Chairman

2013–present

Silverthread's services and tools help clients diagnose and improve the design architecture of large software systems to improve predictability of project schedules, reduce unnecessary overhead costs, and prevent compounding complexity. The company's clients include large corporations and government entities that own and manage large, complex software systems.

Zero-360

Co-Founder and founding Chairman

2012–2015

Strategic thought leader for this next-generation wearable device and solutions company focused on unique interactions and bio-sensing capabilities. Its particular focus is on how to support behavioral change. Zero-360's cloud platform provided an open and scalable solution that integrated with third-party wellness programs in capturing valuable health and wearable data.

EquuSys

Co-Founder and Chief Technology Officer

2004–present

EquuSys is an animal instrumental business that provides real-time, real-world data to enhance the evaluation, diagnosis, rehabilitation, training, and conditioning of elite horses. The company commercialized Michael's patented inventions, including the development of a hardware electronics sensor product and the accompanying software. This included developing novel wireless protocols for high-speed asymmetric data transmission in shared spectrum.

Mercator Partners

Founder and Chairman Emeritus

1998–2009

This technology strategy consulting firm designed, directed, and delivered training programs in strategy and technology. Its alumni now fill top strategy roles within a number of industry-leading firms, including Google, HTC, Nielsen, Yahoo!, Sony Ericsson, HTC, and Vodafone. Client work focused on building creative new business models and developing effective business strategies on behalf of:

- leading US mobile company—business ecosystems, business strategies, and anticipating likely customers behavior

- major global JV with European and Japanese parents—emerging applications and potential business models
- most successful MVNO in the world—data services, market entry, and partnership development
- several high-tech R&D-intensive businesses across consumer electronics, telecommunications, automotive, and aerospace—how to commercialize highly innovative technologies
- for the number one US communications infrastructure company—customer needs and company strategy for 3G mobile
- leading Japanese consumer electronics and industrial conglomerate—evolution of consumer electronics; monetizing its semiconductor intellectual property; consumer segmentation; creative business models; and product portfolios, pipeline, and positioning
- variety of media companies—business models and content plays in the Internet and mobile service space
- leading European mobile operator—values- and lifestage-based consumer segmentations to increase customer loyalty and reduce costs
- several broadband and IP players—business models and market entry strategies
- several top-tier private equity players, such as The Carlyle Group, Providence Equity, Kohlberg Kravis Roberts, Blackstone, and Berkshire Partners—due diligence and strategic counsel on technology and telecom investments
- UK 3G auctions—assembled a consortium bid (SpectrumCo), and raising >\$4 billion for an innovative business model, with players such as Virgin, Sonera, Nextel, and Tesco, including strategies for sharing spectrum amongst multiple competing uses

GeoPartners Research

Principal

1996–1998

GeoPartners Research provided technology evaluation and strategy focused on broadband, IP, and next generation wireless technologies on behalf of and in regard to:

- AT&T—overall corporate strategy, including IP, VoIP, local entry, wireless and broadband, including network infrastructure and equipment (including NAT and DNS for VoIP)
- Qualcomm—new technologies, business ventures, and organizational design, including work on Qualcomm’s first smartphone and on the design parameters for spectrum sharing on its next generation of data-oriented technologies such as EV-DO and EV-DV
- Ember Networks—the IEEE 802.15.4 and the standardization of the Zigbee protocols, and comparative evaluation of these protocols versus other wireless mesh protocols, with a particular focus on frequency hopping to mitigate interference in unlicensed spectrums
- HP, Northern Telecom (subsequently Nortel Networks), and Intel—business models and building business ecosystems

AT&T (formerly BellSouth International)

Chief of Strategy, One NZ (formerly BellSouth NZ)

1992–1996

Corporate and business strategy, government relations and industry relations, and R&D, including:

- Chairman of the 3rd Generation Interest Group of the GSM MoU (the largest organization of mobile network operators in the world)—assessed the alternative protocols available for 3G, with particular focus on the use of frequency hopping and other techniques to mitigate interference, the requirements to support global roaming, and to qualify state-of-the-art mobile devices for advanced services
- Chairman of the New Zealand Personal Communications Services working group—assessed the coexistence of various wireless protocols, with a particular focus on their frequency hopping strategies, including, for example, the interaction between DECT and the Japanese Personal Handyphone System (PHS)
- one of the leaders of a global task force evaluating the technologies and business models for satellite networks, including major new networks such as Iridium, Globalstar, and Teledesic
- pioneered the first PDA with digital cellular connectivity (Apple Newton, Nokia Data Card and Nokia 2110) and collaborated with Nokia on the development and testing of the very first modern smartphone, the Nokia Communicator
- built the business from pre-launch through to profitability, which has now become the clear market leader and Vodafone's most successful business worldwide
- designed and drove a path-breaking multi-million-dollar global academic research program on the economics of communications, networks, and technologies in deregulated markets. Fellow participants included Jean-Jacques Laffont, Jean Tirole, Paul David, David Teece, David Gabel, and Glenn Woroch.

Boston Consulting Group

Manager

1991–1993

Michael focused on technology and telecoms businesses, including Philips Electronics, Telecom NZ, Telstra, and in particular BellSouth International. Responsible for training programs in advanced analytical techniques for strategy development.

Braxton Associates

Manager

1987–1991

Michael worked on a wide range of strategy projects, focusing on electronics and defense businesses in particular, such as companies involved in command and control systems, aircraft, tanks, submarines, and satellite networks. Also worked on corporate strategy, product development, manufacturing and operational transformation, and market entry. Played a leading role in development and training, focusing in particular on approaches to organizational transformation.

