

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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ERICSSON INC., and  
NOKIA OF AMERICA CORPORATION  
Petitioners,

v.

ACTIVE WIRELESS TECHNOLOGIES LLC  
Patent Owner.

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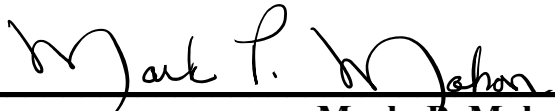
U.S. PATENT NO. 10,785,764  
Title: INFORMATION CHANGE TRANSMISSION METHOD AND DEVICE  
FOR SINGLE-CELL MULTICAST SERVICE

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*Inter Partes* Review No.: IPR2024-00986

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**DECLARATION OF DR. MARK P. MAHON UNDER 37 C.F.R. § 1.68  
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF  
U.S. PATENT NO. 10,785,764**

By:   
Mark, P. Mahon

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I, Dr. Mark P. Mahon, declare as follows:

## **I. INTRODUCTION**

1. I have been retained by Duane Morris on behalf of Petitioners as an independent, technical expert consultant in this proceeding before the United States Patent and Trademark Office (USPTO).<sup>1</sup> I have been ask to consider whether certain references disclose or suggest the limitations found in U.S. Patent No. 10,785,764 (“’764 Patent”) which I may reference as the “challenged patent” in this Declaration as discussed in detail below. My opinions are set forth below.
2. I am being compensated at my rate of \$550 per hour for my services. No part of my compensation depends on my opinions or the outcome of this proceeding. I have no financial interest in any of the parties to this proceeding.
3. In my analysis below, I generally refer to the ’764 Patent for citations unless otherwise noted.
4. Unless otherwise indicated, the emphasis in quotations has been added.

## **II. BACKGROUND AND QUALIFICATIONS**

5. My complete qualifications and professional experience are described in my Curriculum Vitae, a copy of which can be found in Appendix B to this

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<sup>1</sup> Where appropriate, I refer to exhibits that I understand are to be attached to the petition for *Inter Partes* Review of the challenged patent.

Declaration.

6. The following is a brief summary of my relevant qualifications and professional experience
7. I am a Teaching Professor in the School of Electrical Engineering and Computer Science at Pennsylvania State University, University Park, PA (“Penn State” or “PSU”). I have worked on telecommunications and wireless networks, including Z-Wave, Bluetooth, Zigbee, Wi-Fi, NFC, AMPS, IS-95, CDMA2000, GSM, EDGE, UMTS/WCDMA, LTE, and 5G cellular systems since 1988.
8. I received my B.S. in Electronics Engineering from the University of Scranton in 1987. I received my M.S. in Electrical Engineering and Ph.D. in Acoustics from Penn State in 1991 and 2001, respectively.
9. In 1988, after I received my bachelor’s degree, I joined the Central Intelligence Agency (CIA) while pursuing my M.S. degree at Penn State part-time. My first job at the CIA involved designing and testing systems to automatically capture and characterize telecommunication signals and emissions from various wireless and computer networking devices.
10. I returned to Penn State in early 1990 to pursue graduate research full-time and complete my M.S. degree. My graduate research work focused on wideband beamforming and adaptive signal processing. After completing my

M.S. degree in EE in 1991, I accepted a full-time faculty research position at the Applied Research Lab at PSU, primarily working on classified programs, and began working on diverse radio frequency and acoustic sensor systems including wireless communications and small wireless networks for acoustic tracking, source localization, and feature extraction.

11. I began pursuing my Ph.D. part-time in 1993 while continuing my faculty research position. In 1997, as part of my faculty research position, I began working on classified programs focused on mathematical analytical modeling of cellular communication networks and the development of hardware and software systems to test against cellular networks. My role was to develop the algorithms and write the code running on a specially developed embedded system. For this work, I received a letter of recognition as the “genius behind the VELA software algorithms” from the Director of National Reconnaissance Office (NRO) Systems Engineering and Technology Office. As part of this same work, I was extensively involved in protocol and signaling analysis as well as researching model-specific performance and unique functional characteristics associated with individual mobile devices. The work involved testing dozens of handsets from many manufacturers in controlled and real-world environments against network simulators and live operational networks for each research project.

12. In 2000, my research extended into utilizing non-orthogonal wavelets for improving detection and localization of cellular handsets from high altitude sensor systems. In 2001, I completed my Ph.D. and my research focused on the utilization of advanced communication signals for wideband characterization and remote sensing of propagation channels.
13. Beginning in 1997, my cellular communications research work focused on CDMA, GSM, EDGE, UMTS, LTE, and 5G cellular systems primarily under grants sponsored principally by the Department of Defense. This classified research work required 3GPP protocol analysis and development of real-time embedded hardware and software systems capable of interacting with cellular networks and cellular handsets. A large portion of my work was directed at architectures, protocols, software, and signaling.
14. I have been working on classified projects since 1988. Before 1998, because the work was not deemed highly classified, I was able to publish eight journal and conference papers prior to 2000. Between 1999 and 2015, however, I was allowed to publish only one article in an unclassified symposium and published and presented about a dozen articles in classified settings. This is because during this period, the vast majority of my research was highly classified. As a result, nearly all of my research results were summarized in classified reports and not available to the general public. Further, because the

U.S. government owns any intellectual property resulting from the sponsored research work, I did not pursue or file patent applications.

15. In 2015, I transferred to the School of Electrical Engineering and Computer Science at Penn State as a teaching faculty member. In that role, I have continued teaching graduate and undergraduate courses, guiding Ph.D. and M.S. students in communication and mobile networking (including LTE and 5G cellular networks), and pursuing research in this and related areas. Since 2015, I have been an author on nine refereed papers as listed in my curriculum vitae (CV) (attached as Appendix B).
16. Because of my decades of research and my continuing work at Penn State, I have intimate knowledge of telecommunication networks, including the technology involved in the patents in this case. I have been highly recognized as an expert in such systems within the research community. I was recognized twice by the National Reconnaissance Office with commendation letters for work dealing with detecting cellular signals in low signal to noise ratio environments. The U.S. government awarded me over \$12M in grants between 2003 and 2015 for projects focused on mobile communication devices and networks, in which I served as a Principal Investigator (PI), Co-PI, and/or technical lead.
17. Additionally, during my research career, I interacted extensively with

computer scientists and engineers responsible for the design, development, and testing of telephony and data networking systems and testbeds. As a research faculty member, I oversaw engineers and computer scientists that executed many joint projects with development organizations. These interactions exposed me to a wide range of computer scientists and engineers working on telecommunication network technologies. Since 2011, I have been teaching undergraduate and graduate classes in communication and mobile networking and am familiar with the curricula being taught to electrical engineers and computer scientists. The interactions with a wide range of computer scientists and engineers working on telecommunication network technologies and the familiarity with the classes taught to electrical engineers and computer scientists have allowed me to have a good understanding of the level of skills possessed by a person of ordinary skill in the field of cellular technology.

18. I have extensive experience with mobile networks in general and LTE and 5G specifically. While most of my research efforts between 1998 and 2015 were highly classified, I can state that they included detailed investigation of network architectures, signaling, and functional behavior. A typical research effort would involve studying 3GPP, 3GPP2, IEEE, and other protocol standards to fully comprehend all aspects of L1, L2, and L3 requirements

including timing, bit-level construction of the control and user plane messages, and timing characteristics for a given standard as well as functional behavior of network components and user equipment.

19. From 2006 through 2015, my research focused specifically on LTE. My research continues to this day, although I am no longer operating in a classified environment. During this time, I investigated the performance and functional differences of many varied network and handset devices to see how differing signaling and hardware configurations (including MIMO) and environmental factors influenced the behavior of user equipment in a given network environment. This included how diversity techniques (transmit and receive), synchronization, timing, and signal to interference plus noise ratio (SINR) for a given device would affect specific functional aspects including elements of the receiver structure, decoding and demodulation performance, calculation of parameters used by the device for making decisions and deriving parameters reported to the network.
20. As part of my research work, I built several custom CDMA, GSM, UMTS, and LTE platforms that implemented specific network-side and user equipment-side functionality including custom signal generation and processing structures, particularly the signal processing chains on both the transmit and receive sides. This equipment was developed using network

simulation hardware in a laboratory environment and was later tested with corresponding networks in both controlled and fully operational environments. Implementing the transmit and receive chains for custom built protocol-enabled equipment required me to gain an intimate understanding of the relevant 3GPP protocol specifications and the underlying structures. Since 2015, I have been primarily focused on guiding graduate students pursuing research including network scheduling and resource optimization techniques, using code domain non-orthogonal multiple access (NOMA) combined with MIMO sparse coding multiple access to minimize latency and maximize user density in grant free Internet of Things (IoT) environments. Additionally, I am guiding my graduate students in pursuing research in optimized distributed processing algorithms, implementation of block chain coding techniques to improve handover security, and edge computing resource allocation in 4G (LTE)/5G (NR) networks.

21. Much of the classified research work I performed also led to similar approaches for other wireless protocols including IEEE 802.11 and 802.15 (e.g., Zigbee, Bluetooth, and UWB), HART, and other short-range standards as well as HF radio and Wi-MAX.

### **III. MATERIALS REVIEWED**

22. The opinions contained in this Declaration are based on the documents I reviewed, my professional judgment, as well as my education, experience, and knowledge regarding cellular networking systems.
23. I have reviewed all of the documents referenced in this Declaration. I have reviewed the challenged patent and its prosecution history. I have listed the reviewed materials in in Appendix A to this Declaration.

#### **IV. LEGAL STANDARDS**

24. I am not an attorney and offer no legal opinions. My analysis and opinions are based on my expertise in this technical field and on the instructions that counsel has given me for the legal standards relating to patentability as outlined in the rest of this section. I have applied these principles in reaching the opinions set forth herein do not provide any legal opinions in this Declaration. I have been informed and understand that certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims.
25. I understand and the standard that I have used throughout my Declaration is that, in this proceeding, a patent claim may be deemed unpatentable as “anticipated” if it is shown by a preponderance of the evidence that each-and-every feature of the claim is found in a single prior art reference or rendered

“obvious” if, in view of a prior art reference or a combination of prior art references, it would have been obvious to a person of ordinary skill in the art (“POSITA”) at the time of the invention, taking into account the following four issues: (1) the scope and intent of the prior art, (2) the differences between the prior art and the claim under consideration, (3) the level of ordinary skill in the art, and (4) any secondary evidence bearing on obviousness.

26. Counsel has informed me that legal principles regarding unpatentability of a claim due to obviousness have been addressed by the U.S. Supreme Court and that, while not absolute, the principles relating to a “motivation,” “suggestion,” or “teaching” in the prior art to combine references are useful in analyzing whether an invention is obvious. Counsel has also informed me that the suggestion or motivation may be either explicit or implicit and may come from knowledge generally available to a POSITA, from the nature of the problem to be solved, or from a combination of these factors. The test for an implicit motivation, suggestion, or teaching is what the combined teachings, knowledge of a POSITA, and the nature of the problem to be solved as a whole would have suggested to those of ordinary skill in the art. The analysis is not focused on the specific problem solved by the invention, but the general problem that confronted the inventor prior to the invention.

27. Counsel has further informed me that the U.S. Supreme Court has clarified that additional principles may also be applied in such an analysis. Some of those principles are set forth below.
28. I have been informed by counsel that it is no longer always required to present evidence of an explicit teaching, suggestion, or motivation to combine prior art references for purposes of determining whether an invention is obvious. Prior art can be combined based on several factors including: an express teaching, suggestion, or motivation from the prior art itself, or from a reasoned explanation of an expert or other witness.
29. I have been informed that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was independently known in the prior art. In evaluating whether such a claim would have been obvious, I may consider whether there is a reason that would have prompted a person of ordinary skill in the field to combine the elements or concepts from the prior art in the same way as in the claimed invention.
30. To determine whether there was an apparent reason to combine the known elements in the way a patent claims, it will often be necessary to look to interrelated teachings of multiple pieces of prior art, to the effects of demands known to the design community or present in the marketplace, and to the background knowledge possessed by a POSITA. Also, in determining

obviousness, one must be aware of the distortion caused by hindsight bias and be cautious of arguments relying upon hindsight reasoning. An obviousness argument cannot be sustained by mere conclusory statements. Instead, it must be some articulated reasoning with some rational underpinnings to support the legal conclusion of obviousness.

31. In an obviousness analysis, it is my understanding that there are “secondary considerations” that should be analyzed if they apply. I am told that these considerations include (a) whether the prior art teaches away from the claimed invention, (b) whether there was a long felt but unresolved need for the claimed invention, (c) whether others tried but failed to make the claimed invention, (d) skepticism of experts, (e) whether the claimed invention was commercially successful, (f) whether the claimed invention was praised by others, and (g) whether the claimed invention was copied by others.
32. I have also been informed that in order for evidence of secondary considerations to be significant, there must be a sufficient relationship between the claimed invention and the evidence of secondary considerations. I understand that this relationship serves to provide a link between the merits of the claimed invention and the evidence of secondary considerations provided.
33. I have been informed by counsel that the Board construes claims according to

the so-called “Phillips” standard. Under the Phillips standard, terms in a claim are given their ordinary and customary meaning, consistent with the patent’s specification, as understood by a POSITA. I have been informed by counsel that what is to be considered includes the claims, the patent specifications and drawings, and the prosecution history, including any art listed by the examiner or the Applicant. I have been informed by counsel that information external to the patent, including expert and inventor testimony and unlisted prior art, are to be considered if ambiguities remain. However, expert testimony may be useful in helping to explain the technology.

34. I have been informed and understand that a patent claim is not patentable as obvious if the differences between the patent claim and the prior art are such that the claimed subject matter as a whole would have been obvious at the time the claimed invention was made to a person having ordinary skill in the relevant art.
35. In analyzing the relevance of the differences between the claimed invention and the prior art, I have been informed that I must consider the impact of such differences on the obviousness or non-obviousness of the invention as a whole, not merely some portion of it. The person of ordinary skill faced with a problem is able to apply their experience and ability to solve the problem and also look to any available prior art to help solve the problem.

36. I have been informed and understand that there are recognized, exemplary rationales for combining or modifying references to show the obviousness of claimed subject matter. Some of the rationales include the following: combining prior art elements according to known methods to yield predictable results; simple substitution of one known element for another to yield predictable results; use of a known technique to improve a similar device (method or product) in the same way; applying a known technique to a known device (method or product) ready for improvement to yield predictable results; choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; and some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art teachings to arrive at the claimed invention.

## **V. LEVEL OF ORDINARY SKILL IN THE ART**

37. It is my understanding that a person of ordinary skill in the art (“POSITA”) is a hypothetical person who is used to analyze the prior art without the benefit

of hindsight. I have been instructed that the level of ordinary skill may be reflected by the prior art of record, and that a person of ordinary skill in the art to which the claimed subject matter pertains would have the capability of understanding the scientific and engineering principles applicable to the pertinent art. I have been instructed that there are multiple factors that may be considered in determining the level of ordinary skill in the art may include: (1) type of problems encountered in the prior art; (2) prior art solutions to those problems; (3) rapidity with which innovations are made; (4) sophistication of the technology; and (5) educational level of active workers in the field. I also understand that a POSITA is also a person of ordinary creativity, not an automaton. They would be able to fit the teachings of multiple patents together like a puzzle and have the capability of understanding the scientific and engineering principles applicable to the pertinent art.

38. I have been asked to provide a definition for the level of ordinary skill in the art in the field of the challenged at the time the priority application was filed. As stated in the challenged '764 Patent, "The technology relates to the field of wireless communications technologies. More specifically, the present invention relates to an information change transmission method and device for a single-cell multicast service." EX-1001, 1:7-10.

39. In my opinion, a POSITA as of the claimed priority date of the challenged patent would have had (1) the equivalent of an undergraduate degree in Electrical Engineering or a related field; and (2) at least two years of experience in design, development, and/or testing of wireless telecommunication systems. In a similar vein, a POSITA would also have familiarity with the wireless standards and protocols related to data transmission and network management. It is also my opinion that more education could supplement practical experience or vice versa. For example, such knowledge could be acquired by a mixture of training and work experience such as a Master's degree in Electrical Engineering with less work experience.
40. When forming my opinions herein, I analyzed and applied the prior art and claim constructions from a POSITA's perspective at the invention's time.
41. I understand that a POSITA is presumed to have knowledge of all references that are sufficiently related to one another and to the pertinent art and to have knowledge of all arts reasonably pertinent to the particular problem that the claimed invention addresses.
42. All of my opinions in this Declaration are from the perspective of a POSITA, as I have defined it above and during the relevant time frame, *i.e.*, on or around date of the priority application. During this time frame, I possessed at least

the qualifications of a person of ordinary skill in the art, as defined above, and I am capable of addressing the issues from the perspective of such a person. My opinions in this declaration reflect how a POSITA would have understood the claims and the specification of the challenged patent, the prior art to the patent, and the state of the art on or around the priority date.

## **VI. TECHNICAL BACKGROUND AND STATE OF THE ART**

43. The following section describes the relevant state of the art as of the priority date. The prior art references, and the discussions of what was known to a POSITA, provide the factual support for the general description of the state of the art, assist in understanding how a POSITA would have understood the prior art, and provide the motivation to modify or combine the teachings of references.

### **A. SC-PTM**

44. Single-cell point-to-multipoint (“SC-PTM”) is a term referring to multicast transmission of a multimedia broadcast performed within a single cell. EX-1001, 51-53. A representation of a SC-PTM transmission is shown in Figure 1 of Xu, reproduced below.

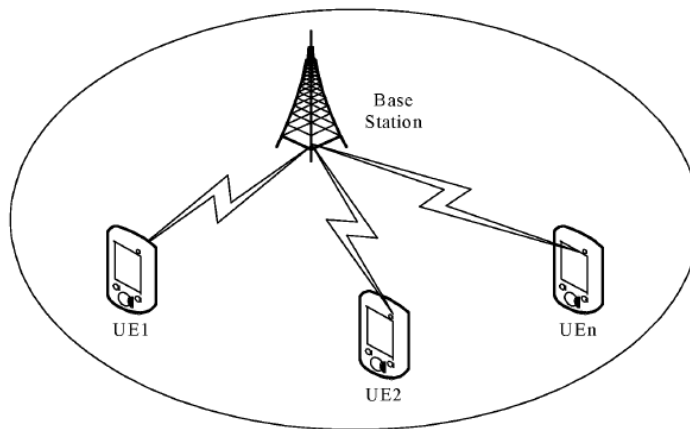


Fig. 1

EX-1006, Fig. 1.

45. A group known as the 3rd Generation Partnership Project (3GPP) defines global technical specifications and reports for present and future wireless communication systems. These standards are used by equipment manufacturers – both for network equipment, such as base stations (BS), and end-user devices, referred to as user equipment (UE) – to ensure that the devices may communicate with one another. Standards for SC-PTM were longstanding by August 2016. For example, 3GPP Technical Specification 36.331 v.13.2.0, which was publicly available and accessible by July 11, 2016, discloses:

SC-PTM control information is provided on a specific logical channel: the SC-MCCH. The SC-MCCH carries the *SCPTMConfiguration* message which indicates the MBMS sessions that are ongoing as well

as the (corresponding) information on when each session may be scheduled, i.e. scheduling period, scheduling window and start offset. The *SCPTMConfiguration* message also provides information about the neighbour cells transmitting the MBMS sessions which are ongoing on the current cell.

EX-1009, Section 5.8.1.1 (emphasis in original).

46. “MBMS” refers to a Multimedia Broadcast/Multicast Service, which was also well known in the art. 3GPP proposed MBMS in order to effectively utilize mobile network resources. EX 1004, 1:28-30. MBMS is a technology used to transmit from a data source (e.g., a BS) to multiple target mobile terminals (e.g., UEs) in order to implement sharing of a network resource and increase the resource’s utilization. EX-1006, 1:30-35.
47. SC-MCCH refers to a single-cell multicast control channel, which carries information necessary to schedule and configure the transmission of a MBMS. EX-1001, 1:56-63. The use of change notifications to indicate a change in SC-MCCH information was also well established in the prior 3GPP specifications. For example:

### 5.8a.1.3 SC-MCCH information validity and notification of changes

Change of SC-MCCH information only occurs at specific radio frames, i.e. the concept of a modification period is used. Within a modification period, the same SC-MCCH information may be transmitted a number of times, as defined by its scheduling (which is based on a repetition period). The modification period boundaries are defined by SFN values for which  $\text{SFN} \bmod m = 0$ , where  $m$  is the number of radio frames comprising the modification period. The modification period is configured by means of *SystemInformationBlockType20*.

When the network changes (some of) the SC-MCCH information, it notifies the UEs about the change in the first subframe which can be used for SC-MCCH transmission in a repetition period. LSB bit in 8-bit bitmap when set to '1' indicates the change in SC-MCCH. Upon receiving a change notification, a UE interested to receive MBMS services transmitted using SC-PTM acquires the new SC-MCCH information starting from the same subframe. The UE applies the previously acquired SC-MCCH information until the UE acquires the new SC-MCCH information.

EX-1009, pg. 184 (Section 5.8a.1.3).

### B. NB-IoT

48. The '764 Patent acknowledges that the Narrowband Internet of Things ("NB-IoT") was a project implemented by the 3GPP prior to the filing of the '544 Provisional. EX-1001, 1:25-30. The project aimed to meet the requirements of terminals in the IoT, such as low power consumption, long standby, cost reduction, and wide coverage. EX-1001, 1:34-36. To meet these requirements, the NB-IoT was configured to be a narrow band system that operates on 180 kHz uplink and downlink. EX-1001, 1:31-34. The 180 kHz bandwidth corresponds is the size of one resource block (RB)/physical resource block (PRB) in the frequency direction, which is made up of 12 15KHz subcarriers and is 1/6 the number of usable resource blocks of the narrowest LTE system bandwidth (1.4MHz). EX-1011 ¶85; EX-1004, 19. A resource block includes a plurality of subcarriers in the frequency direction. EX-1011 ¶64.

49. Established support and standards already existed by August 2016 for basic function designs for the NB-IoT including broadcast notification of system information, point-to-point unicast uplink data transmission, and downlink data transmission. EX-1001, 1:35-40. Specifically, it was decided at the 3GPP RAN #72 plenary meeting held in June 2016 that multicast transmission in the NB-IoT system was to be implemented on the basis of the features of the existing version 13 LTE SC-PTM. EX-1001, 1:36-50.

### **C. DCI formats**

50. The admitted prior art version of the 3GPP specification, i.e., version 13, defined several DCI formats, including three DCI formats for NB-IoT: N0, N1, and N2.

#### **6.4.3.1 DCI Format N0**

DCI format N0 is used for the scheduling of NPUSCH in one UL cell.

The following information is transmitted by means of the DCI format N0:

- Flag for format N0/format N1 differentiation – 1 bit, where value 0 indicates format N0 and value 1 indicates format N1
- Subcarrier indication – 6 bits as defined in section 16.5.1.1 of [3]
- Resource assignment – 3 bits as defined in section 16.5.1.2 of [3]
- Scheduling delay – 2 bits as defined in section 16.5.1 of [3]
- Modulation and coding scheme – 4 bits as defined in section 16.5.1.2 of [3]
- Redundancy version – 1 bit as defined in section 16.5.1.2 of [3]
- Repetition number – 3 bits as defined in section 16.5.1.2 of [3]
- New data indicator – 1 bit
- DCI subframe repetition number – 2 bits as defined in section 16.6 in [3]

### 6.4.3.2 DCI Format N1

DCI format N1 is used for the scheduling of one NPDSCH codeword in one cell and random access procedure initiated by a NPDCCH order. The DCI corresponding to a NPDCCH order is carried by NPDCCH.

The following information is transmitted by means of the DCI format N1:

- Flag for format N0/format N1 differentiation – 1 bit, where value 0 indicates format N0 and value 1 indicates format N1
- NPDCCH order indicator – 1 bit

Format N1 is used for random access procedure initiated by a NPDCCH order only if NPDCCH order indicator is set to '1', format N1 CRC is scrambled with C-RNTI, and all the remaining fields are set as follows:

- Starting number of NPRACH repetitions – 2 bits as defined in section 16.3.1 of [3]
- Subcarrier indication of NPRACH – 6 bits as defined in section 16.3.1 of [3]
- All the remaining bits in format N1 are set to one

Otherwise,

- Scheduling delay – 3 bits as defined in section 16.4.1 of [3]
- Resource assignment – 3 bits as defined in section 16.4.1.3 of [3]
- Modulation and coding scheme – 4 bits as defined in section 16.4.1.5 of [3]
- Repetition number – 4 bits as defined in section 16.4.1.3 of [3]
- New data indicator – 1 bit
- HARQ-ACK resource – 4 bits as defined in section 16.4.2 of [3].
- DCI subframe repetition number – 2 bits as defined in section 16.6 in [3]

When the format N1 CRC is scrambled with a RA-RNTI, then the following fields among the fields above are reserved:

- New data indicator
- HARQ-ACK resource

If the number of information bits in format N1 is less than that of format N0, zeros shall be appended to format N1 until the payload size equals that of format N0.

### 6.4.3.3 DCI Format N2

DCI format N2 is used for for paging and direct indication.

The following information is transmitted by means of the DCI format N2:

Flag for paging/direct indication differentiation – 1 bit, with value 0 for direct indication and value 1 for paging

If Flag=0:

- Direct Indication information – 8 bits provide direct indication of system information update and other fields, as defined in [6]
- Reserved information bits are added until the size is equal to that of format N2 with Flag=1

If Flag=1:

- Resource assignment – 3 bits as defined in section 16.4.1.3 of [3]
- Modulation and coding scheme – 4 bits as defined in section 16.4.1.5 of [3]

EX-1007, pp. 134-36 (Sections 6.4.3.1-6.4.3.3).

51. DCI is responsible for transporting several categories of instruction including downlink scheduling information and notifications of MCCH and SC-MCCH change. EX-1007, Section 5.3.3. NB-IoT DCI is carried on narrowband physical downlink control channels (“NPDCCH”). EX-1007, Section 6.1.

### **D. RNTI**

52. For each DCI, one Radio Network Temporary Identifier (“RNTI”) value is implicitly encoded for a Cyclic Redundancy Check (“CRC”):

### 5.3.3 Downlink control information

A DCI transports downlink, uplink or sidelink scheduling information, requests for aperiodic CQI reports, LAA common information, notifications of MCCCH change [6] or uplink power control commands for one cell and one RNTI. The RNTI is implicitly encoded in the CRC.

Figure 5.3.3-1 shows the processing structure for one DCI. The following coding steps can be identified:

- Information element multiplexing
- CRC attachment
- Channel coding
- Rate matching

The coding steps for DCI are shown in the figure below.

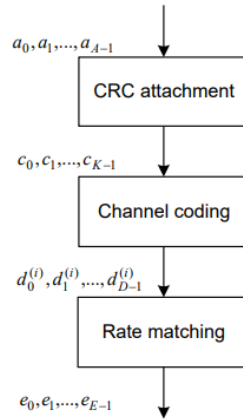


**Figure 5.3.3-1: Processing for one DCI.**

EX-1007, pg. 100 (Section 5.3.3).

53. The CRC provides error detection on DCI transmissions. EX-1007, at 5.3.3.2 (“Error detection is provided on DCI transmissions through a Cyclic Redundancy Check (CRC).”). RNTI values are used to scramble CRC parity bits to be checked by the UE:

In the case where closed-loop UE transmit antenna selection is not configured or applicable, after attachment, the CRC parity bits are scrambled with the corresponding RNTI  $x_{rnti,0}, x_{rnti,1}, \dots, x_{rnti,15}$ , where  $x_{rnti,0}$  corresponds to the MSB of the RNTI, to form the sequence of bits  $c_0, c_1, c_2, c_3, \dots, c_{B-1}$ . The relation between  $c_k$  and  $b_k$  is:

$$c_k = b_k \quad \text{for } k = 0, 1, 2, \dots, A-1$$

$$c_k = (b_k + x_{rnti,k-A}) \bmod 2 \quad \text{for } k = A, A+1, A+2, \dots, A+15.$$

EX-1007, pg. 126 (Section 5.3.3.2).

54. RNTI values can be used to indicate different DCI uses in addition to being used for error detection. Because of this, the detection of different RNTI values are used by UEs in receiving and decoding NPDCCHs and narrowband physical downlink shared channels (“NPDSCH”). For example, if the CRC of a DCI is scrambled by paging RNTI (“P-RNTI”), it indicates that the UE will decode the corresponding NPDCCH and NPDSCH assuming DCI format N2 in a Type-1 Common search space:

If a UE is configured by higher layers to decode NPDCCH with CRC scrambled by the P-RNTI, the UE shall decode the NPDCCH and the corresponding NPDSCH according to any of the combinations defined in Table 16.4.1-2. The scrambling initialization of NPDSCH corresponding to these NPDCCHs is by P-RNTI.

**Table 16.4.1-2: NPDCCH and NPDSCH configured by P-RNTI**

| DCI format    | Search Space  | Transmission scheme of NPDSCH corresponding to NPDCCH                                                                                                             |
|---------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DCI format N2 | Type-1 Common | If the number of NPBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 16.4.1.1), otherwise Transmit diversity (see subclause 16.4.1.2). |

EX-1008, pg. 358 (Section 16.4.1) (Table 16.4.1-2).

55. Similarly, when scrambled with cell RNTI (“C-RNTI”), the UE will decode by assuming DCI format N1 in a UE-specific search space:

If a UE is configured by higher layers to decode NPDCCH with CRC scrambled by the C-RNTI, the UE shall decode the NPDCCH and the corresponding NPDSCH according to any of the combinations defined in Table 16.4.1-4. The scrambling initialization of NPDSCH corresponding to these NPDCCHs is by C-RNTI.

**Table 16.4.1-4: NPDCCH and NPDSCH configured by C-RNTI**

| DCI format    | Search Space          | Transmission scheme of NPDSCH corresponding to NPDCCH                                                                                                             |
|---------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DCI format N1 | UE specific by C-RNTI | If the number of NPBCH antenna ports is one, Single-antenna port, port 0 is used (see subclause 16.4.1.1), otherwise Transmit diversity (see subclause 16.4.1.2). |

EX-1008, pg. 359 (Section 16.4.1) (Table 16.4.1-4).

## **VII. OVERVIEW OF THE CHALLENGED PATENT**

### **A. Priority Date**

56. I have been instructed, for this purpose of this IPR Petition, to assume the priority date for the challenged patent is August 11, 2016 (i.e., the filing date of Foreign Patent Application No. CN2016/0658544 to which the challenged patent claims priority). To the extent the Challenged Claims (i.e., claims 3, 4 and 6) are only entitled to the August 10, 2017 filing date of International Patent Application No. PCT/CN2017/096794, my analysis herein would not change.

### **B. Overview of the Content of the Challenged Patent**

57. The Challenged Claims are directed to techniques for communicating an information change for a single-cell multicast service. Specifically, the claims are directed to communications between a base station (BS) and User Equipment (UE) indicating a change of information on the Single-Cell Multicast Control Channel (SC-MCCH) in a Narrowband Internet of Things (NB-IoT) system. Ordinarily, in a system which conforms to the Long Term Evolution Project (LTE) standard, a UE interested in receiving a multicast service first must acquire scheduling and configuration of an SC-MCCH. The UE can then acquire the necessary control information from that SC-MCCH.

The UE periodically monitors whether any information on the SC-MCCH changes so it can obtain the updated information in time. Changes to the SC-MCCH only occur during specified change periods. When a new service begins or ends, and information on the SC-MCCH therefore needs to change, a BS will broadcast two things in the same subframe: 1) an indication that the SC-MCCH information has changed, and 2) information corresponding to a physical downlink control channel (PDCCH) which will schedule the new SC-MCCH transmission. EX-1001, 1:64-65, 1:67-2:1, 2:10-33.

58. The Challenged Claims “solve” a problem resulting from transmitting the change notification described above on a NB-IoT system. Namely, in order to reduce costs, the NB-IoT system does not support transmitting a change indication and scheduling a new SC-MCCH transmission in the same subframe. The ’764 Patent’s purported solution consists of an information change transmission method and device where the change indication and scheduling of the updated SC-MCCH information are transmitted in different subframes. EX-1001, 2:55-3:3.
59. The Challenged Claims require a BS to be configured to send downlink control information (DCI) on a second narrowband physical downlink control channel (NPDCCH) wherein the DCI includes a change notification for a SC-MCCH. The SC-MCCH change notification is indicated by one bit or a

plurality of bits. The DCI format may be an existing DCI format such as DCI format N1 or N2. The Challenged Claims further require a BS to be configured to send DCI on a first NPDCCH, which indicates transmission of SC-MCCH information. EX-1001, 5:58-67; 6:27-28; 9:6-9.

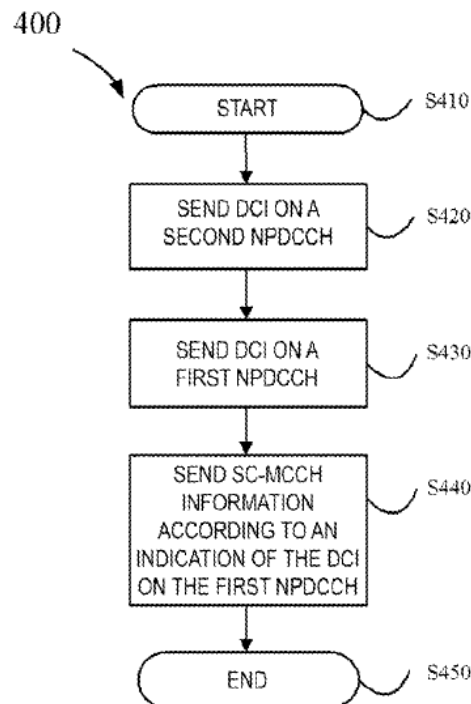


FIG. 4

EX-1001, FIG. 4.

60. The Challenged Claims also recite that when the first NPDCCH and the second NPDCCH are on the same carrier, the first NPDCCH and the second NPDCCH are not within the same subframe. EX-1001, 6:7-9.

61. The Challenged Claims recite a known principle. As acknowledged by the '764 Patent itself, there is nothing novel about transmitting SC-MCCH change information nor about transmitting DCI over NPDCCHs. Shin as well as Xu in view of RAN72 and Fujishiro disclose sending a SC-MCCH change notification in different subframes from the scheduling of updated SC-MCCH information.