Mars Electronics

Project Manager, Program Manager

1984–1987

Michael worked as roboticist; cyberneticist; and designer, developer, and program manager for large-scale real-time systems for manufacturing and logistics. Involved in the development of overall business strategy.

Cookson Group

Robotics Engineer, Project Manager

1982–1984

Michael worked as a robotics engineer and automation manager overseeing and supporting many existing robotic handling and other automation systems. Designed, developed, and deployed additional state-of-the-art robotic and automation systems for manufacturing processes and material handling.

Academic Experience

Massachusetts Institute of Technology

Senior Lecturer–Integrated Design and Management

Michael was invited to create and teach, as part of Integrated Design Lab I and Integrated Design Lab II (EM.441 and EM.442), courses that present fundamentals of and advanced topics in integrated design and product development process.

Michael developed and taught fundamental concepts, including innovation, emerging technologies, product management, product marketing, basic finance and business models, and pricing and marketing. Developed and taught advanced topics, including competitive analysis and market opportunity identification, funding entrepreneurship, business plan and pitch, and data-driven decision-making.

Senior Lecturer–Engineering Systems Division (now Institute for Data, Systems, and Society)

Michael was responsible for creating, managing, and teaching two capstone leadership courses, the Systems Leadership & Management Lab (SL&M Lab) and Praxis (ESD.39 and ESD.S51).

SL&M Lab is a semester-long course in which System, Design, and Management (SDM) Fellows work at least one full day per week ("fifteen person-days) on average with the top management of a high-tech business on a relevant real-world systems and management challenge. The host companies set the focus; therefore, project teams work on problems of true concern to the host companies.

The course also focuses on challenges such as team roles, logical thinking and writing, and the use of graphical communication. Assignments can range from high-level systems thinking issues to building a prototype. SDM students take this experience with them as they work with their host companies or continue in their career progression and development.

The SL&M Praxis course is about praxis: practice—application or use of knowledge or skills—as distinguished from theory. The course gives SDM Fellows insights into the realities of decision-making and managerial behavior in large, complex, high-tech, and systems businesses. It provides students with systematic approaches to apply their systems, architecture, technology, and strategy learnings to real-world leadership and management challenges. This course runs during the summer session as a complement to and preparation for the SL&M Lab course.

Senior Lecturer–Bernard M. Gordon-MIT Engineering Leadership Program, School of Engineering

The Bernard M. Gordon-MIT Engineering Leadership Program (<http://web.mit.edu/gordonelp/>) fosters new approaches that prepare the nation's young engineering leaders for productive and effective careers in engineering companies, and continues MIT's rich, innovative tradition of engineering leadership.

Michael taught the capstone undergraduate leadership course, Engineering Leadership (ESD.045).

The Engineering Leadership course exposes students to the models and methods of engineering leadership within the contexts of conceiving, designing, implementing, and operating products, processes, and systems. In particular, taught the Engineering Systems elements of the course, homed within AeroAstro.

The Technology & Strategy course provides a strategic framework for managing high-tech businesses. It emphasizes the development and application of ways of thinking or mental models that bring clarity to the complex co-evolution of technological innovation, the demand opportunity, business ecosystems, decision-making, and execution within the business.

These tools help managers anticipate and decide how to respond to the behavior of competitors, complementors, and customers; and decide which technologies to invest in, opportunities to target, or partnerships to pursue.

Principal Investigator—Engineering Systems Division (now Institute for Data, Systems, and Society)

Involved in the research on the improvement of software project outcomes by attacking complexity and technical debt as part of a National Science Foundation (NSF) I-Corps program.

Researcher and Thesis Advisor

Supervises thesis work on related areas, including recent prize-winning work on the future of the smart grid, and theses on a broad range of issues.

Conducts research on how psychology shapes consumers' buying behavior and how product features and specifications influence consumers' choices among products and their liking for products. This culminated in a keynote presentation at MIT in Europe, held in Vienna, Austria and a keynote presentation at MIT in South America, held in Chile in 2023

London Business School

The Business of Artificial Intelligence

Course director for the highly rated flagship online program in how to create business value from Artificial Intelligence.

New Technologies Ventures Program

Manage and teach this unique program that brings MBAs and business students from London Business School together with post-doctoral researchers from University College London.

The goal of this course is to enable would-be entrepreneurs to evaluate novel ideas and inventions and turn them into new technology ventures. Participants, who are business professionals, scientists, engineers, and would-be entrepreneurs, explore how entrepreneurs and investors identify and analyze the feasibility of innovative technical ideas, turn them into products and services, and take these products and services to market, as both start-ups and established businesses. A key element of the program is projecting demand for innovative products and new product features

Professional Affiliations

Recognized as a World Class New Zealander (March 2007)

Member, Board of Advisors, Department of Systems Engineering at the United States Military Academy at West Point

Appointed to U.S. Beachhead Board of New Zealand Trade & Enterprise (NZTE) (July 2006)

Member, Board of Directors, Massachusetts Technology Leadership Council (MassTLC)

Co-Chairman, Mobile Cluster, Massachusetts Technology Leadership Council (MassTLC)

Member, Executive Committee, Boston Area Chapter of the Communications Society of the Institute of Electrical and Electronic Engineers (IEEE)

Member, Association for Computing Machinery (ACM)

Member, Academy of Management

Member, Strategic Management Society

Member, Institute for Operations Research and the Management Sciences (INFORMS)

Member, Product Development Management Association (PDMA)

Freeman of the Worshipful Company of Ironmongers