### **C. Prosecution History**

62. The '764 Patent issued from U.S. Patent Application No. 16/324,359 which was filed on February 8, 2019 as a National Stage Entry of International Application No. PCT/CN2017/096794. The '764 Patent claims priority from Foreign Patent Application No. CN2016/0658544 ("544 Provisional") filed on August 11, 2016.
63. Before examination, the Applicant cancelled the original 44 claims in a preliminary amendment and added claims 45-48. EX-1002, 67-71. The Claims as originally presented, recited:

Claim 45 (New):

A User Equipment (UE) comprising:

receiving circuitry configured to receive downlink control information (DCI) on a narrowband physical downlink control channel (NPDCCH) after receiving Single-Cell Multicast Control Channel (SC-MCCH) information; and

processing circuitry configured to acquire, in a case that the DCI includes (a) a first field indicating an SC-MCCH information change notification and (b) a second field indicating a resource for a transmission of another SC-MCCH information, the another SC-MCCH information based on the first field and the second field.

Claim 46 (New):

A base station comprising:

transmitting circuitry configured to transmit Single-Cell Multicast Control Channel (SC-MCCH) information; and

generating circuitry configured to generate downlink control information (DCI) which includes (a) a first field indicating an SC-MCCH information change notification and (b) a second field indicating a resource for a transmission of another SC-MCCH information; wherein

the transmitting circuitry is configured to transmit the DCI on a narrowband physical downlink control channel (NPDCCH), and

the transmitting circuitry is configured to transmit the another SC-MCCH information using the resource indicated by the second field.

Claim 47 (New):

A method performed by a User Equipment (UE) comprising:

receiving Single-Cell Multicast Control Channel (SC-MCCH) information;

receiving downlink control information (DCI) on a narrowband physical downlink control channel (NPDCCH);

acquiring, in a case that the DCI includes (a) a first field indicating an SC-MCCH information change notification and (b) a second field indicating a resource for a transmission of another SC-MCCH information, the another SC-MCCH information based on the first field and the second field.

Claim 48 (New):

A method performed by a base station comprising:  
transmitting Single-Cell Multicast Control Channel (SC-MCCH) information;  
generating downlink control information (DCI) which includes (a) a first field  
indicating an SC-MCCH information change notification and (b) a second field indicating a  
resource for a transmission of another SC-MCCH information;  
transmitting the DCI on a narrowband physical downlink control channel (NPDCCH);  
and  
transmitting the another SC-MCCH information using the resource indicated by the second  
field.

EX-1002, 68-69.

64. The Examiner rejected original claims 45-48 as being obvious from U.S. Provisional Application No. 62/372,324 (referred to in the file history as “Shin ‘372,324”; EX-1015), which was partially in Korean, in view of U.S. Patent Publication No. 2019/0182632 (Fujishiro). EX-1002, 171-181. The Examiner’s reasons for rejection are reproduced below.

### ***Claim Rejections - 35 USC § 103***

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, 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 invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

**2a. Claims 45-48** are rejected under 35 U.S.C. 103(a) as being unpatentable over Shin Provisional Application 62/372,324 filed 8/9/2016 (of Application 16/324,288, hereinafter Shin '372,324) in view of Fujishiro (US 20190182632 A1).

#### **2b. Summary of the Cited Prior Art**

Shin '372,324 discloses a method for transmitting/receiving data in a wireless communication system supporting NB-IoT.

Fujishiro discloses a method of SC-MCCH channel management in narrowband IoT.

#### **2c. Claim Analysis**

##### **Regarding Claim 45, Shin '372,324**

A User Equipment (UE) comprising [(see Sec 5.8a.2.1 Fig 5.8a.2.1-1 UE and E-

Further, Shin '372,324 discloses monitoring and receiving NPDCCH, see:

## 16.6 Narrowband physical downlink control channel related procedures

A UE shall monitor a set of NPDCCH candidates (described in subclause 10.2.2.1 of [3]) as configured by higher layer signalling for control information, where monitoring implies attempting to decode each of the NPDCCHs in the set according to all the monitored DCI formats.

The set of NPDCCH candidates to monitor are defined in terms of NPDCCH search spaces.

The UE shall monitor one or more of the following search spaces

- a Type1-NPDCCH common search space,
- a Type2-NPDCCH common search space, and
- a NPDCCH UE-specific search space.

));

processing circuitry configured to acquire, in a case that the DCI includes (a) a first field indicating an SC-MCCH information change notification and (b) a second field indicating a resource for a transmission of another SC-MCCH information, the another SC-MCCH information based on the first field and the second field

[(Shin '372,324 discloses SC-MCCH information including (a) SC-MCCH information change notification indication and period, and (b) other information based on SC-MCCH change and radio resource and MCS information, see:

### 5.8a.1.2 SC-MCCH scheduling

The SC-MCCH information (i.e. information transmitted in messages sent over SC-MCCH) is transmitted periodically, using a configurable repetition period. SC-MCCH transmissions (and the associated radio resources and MCS) are indicated on PDCCH.

### 5.8a.1.3 SC-MCCH information validity and notification of changes

Change of SC-MCCH information only occurs at specific radio frames, i.e. the concept of a modification period is used. Within a modification period, the same SC-MCCH information may be transmitted a number of times, as defined by its scheduling (which is based on a repetition period). The modification period boundaries are defined by SFN values for which  $\text{SFN} \bmod m = 0$ , where  $m$  is the number of radio frames comprising the modification period. The modification period is configured by means of *SystemInformationBlockType20*.

When the network changes (some of) the SC-MCCH information, it notifies the UEs about the change in the first subframe which can be used for SC-MCCH transmission in a repetition period. LSB bit in 8-bit bitmap when set to '1' indicates the change in SC-MCCH. Upon receiving a change notification, a UE interested to receive MBMS services transmitted using SC-PTM acquires the new SC-MCCH information starting from the same subframe. The UE applies the previously acquired SC-MCCH information until the UE acquires the new SC-MCCH information.

### Sec 5.8a.3.4

#### — *SystemInformationBlockType20*

The IE *SystemInformationBlockType20* contains the information required to acquire the control information associated transmission of MBMS using SC-PTM.

#### ***SystemInformationBlockType20* information element**

```

-- ASN1START
SystemInformationBlockType20-r13 ::= SEQUENCE {
    sc-mcch-RepetitionPeriod-r13    ENUMERATED {rf2, rf4, rf8, rf16, rf32, rf64, rf128, rf256},
    sc-mcch-Offset-r13              INTEGER (0..10),
    sc-mcch-FirstSubframe-r13       INTEGER (0..9),
    sc-mcch-duration-r13            INTEGER (2..9) OPTIONAL,
    sc-mcch-ModificationPeriod-r13  ENUMERATED {rf2, rf4, rf8, rf16, rf32, rf64, rf128, rf256,
                                                rf512, rf1024, rf2048, rf4096, rf8192, rf16384, rf32768,
                                                rf65536},
    lateNonCriticalExtension         OCTET STRING OPTIONAL,
    ...
}
-- ASN1STOP
```

UTRAN)]:

receiving circuitry configured to receive downlink control information (DCI) on a narrowband physical downlink control channel (NPDCCH) after receiving Single-Cell Multicast Control Channel (SC-MCCH) information

[(Shin '372,324 discloses UE acquiring SC-MCCH information, see:

## 5.8a.2 SC-MCCH information acquisition

### 5.8a.2.1 General



Figure 5.8a.2.1-1: SC-MCCH information acquisition

The UE applies the SC-MCCH information acquisition procedure to acquire the SC-PTM control information that is broadcast by the E-UTRAN. The procedure applies to SC-PTM capable UEs that are in RRC\_IDLE or in RRC\_CONNECTED.

### 5.8a.2.2 Initiation

A UE interested to receive MBMS services via SC-MRB shall apply the SC-MCCH information acquisition procedure upon entering the cell broadcasting *SystemInformationBlockType20* (e.g. upon power on, following UE mobility) and upon receiving a notification that the SC-MCCH information has changed. A UE that is receiving an MBMS service via SC-MRB shall apply the SC-MCCH information acquisition procedure to acquire the SC-MCCH information that corresponds with the service that is being received, at the start of each modification period.

Unless explicitly stated otherwise in the procedural specification, the SC-MCCH information acquisition procedure overwrites any stored SC-MCCH information, i.e. delta configuration is not applicable for SC-MCCH information and the UE discontinues using a field if it is absent in SC-MCCH information unless explicitly specified otherwise.

### 5.8a.2.3 SC-MCCH information acquisition by the UE

A SC-PTM capable UE shall:

- 1> if the procedure is triggered by an SC-MCCH information change notification:
- 2> start acquiring the *SCPTMConfiguration* message from the subframe where the change notification was received;

NOTE 1: The UE continues using the previously received SC-MCCH information until the new SC-MCCH information has been acquired.

| <b>SystemInformationBlockType20 field descriptions</b> |                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>sc-mcch-ModificationPeriod</b>                      | Defines periodically appearing boundaries, i.e. radio frames for which $\text{SFN mod sc-mcch-ModificationPeriod} = 0$ . The contents of different transmissions of SC-MCCH information can only be different if there is at least one such boundary in-between them. Value r2 corresponds to 2 radio frames, value r4 corresponds to 4 radio frames and so on. |
| <b>sc-mcch-duration</b>                                | Indicates, starting from the subframe indicated by <i>sc-mcch-FirstSubframe</i> , the duration during which SC-MCCH may be scheduled in non-MBSFN subframes. Absence of this IE means that SC-MCCH is only scheduled in the subframe indicated by <i>sc-mcch-FirstSubframe</i> .                                                                                |
| <b>sc-mcch-Offset</b>                                  | Indicates, together with the <i>sc-mcch-RepetitionPeriod</i> , the radio frames in which SC-MCCH is scheduled i.e. SC-MCCH is scheduled in radio frames for which: $\text{SFN mod sc-mcch-RepetitionPeriod} = \text{sc-mcch-Offset}$ .                                                                                                                          |
| <b>sc-mcch-FirstSubframe</b>                           | Indicates the first subframe in which SC-MCCH is scheduled                                                                                                                                                                                                                                                                                                      |
| <b>sc-mcch-RepetitionPeriod</b>                        | Defines the interval between transmissions of SC-MCCH information, in radio frames. Value r2 corresponds to 2 radio frames, r4 corresponds to 4 radio frames and so on.                                                                                                                                                                                         |

Further, Fujishiro also discloses SC-MCCH information including (a) SC-MCCH information change notification indication and period, and (b) other information based on SC-MCCH change and radio resource and MCS information, see:

processing circuitry configured to acquire, in a case that the DCI includes (a) a first field indicating an SC-MCCH information change notification and (b) a second field indicating a resource for a transmission of another SC-MCCH information, the another SC-MCCH information based on the first field and the second field

[(Fujishiro discloses:

[0117] FIGS. 15A and 15B are diagrams is a diagram illustrating the repetition number information. FIG. 15A illustrates a case where the repetition number information (#of repetition) is provided in the SIB20. As illustrated in FIG. 15A, the eNB 200 provides the repetition number information of the MPDCCH (or NPDCCH) corresponding to the SC-MCCH and the repetition number information of the narrowband PDSCH corresponding to the SC-MCCH in the SIB20. Even when the

repetitive transmission is applied to the SC-MCCH, the UE 100 can appropriately receive the SC-MCCH based on the repetition number information in the SIB20. FIG. 15B illustrates a case where the repetition number information (# of repetition) is provided in the SC-MCCH. As illustrated in FIG. 15B, the eNB 200 provides the repetition number information of the MPDCCH (or NPDCCH) corresponding to the SC-MTCH and the repetition number information of the narrowband PDSCH corresponding to the SC-MTCH in the SC-MCCH. Here, an example is illustrated in which the repetition number information is provided for each MBMS service (TMGI). The UE 100 can appropriately receive the SC-MTCH based on the repetition number information in the SC-MCCH.

Fig 9-13 and 15A-15B)].

Therefore, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to integrate Shin '372,324's method for transmitting/receiving data in a wireless communication system supporting NB-IoT with Fujishiro's method of SC-MCCH channel management in narrowband IoT with the motivation being to efficiently receive multicast/broadcast services (Fujishiro, Para [0004]).

**Regarding Claim 46,** the claim discloses similar features as of Claim 45, and is rejected based on the same rationales of Claim 45. Further, Claim 46 discloses the same operations of Claim 45, but are performed by a base station.

**Regarding Claim 47,** the claim discloses similar features as of Claim 45, and is rejected based on the same rationales of Claim 45.

**Regarding Claim 48,** the claim discloses similar features as of Claim 45, and is rejected based on the same rationales of Claim 45. Further, Claim 46 discloses the same operations of Claim 45, but are performed by a base station.

EX-1002, 174-80.

65. In response, the Applicant amended Claims 45-48 to require multiple DCI formats and to be carried in different subframes, and Applicant added Claims 49 and 50. EX-1002, 208-211. The amended and new claims are reproduced below.

**45. (Currently Amended)**

A User Equipment (UE) comprising:

receiving circuitry configured to receive, in more than one second subframe, a second downlink control information (DCI) format carried on a second narrowband physical downlink control channel (NPDCCH), after receiving Single-Cell Multicast Control Channel (SC-MCCH) information; and

processing circuitry configured to acquire, on the basis of a first DCI format carried on a first NPDCCH and received in more than one first subframe, another SC-MCCH information, in a case that the second DCI format includes (a) a first field indicating indicates an SC-MCCH information change notification, wherein

a period of the more than one first subframe is different from a period of the more than one second subframe, and

(b) a second field indicating the first DCI format indicates a resource for a transmission of the another SC-MCCH information, ~~the another SC-MCCH information based on the first field and the second field.~~

**46. (Currently Amended)**

A base station comprising:

transmitting circuitry configured to transmit Single-Cell Multicast Control Channel (SC-MCCH) information; and

generating circuitry configured to generate a second downlink control information (DCI) ~~format which includes (a) a first field indicating an SC-MCCH information change notification, and (b) a second field indicating a resource for a transmission of another SC-MCCH information;~~ wherein

the transmitting circuitry is configured to transmit, in more than one second subframe, the second DCI format carried on a second narrowband physical downlink control channel (NPDCCH),  
[[and]]

the generating circuitry configured to generate a first DCI format indicating a resource for a transmission of another SC-MCCH information.

the transmitting circuitry is configured to transmit, in more than one first subframe, the first DCI format carried on a first NPDDCH.

a period of the more than one first subframe is different from a period of the more than one second subframe, and

the transmitting circuitry is configured to transmit the another SC-MCCH information ~~using~~ with use of the resource indicated by the first DCI format and in accordance with the second DCI format second field.

**47. (Currently Amended)**

A method performed by a User Equipment (UE) comprising:

receiving Single-Cell Multicast Control Channel (SC-MCCH) information;

receiving, in more than one second subframe, a second downlink control information (DCI) format carried on a second narrowband physical downlink control channel (NPDCCH);

acquiring, on the basis of a first DCI format carried on a first NPDCCH and received in more than one first subframe, another SC-MCCH information, in a case that the second DCI format includes (a) a first field indicating indicates an SC-MCCH information change notification, wherein

a period of the more than one first subframe is different from a period of the more than one second subframe, and

~~(b) a second field indicating~~ the first DCI format indicates a resource for a transmission of the another SC-MCCH information, ~~the another SC-MCCH information based on the first field and the second field.~~

**48. (Currently Amended)**

A method performed by a base station comprising:

- transmitting Single-Cell Multicast Control Channel (SC-MCCH) information;
- generating a second downlink control information (DCI) format which includes (a) a first field indicating an SC-MCCH information change notification and (b) a second field indicating a resource for a transmission of another SC-MCCH information;
- transmitting, in more than one second subframe, the second DCI format carried on a second narrowband physical downlink control channel (NPDCCH);
- generating a first DCI format indicating a resource for a transmission of another SC-MCCH information;
- transmitting, in more than one first subframe, the first DCI format carried on a first NPDDCH; and
- transmitting the another SC-MCCH information using with use of the resource indicated by the first DCI format and in accordance with the second DCI format-second field, wherein
  - a period of the more than one first subframe is different from a period of the more than one second subframe.

**49. (New)**

The UE according to claim 45, wherein

- the second DCI format includes a field of multiple bits, and
- the SC-MCCH information change notification is indicated by the field of the multiple bits, one of the multiple bits indicating that a multimedia broadcast multicast service (MBMS) service is changed.

**50. (New)**

The base station according to claim 46, wherein

- the second DCI format includes a field of multiple bits, and
- the SC-MCCH information change notification is indicated by the field of the multiple bits, one of the multiple bits indicating that a multimedia broadcast multicast service (MBMS) service is changed.

EX-1002, 209-11.

66. Applicant also argued Shin ‘372,324 fails to disclose the feature of “more than one second subframe” as recited in the independent claims. EX-1002, 212-

214. Applicant further argued that both Shin ‘372,324 and Fujishiro fail to disclose whether “a period of the more than one first subframe in which a resource for a transmission of the another SC-MCCH information is received is different from a period of the more than one second subframe in which an SC-MCCH information change notification is received,” as recited by the independent claims. EX-1002, 213-214.

67. A Notice of Allowance then issued. EX-1002, 217. The Notice of Allowance provided a Reason for Allowance stating:

***Reason for Allowance***

The present invention is directed to information change transmission method and device related to a single-cell multicast service.

Each independent claim identifies the uniquely distinct features, particularly:

receiving circuitry configured to receive, in more than one second subframe, a second downlink control information (DCI) format carried on a second narrowband physical downlink control channel (NPDCCH). after receiving Single-Cell Multicast Control Channel (SC-MCCH) information; and

processing circuitry configured to acquire, on the basis of a first DCI format carried on a first NPDCCH and received in more than one first subframe, another SC-

MCCH information, in a case that the second DCI format indicates an SC-MCCH information change notification, wherein

a period of the more than one first subframe is different from a period of the more than one second subframe, and

the first DCI format indicates a resource for a transmission of the another SC-MCCH information.

EX-1002, 223-24.

68. The Reason for Allowance also listed the closest prior art as Shin (disclosing a method for transmitting/receiving data in a wireless communication system supporting NB-IoT), Fujishiro (disclosing a method of SC-MCCH channel management in narrowband IoT), and U.S. Patent Publication No. 2010/0178895 (disclosing a method for emergency information broadcasting in a wireless network). EX-1002, 224.

## **VIII. OVERVIEW OF THE PRIOR ART**

### **A. Overview of Shin (EX-1004; EX-1005; EX-1013; EX-1015; EX-1016)**

69. United States Patent No. 11,160,094 issued to Shin et al. (EX-1005; “Shin 094”) was filed on February 7, 2019 as a National Stage Entry under 35 U.S.C. § 371 of International Application No. PCT/KR2017/008647, which was filed on Aug. 9, 2017 (“Shin PCT”). The Shin PCT was filed on August 9, 2017 claiming the priority benefit of U.S. Provisional Application Nos. 62/372,323

(EX-1013; “323 Provisional”) and 62/372,324 (“324 Provisional”; EX-1015), which were both filed on August 9, 2016. I understand that both the 323 and 324 Provisionals are prior art to the ’764 Patent under 35 U.S.C. §102(a)(2) because they were filed prior to the filing of the earliest patent application to which ’764 Patent claims priority, i.e., Chinese Patent Application No. 2016 1 0658544, filed August 11, 2016. I further understand that Shin 094 is prior art to the ’764 Patent due, at least in part, to its priority claim to the 323 and 324 Provisionals.

70. Both the 323 and 324 Provisionals are written partially in English and partially in Korean. During prosecution, the Examiner exclusively referred to the 324 Provisional (referenced “372,324”), but did not cite to any of the 324 Provisional that was written in Korean. Nor did the Examiner expressly cite to the 323 Provisional, including any of the portions of the 323 Provisional that was in Korean. I have not seen any evidence that a translation of either of the 323 and 324 Provisionals was provided to the Patent Office or cited by the Examiner. Certified English translations of the 323 Provisional (EX-1004; “Shin 323”) and the 324 Provisional (EX-1016, “Shin 324”) have been provided as exhibits to the Petition.
71. Shin is directed to determining appropriate physical resource blocks (PRBs) on which NPDCCHs and NPDSCHs may transmit SC-PTM related

information in an NB-IoT system. Figure 5, which is reproduced below, illustrates a BS having a processor that can be configured to implement the disclosed invention.

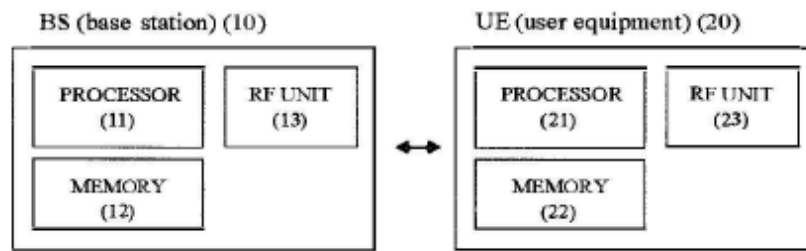


Figure 5. System for implementing present invention

EX-1004 (Shin 323), FIG. 5, pg. 17; EX-1005 (Shin 094), FIG. 15, 1:58-67, 5:55-57.

# **1. Disclosure of 3GPP Technical Specifications in Shin**

72. Shin recites several 3GPP technical specifications (“TS”) including TS 36.211, TS 36.212, TS 36.213 and TS 36.331. Through its recitation of TS 36.212, Shin discloses three DCI formats used to transmit information in a NB-IoT system: N0, N1, and N2. EX-1004 (Shin 323), pp. 28-30; EX-1005 (Shin 094), 25:38-26:25.

73. With its recitation to TS 36.213, Shin discloses the procedure by which a UE monitors a NPDCCH search space to receive a NPDCCH. Specifically, a NPDCCH search space is defined by an aggregation level,  $L' \in \{1, 2\}$ , and a repetition level  $R \in \{1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048\}$ . The search space

consists of a set of NPDCCH candidates where each candidate is repeated in a set of  $R$  consecutive NB-IoT downlink subframes excluding subframes used for SI messages. A UE is configured to monitor two NPDCCH common search spaces: Type1 and Type2. EX-1004 (Shin 323), pg. 13. For Type1, the starting subframe of the search space is determined based on locations of NB-IoT paging opportunity subframes. EX-1004 (Shin 323), pp. 25-26; EX-1005 (Shin 094), 18:26-63.

74. Through its recitation of TS 36.331, Shin discloses legacy procedures for sending and acquiring SC-PTM information in a non-NB-IoT. SC-PTM control information is carried on a specific logical channel: SC-MCCH. Information which is transmitted in messages sent over SC-MCCH (“SC-MCCH information”) is transmitted periodically using a repetition period. SC-MCCH transmissions are indicated on PDCCH. EX-1004, pg. 10. When SC-MCCH information changes, it notifies the UE of the change in the first subframe used for SC-MCCH transmission in a repetition period. In a typical (i.e. non-NB-IoT) change notification, the least significant bit (“LSB”) in an 8-bit bitmap is set to “1” which indicates a change in the SC-MCCH. Upon receiving a change notification, an interested UE acquires the SC-MCCH information starting from the same subframe. EX-1004 (Shin 323), pg. 22; EX-1005 (Shin 094), 15:19-63.

## **2. Transmitting SC-PTM Transmission**

75. Shin discloses new procedures for sending and receiving SC-PTM information in a NB-IoT system. Specifically, Shin presents procedures for determining the appropriate PRB where NPDCCH/NPDSCH carrying SC-PTM is transmitted and how the corresponding PRB(s) are allocated. EX-1004 (Shin 323), p 14; EX-1005 (Shin 094), 1:63-2:4.
76. One procedure discussed is to transmit the NPDCCH SC-MCCH control information and the NPDCCH that transmits the SC-MTCH on PRBs different from the PRBs from those used in other NB-IoT transmissions, such as unicast. Because the SC-PTM information are transmitted on a different PRB than other NPDCCH applications, there is no chance that a unicast NPDCCH or paging NPDCCH will be transmitted to the same PRB as a SC-PTM NPDCCH. Shin discloses that the corresponding NPDCCH may be transmitted to one PRB or transmitted through several PRBs. In either, the information carried on the NPDCCH may transmitted with DCI format N1, DCI format N2, or can be set to a new DCI format. In either, a UE can obtain SC-MCCH change notification information by monitoring a common search space and the change notification may be sent using DCI format N1, N2 or a new DCI format. EX-1004, pp. 31-34; EX-1005, 29:25-33, 30:20-24, 31:57-60, 33:28-41, 34:7-13.

77. Another procedure disclosed by Shin is that the NPDCCH carrying the SC-MCCH control information and the NPDCCH carrying the SC-MTCH control information utilize the existing PRBs used for legacy NB-IoT (i.e. PRBs used for existing NPDCCH procedures). In such a procedure, SC-MCCH control information may be also be sent with either DCI format N1 or DCI format N2. Additional actions may be performed to use each format depending on whether the UE is in idle mode or connected mode. In connected mode and sent with DCI format N1, SC-MCCH control information may be distinguished by using CRC masking where different RNTIs (Radio Network Temporary Identifiers) are used to differentiate between transmitted in NPDCCH UE-specific search space without frequency shift or unicast interruption since both utilize DCI format N1. In idle mode, the DCI format of the NPDCCH carrying the SC-MCCH control information can still be set to DCI format N1, but additional actions are performed. Idle mode UEs monitor for DCI format N2 using the P-RNTI (Radio Network Temporary Identifier) value which is used to identify paging. When SC-PTM specific DCI (i.e. in DCI format N1) is transmitted in the same subframe, it can be decoded as long as the terminal is capable of performing Blind Decoding (“BD”) of additional RNTIs. Such a terminal can obtain the SC-PTM related information by additional monitoring for DCI format N1 by using SC-RNTI

or G-NTI. If a UE is capable of adding additional an additional Blind Decoder (“BD”) then the UE can monitor for the DCI format N1 by using one of two RNTIs (Radio Network Temporary Identifiers): SC-RNTI or G-RNTI. EX-1004 (Shin 323), pp. 34-35; EX-1005 (Shin 094), 34:46-48; 36:1-38.

78. Finally, Shin also discloses a procedure by which the NPDCCH which transmits MCCH control information may be transmitted through multiple PRBs. These PRBs may semi-statically selected by the BS. EX-1004, pg. 36; EX-1005, 45:18-27.

**B. Overview of Xu (EX-1006)**

79. United States Patent No. 10,785,752 to Xu et al. (“Xu”) was filed on February 14, 2018 as a continuation of International Patent Application PCT/CN2016/083166, which was filed on May 24, 2016. I understand that Xu qualifies as prior art to the ’764 Patent under 35 U.S.C. §102(a)(1).
80. Xu discloses a resource configuration method, system, and device for a Single-Cell Multicast Control Channel (“SC-MCCH”). Xu discloses that the method consists of sending a broadcast message containing configuration information of the SC-MCCH configured by a base station. This configuration information can include a modification period of the SC-MCCH, time-domain location information of the SC-MCCH, and at least one

of: a repetition period of the SC-MCCH, configuration information of SC-MCCH change notification, and a value tag. EX-1006, Abstract, 3:16-26.

81. The configuration information of the SC-MCCH change notification can be used for indicating the locations of a radio frame and radio subframe where the SC-MCCH change notification is located. EX-1006, 3:34-41.
82. FIG. 13, reproduced below illustrates an embodiment of the disclosed SC-MCCH change notification. EX-1006, 19:51-55.

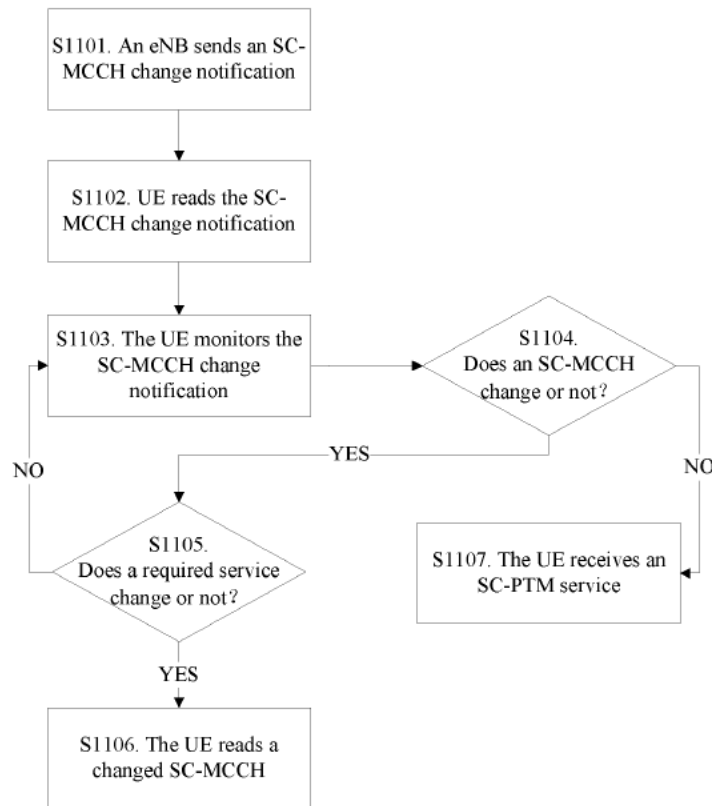


**Fig. 13**

EX-1006, FIG. 13.

83. Xu discloses that this SC-MCCH change notification information may be indicated by 1) a value tag or 2) DCI in a PDCCH. When an SC-MCCH change notification information is borne on the DCI in the PDCCH of the time-domain subframe, Xu discloses using DCI format 1-c. The notification message can indicate only if the SC-MCCH changes or not in which case a single bit may be adopted. The message can also include a second bit to indicate whether a public service or an ordinary service has changed. Xu further discloses that more than two bits may be used to indicate more change information. EX-1006, 16:20-22, 16:51-65.
84. Xu also discloses that SC-MCCH information may be sent through the PDCCH of the SC-MCCH, and specifically, may be sent through the DCI in the PDCCH. The DCI used to send the SC-MCCH information may include at least the scheduling information of the SC-MCCH on the frequency domain. EX-1006, 17:15-20.

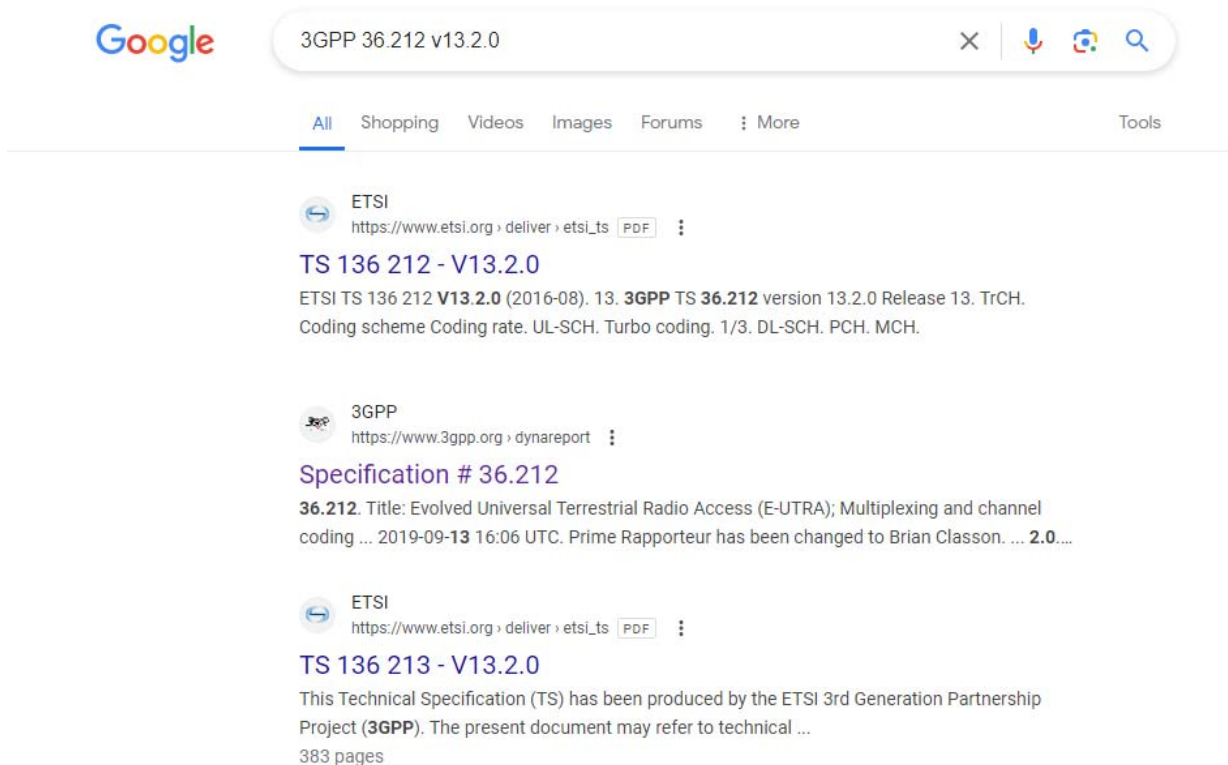
**C. Overview of RAN72 (EX-1007, EX-1008, EX-1009; EX-1012)**

85. I understand RAN72 includes version 13.2 of 3GPP technical specifications (“TS”) 36.212, 36.213, 36.321, and 36.331. As discussed in greater detail below, it is my opinion that the versions of RAN72 submitted with the Petition are authentic, published, and publicly available and accessible by July 2016.

As such, I understand that RAN72 qualifies as prior art to the '764 Patent under 35 U.S.C. §102(a)(1).

**1. Public Accessibility of RAN72**

86. It is my opinion that RAN72 was publicly accessible prior to the earliest claimed priority date of the '764 Patent. As a preliminary matter, the various specifications comprising RAN72 are just that, the specifications put out by 3GPP. These specifications may be located easily with a simple web search (e.g., a Google or Bing search) of the the specification number. For example, below is a partial screenshot of what Google returns when "3GPP TS 36.212" is entered in the search bar. As shown below, a link to the 3GPP website for the TS 36.212 specification is the second search result. Clicking on the link takes the user to the 3GPP website, where a user may select the version of interest, as shown in the screen shots discussed below with respect to the individual standards TS-36.212, TS-36.213, TS-36.321, and TS-36.331. The specifications are accessible to anyone on the Internet, without the need to register or enter credentials or other exclusive access criteria.



87. TS 36.212 v.13.2.0 is listed on the face of the '764 Patent, as shown below.

### OTHER PUBLICATIONS

3RD Generation Partnership Project (3GPP TM), Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding, (Release 13), 3GPP TS 36.212 V13.2.0, Jun. 2016, Valbonne, France.

EX-1001, Field 56 (References Cited).

88. As shown above, TS 36.212 v.13.2.0 is listed on the face of the '764 Patent with a June 2016 date, which is the date provided by the Applicant when citing the document in an Information Disclosure Statement (IDS) on February 8,

2019. EX-1002, pg. 39.

89. The June 2016 date shown on the face of the '764 Patent is consistent with the "Upload date" listed on the 3GPP website, [www.3gpp.org](http://www.3gpp.org), at which time the document was publicly accessible. The 3GPP website and its repository of standards was well known to persons in the cellular telecommunications industry as a source of public information regarding industry standards and technological advances. As shown below, TS 36.212 v.13.2.0 was uploaded to the 3GPP on June 30, 2016, as shown in the below screenshot from the 3GPP website.

General

Versions

Responsibility

Related

Specification #: 36.212

Release 13 (Spec is UCC for this Release)

Latest Remark:

| Meetings                 | Version                 | Upload date | Comment                      |  |      |      |    |
|--------------------------|-------------------------|-------------|------------------------------|--|------|------|----|
| <a href="#">RAN#91-e</a> | <a href="#">13.11.0</a> | 2021-03-31  |                              |  | ETSI | TDec | CR |
| <a href="#">RAN#86</a>   | <a href="#">13.10.0</a> | 2020-01-06  |                              |  | ETSI | TDec | CR |
| <a href="#">RAN#84</a>   | <a href="#">13.9.0</a>  | 2019-06-24  |                              |  | ETSI | TDec | CR |
| <a href="#">RAN#80</a>   | <a href="#">13.8.0</a>  | 2018-07-05  |                              |  | ETSI | TDec | CR |
| <a href="#">RAN#78</a>   | <a href="#">13.7.1</a>  | 2018-01-20  | Clean-up fixing ident issues |  | ETSI | TDec | CR |
| <a href="#">RAN#78</a>   | <a href="#">13.7.0</a>  | 2018-01-05  |                              |  | ETSI | TDec | CR |
| <a href="#">RAN#76</a>   | <a href="#">13.6.0</a>  | 2017-06-23  |                              |  | ETSI | TDec | CR |
| <a href="#">RAN#75</a>   | <a href="#">13.5.0</a>  | 2017-03-23  |                              |  | ETSI | TDec | CR |
| <a href="#">RAN#74</a>   | <a href="#">13.4.0</a>  | 2017-01-02  |                              |  | ETSI | TDec | CR |
| <a href="#">RAN#73</a>   | <a href="#">13.3.0</a>  | 2016-09-29  |                              |  | ETSI | TDec | CR |
| <a href="#">RAN#72</a>   | <a href="#">13.2.0</a>  | 2016-06-30  |                              |  | ETSI | TDec | CR |
| <a href="#">RAN#71</a>   | <a href="#">13.1.0</a>  | 2016-03-29  |                              |  | ETSI | TDec | CR |
| <a href="#">RAN#70</a>   | <a href="#">13.0.0</a>  | 2016-01-06  |                              |  | ETSI | TDec | CR |

Release 12 (Spec is UCC for this Release)

Latest Remark: (2015-01-22) .

| Meetings               | Version                | Upload date | Comment                      |  |      |      |    |
|------------------------|------------------------|-------------|------------------------------|--|------|------|----|
| <a href="#">RAN#78</a> | <a href="#">12.9.1</a> | 2018-01-20  | Clean-up fixing ident issues |  | ETSI | TDec | CR |
| <a href="#">RAN#78</a> | <a href="#">12.9.0</a> | 2018-01-05  |                              |  | ETSI | TDec | CR |

<https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2426>

90. Similarly, TS 36.213 v.13.2.0 was uploaded to the 3GPP website was uploaded to the 3GPP website on June 30, 2016 as shown in the below screenshot from the 3GPP website.

| General                                  |         |             |                                  | Specification #: 36.213 |    |    |
|------------------------------------------|---------|-------------|----------------------------------|-------------------------|----|----|
| Versions                                 |         |             |                                  |                         |    |    |
| Responsibility                           |         |             |                                  |                         |    |    |
| Related                                  |         |             |                                  |                         |    |    |
| RAN#73                                   | 14.0.0  | 2016-09-29  |                                  | ETS                     | TD | CR |
| Release 13(Spec is UCC for this Release) |         |             |                                  | Latest Remark:          |    |    |
| Meetings                                 | Version | Upload date | Comment                          |                         |    |    |
| RAN#87-e                                 | 13.16.0 | 2020-04-03  |                                  | ETS                     | TD | CR |
| RAN#86                                   | 13.15.0 | 2020-01-06  |                                  | ETS                     | TD | CR |
| RAN#84                                   | 13.14.0 | 2019-06-24  |                                  | ETS                     | TD | CR |
| RAN#83                                   | 13.13.0 | 2019-03-28  |                                  | ETS                     | TD | CR |
| RAN#82                                   | 13.12.0 | 2019-01-11  |                                  | ETS                     | TD | CR |
| RAN#81                                   | 13.11.0 | 2018-10-01  |                                  | ETS                     | TD | CR |
| RAN#80                                   | 13.10.0 | 2018-07-08  |                                  | ETS                     | TD | CR |
| RAN#79                                   | 13.9.0  | 2018-04-03  |                                  | ETS                     | TD | CR |
| RAN#78                                   | 13.8.0  | 2018-01-09  |                                  | ETS                     | TD | CR |
| RAN#77                                   | 13.7.0  | 2017-09-26  |                                  | ETS                     | TD | CR |
| RAN#76                                   | 13.6.0  | 2017-06-23  |                                  | ETS                     | TD | CR |
| RAN#75                                   | 13.5.0  | 2017-03-23  |                                  | ETS                     | TD | CR |
| RAN#74                                   | 13.4.0  | 2017-01-02  |                                  | ETS                     | TD | CR |
| RAN#73                                   | 13.3.0  | 2016-09-29  |                                  | ETS                     | TD | CR |
| RAN#72                                   | 13.2.0  | 2016-06-30  |                                  | ETS                     | TD | CR |
| RAN#71                                   | 13.1.1  | 2016-03-31  | MCC to correct spec version i... | ETS                     | TD | CR |
| RAN#71                                   | 13.1.0  | 2016-03-30  |                                  | ETS                     | TD | CR |

<https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2427>

91. TS 36.331 v.13.2.0 was uploaded to the 3GPP website on July 11, 2016 as shown in the below screenshots from the 3GPP website. The first screenshot is provided to show the column headers (e.g., Meetings, Version, Upload date), which are not visible in the second screenshot that shows version 13.2.0 from RAN#72 was uploaded on July 11, 2016.

General

Versions

Responsibility

Related

Specification #: 36.331

|        |        |            |  |      |     |    |
|--------|--------|------------|--|------|-----|----|
| RAN#74 | 14.1.0 | 2017-01-12 |  | ETSI | TDG | CR |
| RAN#73 | 14.0.0 | 2016-10-04 |  | ETSI | TDG | CR |

Release 13(Spec is UCC for this Release)

Latest Remark:

| Meetings | Version | Upload date | Comment                          |  | ETSI | TDG | CR |
|----------|---------|-------------|----------------------------------|--|------|-----|----|
| RAN#90-e | 13.17.0 | 2021-01-06  |                                  |  | ETSI | TDG | CR |
| RAN#89-e | 13.16.0 | 2020-10-02  |                                  |  | ETSI | TDG | CR |
| RAN#86   | 13.15.0 | 2020-01-08  |                                  |  | ETSI | TDG | CR |
| RAN#84   | 13.14.0 | 2019-06-29  |                                  |  | ETSI | TDG | CR |
| RAN#83   | 13.13.0 | 2019-04-11  |                                  |  | ETSI | TDG | CR |
| RAN#82   | 13.12.0 | 2019-01-16  |                                  |  | ETSI | TDG | CR |
| RAN#81   | 13.11.0 | 2018-09-27  |                                  |  | ETSI | TDG | CR |
| RAN#80   | 13.10.0 | 2018-07-10  |                                  |  | ETSI | TDG | CR |
| RAN#79   | 13.9.1  | 2018-04-03  | New version to fix ASN.1 form... |  | ETSI | TDG | CR |
| RAN#79   | 13.9.0  | 2018-04-03  |                                  |  | ETSI | TDG | CR |
| RAN#78   | 13.8.1  | 2018-01-09  | Corrects an ASN.1 problem        |  | ETSI | TDG | CR |
| RAN#78   | 13.8.0  | 2018-01-08  |                                  |  | ETSI | TDG | CR |
| RAN#77   | 13.7.1  | 2017-09-29  | Reordering of fields in RRCCo... |  | ETSI | TDG | CR |
| RAN#77   | 13.7.0  | 2017-09-25  |                                  |  | ETSI | TDG | CR |
| RAN#76   | 13.6.1  | 2017-07-03  |                                  |  | ETSI | TDG | CR |

| General                |                         |            |                                  | Specification #: 36.331                                                             |                                                                                     |                                                                                     |                                                                                     |
|------------------------|-------------------------|------------|----------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Versions               |                         |            |                                  | Responsibility                                                                      |                                                                                     |                                                                                     |                                                                                     |
| Related                |                         |            |                                  |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
| <a href="#">RAN#86</a> | <a href="#">13.15.0</a> | 2020-01-08 |                                  |  |  |  |  |
| <a href="#">RAN#84</a> | <a href="#">13.14.0</a> | 2019-06-29 |                                  |  |  |  |  |
| <a href="#">RAN#83</a> | <a href="#">13.13.0</a> | 2019-04-11 |                                  |  |  |  |  |
| <a href="#">RAN#82</a> | <a href="#">13.12.0</a> | 2019-01-16 |                                  |  |  |  |  |
| <a href="#">RAN#81</a> | <a href="#">13.11.0</a> | 2018-09-27 |                                  |  |  |  |  |
| <a href="#">RAN#80</a> | <a href="#">13.10.0</a> | 2018-07-10 |                                  |  |  |  |  |
| <a href="#">RAN#79</a> | <a href="#">13.9.1</a>  | 2018-04-03 | New version to fix ASN.1 form... |  |  |  |  |
| <a href="#">RAN#79</a> | <a href="#">13.9.0</a>  | 2018-04-03 |                                  |  |  |  |  |
| <a href="#">RAN#78</a> | <a href="#">13.8.1</a>  | 2018-01-09 | Corrects an ASN.1 problem        |  |  |  |  |
| <a href="#">RAN#78</a> | <a href="#">13.8.0</a>  | 2018-01-08 |                                  |  |  |  |  |
| <a href="#">RAN#77</a> | <a href="#">13.7.1</a>  | 2017-09-29 | Reordering of fields in RRCCo... |  |  |  |  |
| <a href="#">RAN#77</a> | <a href="#">13.7.0</a>  | 2017-09-25 |                                  |  |  |  |  |
| <a href="#">RAN#76</a> | <a href="#">13.6.1</a>  | 2017-07-03 |                                  |  |  |  |  |
| <a href="#">RAN#76</a> | <a href="#">13.6.0</a>  | 2017-06-24 |                                  |  |  |  |  |
| <a href="#">RAN#75</a> | <a href="#">13.5.0</a>  | 2017-03-21 |                                  |  |  |  |  |
| <a href="#">RAN#74</a> | <a href="#">13.4.0</a>  | 2017-01-12 |                                  |  |  |  |  |
| <a href="#">RAN#73</a> | <a href="#">13.3.0</a>  | 2016-10-03 |                                  |  |  |  |  |
| <a href="#">RAN#72</a> | <a href="#">13.2.0</a>  | 2016-07-11 |                                  |  |  |  |  |
| <a href="#">RAN#71</a> | <a href="#">13.1.0</a>  | 2016-04-01 |                                  |  |  |  |  |
| <a href="#">RAN#70</a> | <a href="#">13.0.0</a>  | 2016-01-07 |                                  |  |  |  |  |

<https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2440>

92. The Petition also references TS-36.321. Version 13.2.0 of the specification was uploaded to the 3GPP website on July 7, 2016 as shown in the below screenshots from the 3GPP website.

General

Versions

Responsibility

Related

Specification #: 36.321

|                        |                        |            |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
|------------------------|------------------------|------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <a href="#">RAN#74</a> | <a href="#">14.1.0</a> | 2016-12-30 |  |  |  |  |
| <a href="#">RAN#73</a> | <a href="#">14.0.0</a> | 2016-10-03 |  |  |  |  |

Release 13(Spec is UCC for this Release)

Latest Remark:

| Meetings               | Version                | Upload date | Comment                                                                             |                                                                                     |                                                                                     |                                                                                     |
|------------------------|------------------------|-------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <a href="#">RAN#80</a> | <a href="#">13.9.0</a> | 2018-07-06  |  |  |  |  |
| <a href="#">RAN#79</a> | <a href="#">13.8.0</a> | 2018-04-02  |  |  |  |  |
| <a href="#">RAN#77</a> | <a href="#">13.7.0</a> | 2017-09-25  |  |  |  |  |
| <a href="#">RAN#76</a> | <a href="#">13.6.0</a> | 2017-06-23  |  |  |  |  |
| <a href="#">RAN#75</a> | <a href="#">13.5.0</a> | 2017-03-21  |  |  |  |  |
| <a href="#">RAN#74</a> | <a href="#">13.4.0</a> | 2016-12-30  |  |  |  |  |
| <a href="#">RAN#73</a> | <a href="#">13.3.0</a> | 2016-10-03  |  |  |  |  |
| <a href="#">RAN#72</a> | <a href="#">13.2.0</a> | 2016-07-07  |  |  |  |  |
| <a href="#">RAN#71</a> | <a href="#">13.1.0</a> | 2016-04-01  |  |  |  |  |
| <a href="#">RAN#70</a> | <a href="#">13.0.0</a> | 2016-01-14  |  |  |  |  |

Release 12(Spec is UCC for this Release)

Latest Remark: (2015-01-22) .

| Meetings               | Version                 | Upload date | Comment                                                                               |                                                                                       |                                                                                       |                                                                                       |
|------------------------|-------------------------|-------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <a href="#">RAN#77</a> | <a href="#">12.10.0</a> | 2017-09-25  |   |   |   |   |
| <a href="#">RAN#71</a> | <a href="#">12.9.0</a>  | 2016-03-30  |  |  |  |  |
| <a href="#">RAN#70</a> | <a href="#">12.8.0</a>  | 2016-01-04  |  |  |  |  |

<https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2437>

93. The '764 Patent acknowledges that the 3GPP RAN #72 plenary meeting was held in June 2016, and references the existing version 13 LTE SC-PTM, which is disclosed in RAN72. EX-1001, 1:40-50. The '764 Patent also refers to TS-36.212 as disclosing the definitions of DCI formats N1 and N2. EX-1001, 8:64-9:1. Thus, the '764 Patent itself demonstrates that RAN72 was published and publicly accessible prior to the earliest claimed priority date.

94. Further, the 3GPP standards were acknowledged in the prior art. As mentioned above, the examiner initially rejected the claims as obvious over Shin '324 in view of Fujishiro. EX-1002, 174-80. In citing to Shin '324, the examiner relied on portions which were directly excerpted from the 3GPP standards. For example, below the examiner cites to a portion of Shin '324:

[(Shin '372,324 discloses UE acquiring SC-MCCH information, see:

## 5.8a.2 SC-MCCH information acquisition

### 5.8a.2.1 General



**Figure 5.8a.2.1-1: SC-MCCH information acquisition**

The UE applies the SC-MCCH information acquisition procedure to acquire the SC-PTM control information that is broadcast by the E-UTRAN. The procedure applies to SC-PTM capable UEs that are in RRC\_IDLE or in RRC\_CONNECTED.

EX-1002, 175.

95. This portion of the 324 Provisional is identical to TS-36.331:

## 5.8a.2 SC-MCCH information acquisition

### 5.8a.2.1 General

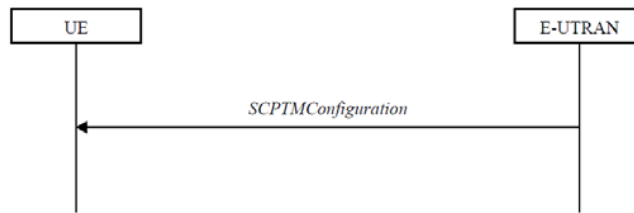


**Figure 5.8a.2.1-1: SC-MCCH information acquisition**

The UE applies the SC-MCCH information acquisition procedure to acquire the SC-PTM control information that is broadcast by the E-UTRAN. The procedure applies to SC-PTM capable UEs that are in RRC\_IDLE or in RRC\_CONNECTED.

EX-1009, pg. 185.

96. Thus RAN72 was publicly accessible before August 11, 2016, the earliest priority date of the ‘764 Patent.

## 2. TS 36.212 v.13.2.0 (EX-1007)

97. 3GPP TS 36.212 v.13.2.0 (EX-1007; “TS-36.212”) provides the standards for the coding, multiplexing and mapping to physical channels for Evolved Universal Terrestrial Radio Access (E-UTRA). EX-1007, pg. 7 (Scope). TS-36.212 discloses encoding and decoding data and control schemes from/to the MAC layer to offer transport and control services over a radio transmission link. EX-1007, pg. 10.

98. Specifically, TS-36.212 defines the standard procedures by which a BS is configured to transmit DCI on a PDCCH. TS-36.212 discloses several DCI formats to use when transmitting information on a PDCCH, as is readily

apparent from the Table of Contents.

|            |                                   |     |
|------------|-----------------------------------|-----|
| 5.3.3      | Downlink control information..... | 100 |
| 5.3.3.1    | DCI formats.....                  | 100 |
| 5.3.3.1.1  | Format 0.....                     | 100 |
| 5.3.3.1.2  | Format 1.....                     | 102 |
| 5.3.3.1.3  | Format 1A.....                    | 103 |
| 5.3.3.1.3A | Format 1B.....                    | 105 |
| 5.3.3.1.4  | Format 1C.....                    | 106 |
| 5.3.3.1.4A | Format 1D.....                    | 107 |
| 5.3.3.1.5  | Format 2.....                     | 108 |
| 5.3.3.1.5A | Format 2A.....                    | 112 |
| 5.3.3.1.5B | Format 2B.....                    | 114 |
| 5.3.3.1.5C | Format 2C.....                    | 115 |
| 5.3.3.1.5D | Format 2D.....                    | 117 |
| 5.3.3.1.6  | Format 3.....                     | 118 |
| 5.3.3.1.7  | Format 3A.....                    | 119 |
| 5.3.3.1.8  | Format 4.....                     | 119 |
| 5.3.3.1.9  | Format 5.....                     | 121 |
| 5.3.3.1.10 | Format 6-0A.....                  | 122 |
| 5.3.3.1.11 | Format 6-0B.....                  | 122 |
| 5.3.3.1.12 | Format 6-1A.....                  | 123 |
| 5.3.3.1.13 | Format 6-1B.....                  | 124 |
| 5.3.3.1.14 | Format 6-2.....                   | 125 |

EX-1007, pg. 4 (Table of Contents).

99. TS-36.212 specifies the mapping of downlink control information to a corresponding physical channel as follows:

Table 4.2-2

| Control information | Physical Channel      |
|---------------------|-----------------------|
| CFI                 | PCFICH                |
| HI                  | PHICH                 |
| DCI                 | PDCCH, EPDCCH, MPDCCH |

EX-1007, pg. 9 (Table 4.2-2).

100. These DCI formats are comprised of fields of bits which convey information to a UE. Format 1C is used to schedule notify MCCH change as well as SC-MCCH change. EX-1007, pg. 106 (Section 5.3.3.1.4) (“DCI format 1C is used for very compact scheduling of one PDSCH codeword, notifying MCCH

change [6], notifying SC-MCCH change [6], reconfiguring TDD, and LAA common information.”). When used for notifying SC-MCCH change, Format 1C uses 8 bits to convey information for a SC-MCCH notification and reserves the remaining bits:

Else if the format 1C is used for notifying SC-MCCH change

- Information for SC-MCCH change notification – 8 bits as defined in section 5.8a.1.3 of [6]
- Reserved information bits are added until the size is equal to that of format 1C used for very compact scheduling of one PDSCH codeword

EX-1007, pg. 107 (Section 5.3.3.1.4).

101. TS-36.212 also discloses DCI formats specifically designed to carry information in NB-IoT systems. EX-1007, Section 6 (Narrowband IoT). As with non-NB-IoT DCI formats, these formats are mapped on to their corresponding narrowband physical channels with DCI being mapped onto NPDCCH:

**Table 6.1-3**

| <b>Control information</b> | <b>Physical Channel</b> |
|----------------------------|-------------------------|
| UCI                        | NPUSCH (format 2)       |
| DCI                        | NPDCCH                  |

EX-1007, pg. 131 (Table 6.1-3).

102. TS-36.212 discloses that DCI Format N1 can be used to schedule a Narrowband Physical Downlink Shared channel (“NPDSCH”) in one cell or a random access procedure initiated by an NPDCCH order. EX-1007, pg. 135

(Section 6.4.3.2). When used to schedule a NPDSCH, the fields in DCI format N1 are defined as follows:

#### 6.4.3.2 DCI Format N1

DCI format N1 is used for the scheduling of one NPDSCH codeword in one cell and random access procedure initiated by a NPDCCH order. The DCI corresponding to a NPDCCH order is carried by NPDCCH.

The following information is transmitted by means of the DCI format N1:

- Flag for format N0/format N1 differentiation – 1 bit, where value 0 indicates format N0 and value 1 indicates format N1
- NPDCCH order indicator – 1 bit

Format N1 is used for random access procedure initiated by a NPDCCH order only if NPDCCH order indicator is set to '1', format N1 CRC is scrambled with C-RNTI, and all the remaining fields are set as follows:

- Starting number of NPRACH repetitions – 2 bits as defined in section 16.3.1 of [3]
- Subcarrier indication of NPRACH – 6 bits as defined in section 16.3.1 of [3]
- All the remaining bits in format N1 are set to one

Otherwise,

- Scheduling delay – 3 bits as defined in section 16.4.1 of [3]
- Resource assignment – 3 bits as defined in section 16.4.1.3 of [3]
- Modulation and coding scheme – 4 bits as defined in section 16.4.1.5 of [3]
- Repetition number – 4 bits as defined in section 16.4.1.3 of [3]
- New data indicator – 1 bit
- HARQ-ACK resource – 4 bits as defined in section 16.4.2 of [3].
- DCI subframe repetition number – 2 bits as defined in section 16.6 in [3]

When the format N1 CRC is scrambled with a RA-RNTI, then the following fields among the fields above are reserved:

- New data indicator
- HARQ-ACK resource

EX-1007, pg. 135 (Section 6.4.3.2).

103. TS-36.212 discloses that DCI format N2 can be used for paging or direct indication. EX-1007, pg. 135 (Section 6.4.3.3) (“DCI format N2 is used for for [sic] paging and direct indication.”). DCI Format N2 consists of the following fields:

The following information is transmitted by means of the DCI format N2:

Flag for paging/direct indication differentiation – 1 bit, with value 0 for direct indication and value 1 for paging

If Flag=0:

- Direct Indication information – 8 bits provide direct indication of system information update and other fields, as defined in [6]
- Reserved information bits are added until the size is equal to that of format N2 with Flag=1

If Flag=1:

- Resource assignment – 3 bits as defined in section 16.4.1.3 of [3]
- Modulation and coding scheme – 4 bits as defined in section 16.4.1.5 of [3]
- Repetition number – 4 bits as defined in section 16.4.1.3 of [3]
- DCI subframe repetition number – 3 bits as defined in section 16.6 of [3]

EX-1007, pp. 135-136 (Section 6.4.3.3).

### **3. TS-36.213 v.13.2.0 (EX-1008)**

104. 3GPP TS 36.213 v.13.2.0 (EX-1008; “TS-36.213”) provides the standards for the characteristics of the physical layer procedures in E-UTRA. EX-1008, pg. 8 (Scope) (“The present document specifies and establishes the characteristics of the physical layer procedures in the FDD and TDD modes of E-UTRA.”). Specifically, TS-36.213 specifies procedures for “cell search” where a UE acquires time and frequency synchronization with a cell and detects the narrowband physical layer Cell ID. EX-1008, pg. 354 (Section 16.1.1). TS-36.213 discloses the procedure by which a UE receives a NPDCCH. EX-1008, pg. 367 (Section 16.6). TS-36.213 discloses that a NPDCCH search space is defined by an aggregation level,  $L' \in \{1, 2\}$ , and a repetition level  $R \in \{1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048\}$ . EX-1008, pg. 367

(Section 16.6). The search space consists of a set of NPDCCH candidates where each candidate is repeated in a set of  $R$  consecutive NB-IoT downlink subframes excluding subframes used for SI messages. EX-1008, pg. 367 (Section 16.6).

105. A UE uses this search space definition to receive other channels such as a NPDSCH. Upon detecting a NPDCCH with DCI format N1 or N2 ending in subframe  $n$ , the UE can decode the corresponding NPDSCH transmission in  $N$  consecutive NB-IoT subframes. EX-1008, pg. 358 (Section 16.4.1). Subframe  $n$  (the last subframe in which the NPDCCH) is transmitted is determined by using the starting subframe of the NPDCCH transmission and the “DCI subframe repetition number” field in the corresponding DCI. EX-1008, pg. 358 (Section 16.4.1).  $N$  is defined by multiplying the “repetition number” and “resource assignment” fields from the corresponding DCI. EX-1008, pg. 358 (Section 16.4.1).

#### **4. TS-36.331 v.13.2.0 (EX-1009)**

106. 3GPP TS 36.331 v.13.2.0 (EX-1009; “TS-36.331”) provides the standards for the Radio Resource Control protocol for the radio interface between UE and Evolved Universal Terrestrial Radio Access Network (E-UTRAN). EX-1009, pg. 19 (Scope) (“The present document specifies the Radio Resource Control

protocol for the radio interface between UE and E-UTRAN as well as for the radio interface between RN and E-UTRAN.”). TS-36.331 discloses the procedure for transmitting SC-PTM control information. EX-1009, Section 5.8a.1.1. SC-PTM control information is carried on a specific logical channel: SC-MCCH. EX-1009, pg. 184 (Section 5.8a.1.1). Information which is transmitted in messages sent over SC-MCCH (“SC-MCCH information”) is transmitted periodically using a repetition period. EX-1009, pg. 184 (Section 5.8a.1.2). SC-MCCH transmissions are indicated on PDCCH. EX-1009, pg. 184 (Section 5.8a.1.2).

107. TS-36.331 also discloses general procedures for notifying a UE when SC-MCCH information changes. EX-1009, pg. 184 (Section 5.8a.1.3). When SC-MCCH information changes, it notifies the UE of the change in the first subframe used for SC-MCCH transmission in a repetition period. EX-1009, pg. 184 (Section 5.8a.1.3). In a typical (i.e. non-NB-IoT) change notification, the least significant bit (“LSB”) in a 8-bit bitmap is set to “1” which indicates a change in the SC-MCCH. EX-1009, pg. 184 (Section 5.8a.1.3). Upon receiving a change notification, an interested UE acquires the SC-MCCH information starting from the same subframe. EX-1009, pg. 184 (Section 5.8a.1.3).

**D. Overview of Fujishiro (EX-1010, EX-1011, EX-1014)**

108. U.S. Patent Publication No. 2019/0182632 in the name of Fujishiro et al. (EX-1011; “Fujishiro 632”) is the pre-grant publication of U.S. Patent Application No. 16/271,391, which was filed on February 8, 2019 as a continuation of International Patent Application PCT/CN2016/083166, which was filed on August 4, 2017 claiming the priority benefit of U.S. Provisional Application No. 62/372,919, filed on Aug. 10, 2016 (EX-1014; “Fujishiro 919”). It is my understanding that Fujishiro qualifies as prior art to the ’764 Patent under 35 U.S.C. §102(a)(2).
109. I note that Fujishiro was cited during the prosecution of the ’764 Patent and Applicant did not dispute that Fujishiro is prior art to the application. For the avoidance of doubt, below I have provided citations to both the published application (EX-1011) and to the certified English translation of U.S. Provisional Application No. 62/372,919 (EX-1010) to demonstrate that the subject matter in the published application finds support in the provisional application.
110. Fujishiro relates to providing MBMS services via SC-PTM on a reduced bandwidth network such as NB-IoT. EX-1011 (Fujishiro 632) ¶6; EX-1010 (Fujishiro 919), p. 15. Fujishiro discloses transmitting update notification information through direct indication on NPDCCH. EX-1011 ¶92; EX-1010

p. 22. Then a UE receives a system information block (i.e. SIB20) which includes scheduling information necessary to acquire a SC-MCCH. EX-1011 ¶93; EX-1010, p. 22. Fujishiro discloses that the UE then can then receive SC-PTM configuration information via the SC-MCCH based on the scheduling information sent via the SIB-20. EX-1011 (Fujishiro 632) ¶93; EX-1010 (Fujishiro 919), pg. 22.

## IX. THE CHALLENGED CLAIMS OF THE '764 PATENT ARE OBVIOUS FROM SHIN

### A. Detailed Application of Shin to the Challenged Claims

#### 1. Claim 3

##### *i. [3.0] A base station comprising:*

111. To the extent the preamble is limiting, Shin discloses this claim element. Specifically, Shin discloses a **base station** (i.e. BS 10, also referred to as a E-UTRAN):

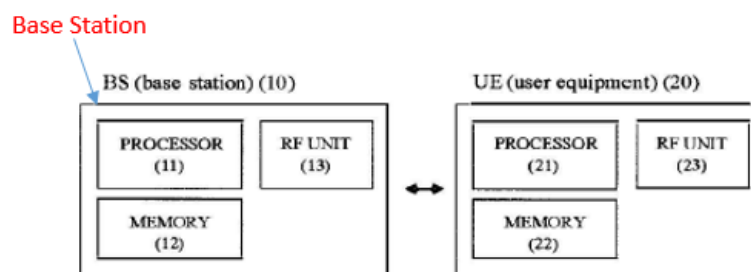


Figure 5. System for implementing present invention

EX-1004 (Shin 323), FIG. 5<sup>2</sup> (annotated); EX-1005 (Shin 094), FIG. 15.

112. Shin further discloses that the base station is configured to implement the disclosed applications:

In Figure 5, a wireless communication system includes a BS 10 and one or more UE 20. In downlink, a transmitter may be a part of the BS 10, and a receiver may be a part of the UE 20. In uplink, a transmitter may be a part of the UE 20, and a receiver may be a part of the BS 10. A BS 10 may include a processor 11, a memory 12, and a radio frequency (RF) unit 13. *The processor 11 may be configured to implement proposed procedures and/or methods described in this application.*

EX-1004 (Shin 323), pg. 17; EX-1005 (Shin 094), 5:55-57 (“FIG. 15 illustrates a block diagram of a wireless communication device to which methods proposed by the present specification may be applied.”).

113. Accordingly, Shin discloses this claim element.

ii. *[3.1] transmitting circuitry configured to transmit Single-Cell Multicast Control Channel (SC-MCCH) information; and*

114. Shin discloses this claim element. Specifically, Shin discloses that the **base station 10** (*base station*) includes an **RF unit 13** (*transmitting circuitry*) as

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<sup>2</sup> All annotations added unless otherwise stated.

shown below:

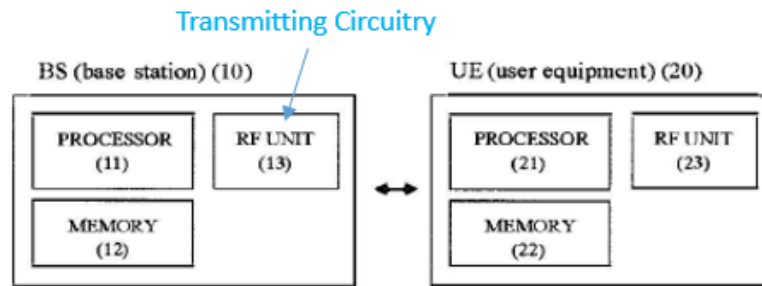


Figure 5. System for implementing present invention

EX-1004 (Shin 323), FIG. 5, pp. 17-18 (“The RF unit 13 is coupled with the processor 11 and transmits and/or receives a radio signal.”); EX-1005 (Shin 094), FIG. 15.

115. Shin discloses transmitting SC-MCCH information (i.e., information transmitted in messages sent over the SC-MCCH):

#### 5.8a.1.2 SC-MCCH scheduling

The SC-MCCH information (i.e. information transmitted in messages sent over SC-MCCH) is transmitted periodically, using a configurable repetition period. SC-MCCH transmissions (and the associated radio resources and MCS) are indicated on PDCCH.

EX-1004 (Shin 323), pg. 22.

According to the scheduling of the SC-MCCH, SC-MCCH information (i.e. information transmitted from messages transmitted through the SC-MCCH) is transmitted periodically by using a configurable repetition period. SC-MCCH transmission (and related radio resources) and the Modulation and Coding Scheme (MCS) are indicated on Physical Downlink Control Channel (PDCCH).

EX-1005 (Shin 094), 15:33-39.

116. Shin further discloses transmitting this information from a Base Station (i.e., E-UTRAN):

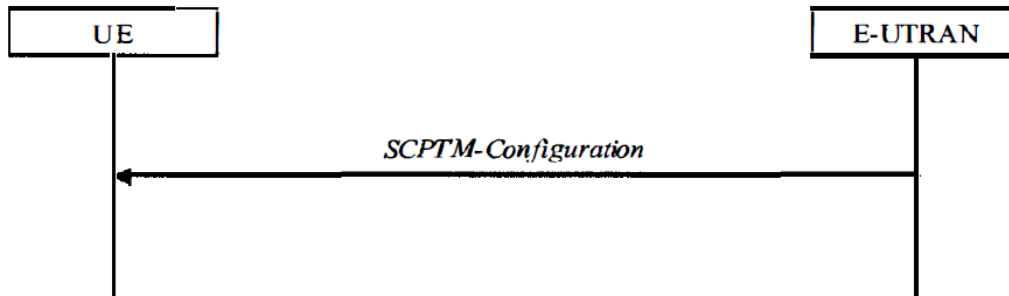


**Figure 5.8a.2.1-1: SC-MCCH information acquisition**

EX-1004 (Shin 323), pg. 22.

The UE applies the SC-MCCH information acquisition procedure to acquire the SC-PTM control information that is broadcast by the E-UTRAN.

EX-1004 (Shin 323), pg. 22.

In general, a UE applies an SC-MCCH information acquisition procedure to acquire SC-PtM control information broadcasted by the E-UTRAN.

EX-1005 (Shin 094), 16:3-5.

117. Accordingly, Shin discloses this claim element.

- iii. [3.2] generating circuitry configured to generate a second downlink control information (DCI) format indicating an SC-MCCH information change notification, wherein*

118. Shin discloses this claim element. Specifically, Shin discloses a processor 11 (*generating circuitry*):

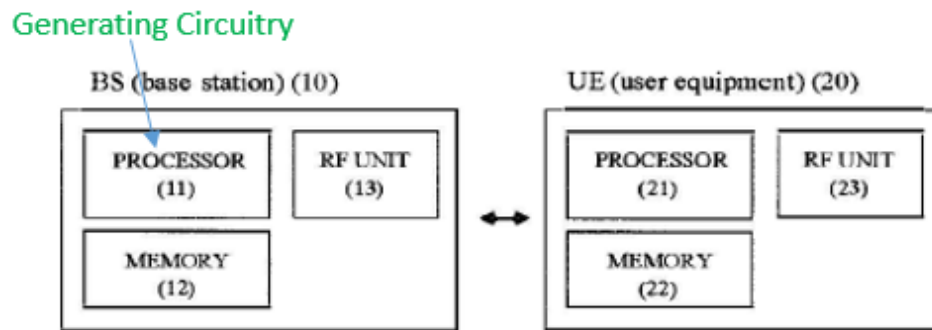


Figure 5. System for implementing present invention

EX-1004 (Shin 323), FIG. 5, pg. 5 (“The processor 11 may be configured to implement proposed procedures and/or methods described in this application.”);

EX-1005 (Shin 094), FIG. 15.

119. Shin further discloses that the **processor 11** (*generating circuitry*) of the **base station 10** (*base station*) is configured to indicate an SC-MCCH change notification:

When the network changes (some of) the SC-MCCH information, *it notifies the UEs about the change* in the first subframe which can be used for SC-MCCH transmission in a repetition period. LSB bit in 8-bit bitmap when set to '1' *indicates the change in SC-MCCH*. Upon receiving a change notification, a UE interested to receive MBMS services transmitted using SC-PTM acquires the new SC-MCCH information starting from the same subframe. The UE applies the previously acquired SC-MCCH information until the UE acquires the

new SC-MCCH information.

EX-1004 (Shin 323), pg. 22.

If the network changes the information of the SC-MCCH (or part of the SC-MCCH), the network notifies UEs about a change of the first subframe which may be used for SC-MCCH transmission at the repetition period. At this time, the Least Significant Bit (LSB) bit in the 8-bit bitmap indicates a change of the SC-MCCH when information notified to the UEs (i.e., change notification) is set to '1'. Upon receiving the change notification, a UE attempting to receive an MBMS service transmitted using SC-PTM may acquire new SC-MCCH information starting from the same subframe. In this case, the UE applies the previously acquired SC-MCCH information until new SC-MCCH information is acquired.

EX-1005 (Shin 094), 15:51-63.

120. Shin further discloses sending this SC-MCCH change notification by generating a DCI format (i.e. DCI Format N1/N2 or a new DCI format):

Furthermore, for both I and II above, the UE may obtain the SC-MCCH change notification information by monitoring a pre-arranged (or preset) common search space (CSS) area in the representative PRB. In this case, the UE may be set to monitor [sic] the aforementioned CSS area using the SC-RNTI value or another pre-arranged RNTI value.

***Further, the DCI format used in this case may be set to use the DCI format N1 or N2 used in the existing NB-IoT, or a new DCI format***

*may be created and set to be used* (i.e., DCI format Nm, where m is an integer).

EX-1004 (Shin 323), pg. 34.

Also, for both of the method 1 and the method 2, a UE may acquire SC-MCCH change notification information by monitoring a predefined (or preconfigured) common search space (CSS) at the representative PRB. Here, the SC-MCCH change notification information may include an indicator notifying that the SC-MCCH has been changed or information in the form of a flag. At this time, the UE may be configured to monitor the CSS region by using an SC-RNTI value or another predefined (or preconfigured) RNTI value. Also, *the DCI format used in this case may be configured to the DCI format N1 or DCI format N2 used in the legacy NB-IoT (i.e. NB-LTE) or to a new DCI format (i.e. DCI format Nm where m is an integer).*

EX-1005 (Shin 094), 33:28-40.

121. Shin discloses that, when using the same PRBs as in other NB-IoT applications, DCI format N2 should be used to transmit a SC-MCCH change notification:

In I and II above, *the MCCH changing notification is transmitted in CSS type 1 using DCI format N2*, but it is transmitted once in a very long time, and *since the MCCH changing notification is transmitted to a different SF than the SF from which MCCH control is transmitted*, it can be said that no additional BD problems occur in

either connected mode or idle mode.

EX-1004 (Shin 323), pg. 36.

Also, in various embodiments of the present invention, an MCCH change notification (i.e. an SC-MCCH change notification) is transmitted to CSS type 1 by using the DCI format N2. However, since *the MCCH change notification is transmitted once over a very long time period and is transmitted from a subframe different from a subframe to which control information of the MCCH (i.e. DCI of the MCCH) is transmitted*, a UE in the connected mode and/or idle mode may not encounter a problem of additional blind decoding (BD).

EX-1005 (Shin 094), 42:37-46. Shin is directed to applying legacy transmission methods for MCCH to SC-PTM. A POSITA would thus understand that its reference to MCCH would be applied to SC-MCCH.

122. A POSITA would have understood the advantage of using this format to transmit a change notification in a NB-IoT system. For example, because of the lower power requirements of NB-IoT, UEs are often set in idle mode.

123. Moreover, when MCCH control information changes, a POSITA would have understood that a change notification sent as a page with DCI format N2 would allow an idle UE to begin monitoring for the updated SC-MCCH control information.

124. Accordingly, Shin discloses this claim element.

- iv. ***[3.3] the transmitting circuitry is configured to transmit, in more than one second subframe, the second DCI format carried on a second narrowband physical downlink control channel (NPDCCH),***

125. Shin discloses this claim element. For example, Shin discloses that the RF unit (transmitting circuitry) of the base station is configured to transmit the second DCI format (i.e. DCI format N2) on a NPDCCH:

If a NB-IoT UE detects ***NPDCCH with DCI Format N1 or N2*** ending in subframe  $n$ , and if the corresponding NPDSCH transmission starts from  $n+k$ , the UE is not required to monitor NPDCCH in any subframe starting from subframe  $n+1$  to subframe  $n+k-1$ .

EX-1004 (Shin 393), pg. 27.

When an NB-IoT UE detects an ***NPDCCH with DCI format N0*** which ends at subframe  $n$ , and transmission of the corresponding NPUSCH format 1 is started from subframe  $n+k$ , the UE is not required to monitor the NPDCCH in any subframe starting from subframe  $n+1$  to subframe  $n+k-1$ .

EX-1005 (Shin 094), 20:49-54.

126. A POSITA would have understood the NPDCCH to be the control channel between the BS and the UE. A POSITA would have further understood that, if the UE detects the NPDCCH, the NPDCCH had been transmitted by the BS.

127. Shin further discloses transmitting the second DCI format (i.e. DCI format N2) in more than one subframe. For example, Shin discloses that DCI Format N2 includes a “DCI subframe repetition number” which is “2 bits as defined in section 16.6 of [3].” EX-1004 (Shin 393), pg. 29; EX-1005 (Shin 094), 26:21-25 (“Meanwhile, if a value of the flag is 1, the DCI format N2 includes (or transmits( resource allocation (for example, 3 bits), modulation and coding scheme (for example, 4 bits), repetition number (for example, 4 bits), and DCI subframe repetition number (for example, 4 bits).”). Shin further discloses that a UE searches for NPDCCH transmissions in NPDCCH search spaces, and these NPDCCH transmissions are repeated in several subframes in these search spaces:

An NPDCCH search space  $NS_k^{(L',R)}$  at aggregation level  $L' \in \{1,2\}$  and repetition level  $R \in \{1,2,4,8,16,32,64,128,256,512,1024,2048\}$  is defined by a set of NPDCCH candidates where *each candidate is repeated in a set of  $R$  consecutive NB-IoT downlink subframes* excluding subframes used for transmission of SI messages starting with subframe  $k$ .

EX-1004 (Shin 393), pg. 25.

The NPDCCH search spaces at aggregation and repetition levels are defined by a set of NPDCCH candidates. Here, *each NPDCCH candidate is repeated in  $R$  consecutive NB-IoT downlink subframes except for subframes used for transmission of System Information*

**(SI) messages** starting from the subframe k.

EX-1005 (Shin 094), 18:58-64.

128. The foregoing demonstrates that Shin discloses transmitting the DCI in more than one subframe on a NPDCCH. Therefore, Shin discloses this claim element.

- v. ***[3.4] the generating circuitry configured to generate a first DCI format indicating a resource for a transmission of another SC-MCCH information,***

129. Shin discloses this claim element. For example, Shin discloses that the processor (*generating circuitry*) is configured to indicate a resource (i.e. NPDCCH transmitting MCCH control information) for a transmission of SC-MCCH control information (*transmission of another SC-MCCH information*):

First of all, ***N-PDCCH, which transmits control information of MCCH***, and N-PDCCH, which transmits control information of MTCH, ***may be transmitted in the same PRB, or they may be transmitted through different PRBs.***

EX-1004 (Shin 393), pg. 31.

First of all, when the multicast PRB transmission is performed in the different PRB, a method for configuring an N-PDCCH transmitting

control information of an MCCH (i.e., SC-MCCH) and an N-PDCCH transmitting control information of an MTCH (i.e., SC-MTCH) to be transmitted from the same PRB (method 1); or *from PRBs different from each other (method 2) may be considered*. In other words, an SC-MCCH-related N-PDCCH and an SC-MTCH-related N-PDCCH may be transmitted from the same PRB or *separately from PRBs different from each other*.

EX-1005 (Shin 094), 29:25-34.

130. Shin further discloses that the SC-MCCH control information may be sent with either DCI format N1 or N2 (*first DCI format*):

In addition, the DCI format used in this case can be set to use the DCI format N1 or N2 used in the existing NB-IoT, or a new DCI format can be created and used (i.e., DCI format Nm, where m is an integer).

EX-1004 (Shin 393), pg. 32.

Also, a DCI format used in this case may be configured to the DCI format N1 or DCI format N2 used in the legacy NB-IoT (i.e. NB-LTE) or to a new DCI format (i.e. DCI format Nm where m is an integer).

EX-1005 (Shin 094), 30:20-24, EX-1005 (Shin 094) (same).

131. When using the legacy NB-IoT PRBs specifically, Shin discloses procedures by which the SC-MCCH control information may be sent with DCI format N1 in both connected mode and idle mode. When a UE is in connected mode, Shin discloses that the SC-MCCH control information may be transmitted

using format N1 in a UE-specific search space without requiring any additional BD and without frequency shift or unicast interruption:

First, considering the case of connected mode, the UE may be set that the search space in which the MCCH and MTCH DCIs are transmitted is the same as the USS (i.e., the NPDCCH UE-specific search space) or has a relationship that is included in the USS. In this case, the connected mode UE may be distinguished using CRC masking by employing different RNTI values (e.g., unicast: C-RNTI, MCCH: SC-RNTI, MTCH: G-RNTI) for the unicast control DCI and the DCI of the MCCH or the MTCH it was looking at *without any additional BD*. In addition, *the UE will be able to decode MCCH control or MTCH control without frequency shift and without unicast interruption*.

EX-1004 (Shin 393), pg. 35.

In this case, a UE in the connected mode, without involving additional separate blind decoding (BD), may distinguish unicast control DCI that the UE has been watching so far (in other words, which has been being monitored) and DCI of an MCCH or DCI of an MTCH from each other by using CRC masking with different RNTI values. In the present specification, distinguishing DCI by using CRC masking with different RNTI values may indicate distinguishing DCI through CRC masking employing a different RNTI value. As one example, *the different RNTI values may be configured as C-RNTI for the case of unicast, SC-RNTI for the case of an MCCH, and G-RNTI for the case of an MTCH. Also, in this case, the corresponding UE, without frequency*

*shift (or transition) and/or unicast interruption*, may decode MCCH control (i.e. an N-PDCCH/DCI related to control information of an MCCH) or MTCH control (i.e., an N-PDCCH/DCI related to control information of an MTCH).

EX-1005 (Shin 094), 36:1-15.

132. Shin further discloses that, when a UE is in idle mode, a terminal is capable of additional blind decoding (i.e. “BD”) and DCI format N1 can be used by monitoring for SC-RNTI or G-RNTI:

The idle mode UEs will monitor the DCI format N2 size using P-RNTI to view the paging that was originally intended to be viewed during the UE DRX cycle. In this case, when SC-PtM (i.e., MCCH or MTCH control) related DCI is transmitted in the same subframe, it is tailored to DCI format N1 size and cannot be decoded without additional BD (i.e., to satisfy the max BD requirement), so it is impossible to obtain SC-PtM related information. However, *if the terminal is capable of performing additional BD, it can obtain SC-PtM related information by additionally monitoring the DCI format N1 size using SC-RNTI or G-RNTI.*

EX-1004 (Shin 393), pg. 35.

*A UE in the idle mode may monitor the DCI format N2 (or size of the DCI format N2) by using Paging-RNTI (P-RNTI) to watch (i.e. detect) paging that the UE previously desired to watch during a Discontinuous Reception (DRX) cycle of the UE.* At this time, when

DCI related to SC-PtM (i.e. MCCH or MTCH control) is transmitted to the same subframe, since the DCI is configured to have the size of the DCI format N1 (i.e. since the DCI format N1 and the DCI format N2 have different sizes), getting SC-PtM related information has to be given up. However, *when a UE is capable of performing additional blind decoding, the UE may acquire SC-PtM related information by monitoring the DCI format N1 (i.e., the DCI format for an MCCH or an MTCH) by using the SC-RNTI or G-RNTI.*

EX-1005 (Shin 094), 36:25-38.

133. As I discussed above with respect to claim element 3.2 in Section IX.A.1.iii, Shin discloses that DCI format N2 is used when SC-MCCH control information is transmitted using NB-IoT legacy PRBs. Accordingly, a POSITA would have understood Shin as disclosing using a DCI format to indicate a resource for transmission of SC-MCCH information (i.e., SC-MCCH control information) than the DCI format used to transmit a SC-MCCH change notification.

134. Thus, Shin discloses this claim element.

*vi. [3.5] the transmitting circuitry is configured to transmit, in more than one first subframe, the first DCI format carried on a first NPDDCH<sup>3</sup>,*

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<sup>3</sup> There appears to be a typographical error in the claim language. By all apparent

135. Shin discloses this claim element. For example, Shin discloses that the RF unit (transmitting circuitry) is configured to transmit first DCI format (DCI format N1) on a NPDCCH:

DCI format N1 is used for scheduling of one NPDSCH codeword in one cell and random access procedure initiated by a NPDCCH order.

***The DCI corresponding to a NPDCCH order is carried by NPDCCH.***

EX-1004 (Shin 393), pg. 29.

At this time, the DCI corresponding to the NPDCCH order may be carried by an NPDCCH.

EX-1005 (Shin 094), 15:41-43.

136. As I discussed above with respect to claim element 3.3 in Section IX.A.1.iv, Shin discloses that the NPDCCH UE search space is configured to allow a NPDCCH to be transmitted in more than one consecutive subframe. Shin further discloses that a change in SC-MCCH modification occurs during a “modification period” in which SC-MCCH information is repeated:

Change of SC-MCCH information only occurs at specific radio frames, i.e. the concept of a modification period is used. ***Within a modification period, the same SC-MCCH information may be transmitted a number of times, as defined by its scheduling (which is based on a***

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context, in claim element 3.5, “NPDDCH” should read “NPDCCH.”

*repetition period*). The modification period boundaries are defined by SFN values for which  $\text{SFN mod } m = 0$ , where  $m$  is the number of radio frames comprising the modification period. The modification period is configured by means of SystemInformationBlockType20.

EX-1004 (Shin 393), pg. 22.

Also, in association with validity and notification of 40 change of SC-MCCH information, change of the SC-MCCH occurs at specific radio frames. In other words, a concept of a modification period is used. Within a modification period, the same SC-MCCH information may be transmitted a number of times (based on the repetition period) as defined 45 by the corresponding scheduling. At this time, the modification period boundaries may be defined by a system frame number (SFN). Here, the modification period may be configured by means of system information (for example, SIB 20 (i.e., SystemInformationBlock 20)).

EX-1005 (Shin 094), 15:40-50.

137. Shin also discloses that the SC-MCCH control information can be sent in multiple physical resource blocks (PRBs), in addition to disclosing that the SC-MCCH control can be repeated:

It is possible to consider a method where N-PDCCH transmitting MCCH control information is *transmitted with multiple PRBs* instead of being transmitted with one PRB.

EX-1004 (Shin 393), pg. 36.

Also, in various embodiments of the present invention, a method for transmitting a NPDCCH transmitting control information of an MCCH (i.e. SC-MCCH) ***through multiple PRBs*** not from a single PRB may be considered. In other words, if an eNB transmits control information (i.e. DCI) of an MCCH by using a plurality of PRBs configured in a semi-static manner, each UE may check (or acquire) control information of an MCCH by selecting one PRB among a plurality of PRBs and check a G-RNTI value configured for each TMGI by decoding the MCCH.

EX-1005 (Shin 094), 45:18-27.

138. As Shin explains, in an NB-IoT system, the entire system bandwidth is limited to one PRB. EX-1004 (Shin 393), pg. 31 (“Narrowband (NB)-LTE is a system for supporting low complexity, low power consumption with a system BW equivalent to 1 PRB of LTE system.”); EX-1005 (Shin 0940), 26:26-29. Given this disclosure, a POSITA would have understood that multiple PRBs would necessarily correspond to multiple subframes.

139. Accordingly, Shin discloses this claim element.

***vii. [3.6] a period of the more than one first subframe is different from a period of the more than one second subframe, and***

140. Shin disclose this claim element. As discussed above with respect to the immediately preceding claim element, Shin discloses that the bandwidth in an

NB-IoT system is limited to a single physical resource block (PRB). EX-1004 (Shin 393), pg. 31 (“Narrowband (NB)-LTE is a system for supporting low complexity, low power consumption with a system BW equivalent to 1 PRB of LTE system.”); EX-1005 (Shin 094), 26:26-29. Given this restriction, a POSITA would have understood it to be necessary to send the period of the more than one first subframe (i.e., the SC-MCCH control information) and the period of the more than one second subframe (i.e., the SC-MCCH change notification). Such an understanding would have been consistent with the acknowledgment disclosed in the ’764 Patent:

However, in the NB-IoT system, in order to reduce costs, the system based on a narrowband design ***does not support transmitting a change indication and scheduling a new SC-MCCH information transmission in the same subframe.*** Therefore, when the SC-PTM feature is introduced for the NB-IoT system, a new change notification is needed for the NB-IoT system.

EX-1001 (’764 Patent), 2:34-40.

141. Shin discloses that the SC-MCCH change notification (i.e. MCCH changing notification) and the SC-MCCH control information (i.e. MCCH control information) must be sent in different subframes when SC-MCCH information is sent using legacy NB-IoT PRBs:

In I and II above, the MCCH changing notification is transmitted in CSS type 1 using DCI format N2, but it is transmitted once in a very long time, and *since the MCCH changing notification is transmitted to a different SF than the SF from which MCCH control is transmitted*, it can be said that no additional BD problems occur in either connected mode or idle mode.

EX-1004 (Shin 393), pg. 36.

Also, in various embodiments of the present invention, an MCCH change notification (i.e. an SC-MCCH change notification) is transmitted to CSS type 1 by using the DCI format N2. However, *since the MCCH change notification is transmitted once over a very long time period and is transmitted from a subframe different from a subframe to which control information of the MCCH (i.e. DCI of the MCCH) is transmitted*, a UE in the connected mode and/or idle mode may not encounter a problem of additional blind decoding (BD).

EX-1005 (Shin 094), 42:37-46.

142. Based on the foregoing, a POSITA would have understood Shin as disclosing that the period of the more than one first subframe as being different from the period of the more than one second subframe.
143. Accordingly, Shin discloses this claim element.

viii. ***[3.7] the transmitting circuitry is configured to transmit the another SC-MCCH information with use of the resource indicated by the first DCI format and in accordance with the second DCI format.***

144. Shin discloses this claim element. For example, Shin discloses that SC-MCCH information is transmitted that SC-MCCH information is transmitted with the resource indicated by the first DCI format, and the SC-MCCH information is indicated on PDCCH:

The SC-MCCH information (i.e. information transmitted in messages sent over SC-MCCH) is transmitted periodically, using a configurable repetition period. ***SC-MCCH transmissions (and the associated radio resources and MCS) are indicated on PDCCH.***

EX-1004 (Shin 393), pg. 22.

According to the scheduling of the SC-MCCH, SC-MCCH information (i.e. information transmitted from messages transmitted through the SC-MCCH) is transmitted periodically by using a configurable repetition period. ***SC-MCCH transmission (and related radio resources) and the Modulation and Coding Scheme (MCS) are indicated on Physical Downlink Control Channel (PDCCH).***

EX-1005 (Shin 094), 15:33-39.

145. Moreover, Shin discloses that the data region, which contains SC-MCCH information carried on a PDSCH, immediately follows (and is thus indicated

by) a control region which contains the first DCI format carried on a PDCCH (i.e. the SC-MCCH control information):

For both I and II above, it is common for the N-PDSCH transmitting the MCCH to be transmitted in the same PRB as the PRB in which the N-PDCCH transmitting the control information of the MCCH is transmitted[.]

EX-1004 (Shin 393), pg. 33.

For both of the method 1 and the method 2, in most cases, a N-PDSCH transmitting an MCCH (i.e. SC-MCCH) is configured to be transmitted to the same PRB to which an N-PDCCH transmitting control information of the MCCH is transmitted[.]

EX-1005 (Shin 094), 32:59-63.

146. This is shown in FIG. 3, which is reproduced below:

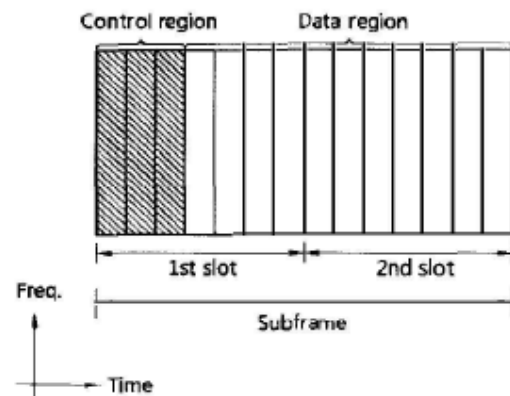


Figure 3. Structure of downlink subframe

EX-1004 (Shin 393), pg. 16 (Figure 3); EX-1005 (Shin 094), FIG. 3.

In Figure 3, a maximum of three OFDM symbols located in a front portion of a first slot within a subframe correspond to a control region to be assigned with a control channel. The remaining OFDM symbols correspond to a data region to be assigned with a physical downlink shared channel (PDSCH).... Control information transmitted through the PDCCH is referred to as downlink control information (DCI).

EX-1004 (Shin 393), pg. 16.

Referring to FIG. 3, a maximum of three OFDM symbols located in a front portion of a first slot of a subframe correspond to a control region in which control channels are allocated, and the remaining OFDM symbols correspond to a data region in which a physical downlink shared channel (PDSCH) is allocated.... Control information transmitted in a PDCCH is called Downlink Control Information (DCI).

EX-1005 (Shin 094), 9:45-64.

147. A POSITA would have understood that the purpose of such control information is to indicate the corresponding PDSCH for a transmission (i.e. for transmission of another SC-MCCH information). Shin further discloses that updated SC-MCCH information is acquired by the UE after the UE receives a SC-MCCH change notification:

Upon receiving a change notification, a UE interested to receive MBMS services transmitted using SC-PTM acquires the new SC-MCCH information....

EX-1004 (Shin 393), pg. 22.

Upon receiving the change notification, a UE attempting to receive an MBMS service transmitted using SC-PtM may acquire new SC-MCCH information....

EX-1005, 15:58-61.

148. Shin therefore discloses that the SC-MCCH information is transmitted with use of the resource indicated by the first DCI format (i.e. the SC-MCCH control information) and in accordance with the second DCI format (i.e., the change notification). Accordingly, Shin discloses this claim element.

149. In view of the foregoing, Shin renders obvious claim 3 of the '764 Patent.

**2. Claim 4**

*i. [4.0] The base station, according to claim 3, wherein*

150. Shin discloses a base station for the reasons detailed above in Section IX.A.1.

*ii. [4.1] the second DCI format includes a field of multiple bits, and the SC-MCCH information change notification is indicated by the field of the multiple bits, one of the multiple bits indicating that a multimedia broadcast multicast service (MBMS) service is changed.*

151. Shin discloses this claim element. Specifically, Shin discloses defining a SC-MCCH information change notification with multiple bits, as it discloses that

a SC-MCCH change notification may be transmitted using an 8-bit bitmap:

When the network changes (some of) the SC-MCCH information, it notifies the UEs about the change in the first subframe which can be used for SC-MCCH transmission in a repetition period. LSB bit *in 8-bit bitmap when set to '1' indicates the change in SC-MCCH*. Upon receiving a change notification, a UE interested to receive MBMS services transmitted using SC-PTM acquires the new SC-MCCH information starting from the same subframe. The UE applies the previously acquired SC-MCCH information until the UE acquires the new SC-MCCH information.

EX-1004 (Shin 393), pg. 22.

If the network changes the information of the SC-MCCH (or part of the SC-MCCH), the network notifies the UEs about a change in the first subframe which may be used for SC-MCCH transmission at the repetition period. The Least Significant Bit (LSB) bit *in 8-bit bitmap indicates a change of the SC-MCCH when information notified to the UEs (i.e., change notification) is set to '1'*. Upon receiving a change notification, a UE attempting to receive MBMS services transmitted using SC-PtM may acquire new SC-MCCH information starting from the same subframe. In this case, the UE applies the previously acquired SC-MCCH information until new SC-MCCH information is acquired.

EX-1005 (Shin 094), 15:51-63.

152. Additionally, Shin discloses that the SC-MCCH information includes a

temporary mobile group identity (“TMGI”), which corresponds to an MBMS service:

Subsequently, the UE may obtain SC-MTCH scheduling information (i.e., N-PDSCH scheduling) by monitoring the pre-arranged (or preset) common search space (CSS) area, user-specific search space (USS), or group-specific search space (GSS) in the M-PRB corresponding to the G-RNTI (or a specific G-RNTI group) of the TMGI to be received. In this case, the UE may be set to monitor the aforementioned CSS or USS or GSS area using a G-RNTI value corresponding to the TMGI it wishes to receive or another pre-arranged RNTI value. In addition, the DCI format used in this case can be set to use the DCI format N1 or N2 used in the existing NB-IoT, or a new DCI format can be created and set to be used (i.e., DCI format Nm, where m is an integer). Therefore, by decoding the corresponding N-PDSCH to obtain SC-MTCH information, *the UE can obtain MBMS data.*

EX-1004 (Shin 393), pg. 32.

At this time, the UE may be configured to monitor the CSS, USS, or GSS (or at least one thereof) by using a G-RNTI value corresponding to a TMGI that the UE wants to receive or another predefined (or preconfigured) RNTI value. Also, a DCI format used in this case may be configured by a DCI format N1 or DCI format N2 used in the legacy NB-IoT (i.e. NB-LTE) or by a new DCI format (i.e. DCI format Nm where m is an integer). Therefore, if the UE acquires SC-MTCH information by decoding the corresponding N-PDSCH, the *UE may*

*acquire MBMS data.* In other words, the UE may acquire multicast or broadcast data by acquiring SC-MTCH information from an N-PDSCH corresponding to the scheduling information acquired through the monitoring.

EX-1005 (Shin 094), 32:45-58.

153. Given the foregoing disclosures, a POSITA would have understood a TMGI as corresponding to an MBMS service, and thus the bit in the SC-MCCH would indicate a change to the MBMS service. Consequently, a POSITA would have understood Shin as disclosing this claim element and rendering claim 4 obvious.

**3. Claim 6**

***i. [6.0] A method performed by a base station comprising:***

154. To the extent the preamble is limiting, Shin discloses a method performed by a base station for the same reasons set forth above in IX.A.1.i. Specifically, although the preamble of claim 6 recites a method, as opposed to a base station apparatus recited in claim 3, Shin discloses that the disclosed base station apparatus performs a method.

***ii. [6.1] transmitting Single-Cell Multicast Control Channel (SC-MCCH) information;***

155. Shin discloses this claim element for the same reasons set forth above in

IX.A.1.ii. Indeed, claim element 3.1 requires transmitting circuitry to be configured to transmit Single-Cell Multicast Control Channel (SC-MCCH) information, as recited in claim element 6.1.

**iii. [6.2] generating a second downlink control information (DCI) format indicating an SC-MCCH information change notification;**

156. Shin discloses this claim element for the same reasons set forth above in IX.A.1.iii. Indeed, claim element 3.2 requires generating circuitry to be configured to generate a second downlink control information (DCI) format indicating an SC-MCCH information change notification, as recited in claim element 6.2.

**iv. [6.3] transmitting, in more than one second subframe, the second DCI format carried on a second narrowband physical downlink control channel (NPDCCH);**

157. Shin discloses this claim element for the same reasons set forth above in IX.A.1.iv. Indeed, claim element 3.3 requires transmitting circuitry to be configured to transmit, in more than one second subframe, the second DCI format carried on a second narrowband physical downlink control channel (NPDCCH), as recited in claim element 6.3.

- v. ***[6.4] generating a first DCI format indicating a resource for a transmission of another SC-MCCH information;***

158. Shin discloses this claim element for the same reasons set forth above in IX.A.1.v. Indeed, claim element 3.4 requires generating circuitry to be configured to generate a first DCI format indicating a resource for a transmission of another SC-MCCH information, as recited in claim element 6.4.

- vi. ***[6.5] transmitting, in more than one first subframe, the first DCI format carried on a first NPDDCH; and***

159. Shin discloses this claim element for the same reasons set forth above in IX.A.1.vi. Indeed, claim element 3.5 requires transmitting circuitry to be configured to transmit, in more than one first subframe, the first DCI format carried on a first NPDDCH, as recited in claim element 6.5.

- vii. ***[6.6] transmitting the another SC-MCCH information with use of the resource indicated by the first DCI format and in accordance with the second DCI format, wherein***

160. Shin discloses this claim element for the same reasons set forth above in IX.A.1.viii. Indeed, claim element 3.7 requires transmitting circuitry to be configured to transmit the another SC-MCCH information with use of the

resource indicated by the first DCI format and in accordance with the second DCI format, as recited in claim element 6.6.

*viii. [6.7] a period of the more than one first subframe is different from a period of the more than one second subframe.*

161. Shin discloses this claim element for the same reasons set forth above in IX.A.1.vii, as this claim element is identical to claim element 3.6. Therefore for at least the foregoing reasons, Shin renders obvious claim 6 of the '764 Patent.

**X. THE CHALLENGED CLAIMS OF THE '764 PATENT ARE OBVIOUS FROM XU IN VIEW OF RAN72 AND FUJISHIRO**

**A. Reasons to Combine Xu, RAN72, and Fujishiro**

162. A POSITA would have understood that because RAN72 sets the standards by which wireless mobile networks communicate, following the 3GPP standards is necessary for a BS to effectively communicate with UEs.

163. Xu references version 13 of the 3rd Generation Partnership Project Specification. EX-1006, 1:28-30 (“In order to effectively utilize mobile network resources, the 3rd Generation Partnership Project (3GPP) proposes a Multimedia Broadcast/Multicast Services (MBMS).”); 2:36-37 (“The 3GPP proposes a research subject of single-cell MBMS in Release 13 (R13) LTE-Advance (LTE-A).”). Xu further makes explicit reference to concepts such

as DCI format 1-c, which are defined in RAN72. EX-1006, 16:51-53 (“Specifically, when an SC-MCCH change notification information is borne on the DCI in the PDCCH of the time-domain subframe, DCI format-1c may be adopted.”); EX-1007, pg. 106 (Section 5.3.3.1.4) (defining DCI format 1C). A POSITA would thus be motivated to combine Xu and RAN72 for the simple reason of RAN72 disclosing the full specification of the operating environment in which the invention of Xu is to work. As such, a POSITA would have thought it obvious to look to RAN72 to fully understand the operating environment and all of the various DCI formats available to transmit control information between a BS and a UE.

164. Additionally, a POSITA would be motivated to combine the teachings of Fujishiro with those of Xu and RAN72. Xu and Fujishiro are both directed to the same concept of transmitting MBMS services via SC-PTM:

A resource configuration method, system and device for a Single-Cell Multicast Control Channel (SC-MCCH) are provided. In the method, a base station sends a system broadcast message, which includes configuration information of the SC-MCCH configured by the base station, the configuration information includes a Modification Period (MP) of the SC-MCCH and time-domain location information of the SC-MCCH, and the configuration information further includes at least one of: a Repetition Period (RP) of the SC-MCCH, configuration

inform SC-MCCH change notification information, and a value tag.

EX-1006 (Xu), Abstract

A base station according to a second aspect is a base station for a mobile communication system. The base station comprises a controller configured to provide Multimedia Broadcast Multicast Service (MBMS) services via Single Cell Point-to-Multipoint (SC-PTM) to a user equipment configured to transmit and receive radio signals within a reduced bandwidth narrower than a system transmission and reception band. The controller is configured to perform a process of transmitting first information to the user equipment. The first information indicates at least one of: a maximum number of repetitions of a physical downlink control channel having a bandwidth equal to or less than the reduced bandwidth and a maximum number of repetitions of a physical downlink shared channel having a bandwidth equal to or less than the reduced bandwidth. The first information is transmitted from the base station by a system information block for the SC-PTM or a multicast control channel for the SC-PTM.

EX-1011 (Fujishiro) ¶6.

165. As Xu does not disclose transmitting the services in an NB-IoT system, it would have been obvious to a POSITA to turn to look to Fujishiro for this purpose given the express mandate from the RAN#69 and #72 meetings:

For better implementation of the Internet of Everything, *at the 3GPP RAN #69 plenary meeting held in September 2015, a new work item*

*was proposed in the Third Generation Partnership Project (3GPP) Long Term Evolution Project (LTE) standard (see non-patent document: RP-151621 New Work Item: NarrowBand IoT (NB-IoT), which may be referred to as narrowband Internet of Things (NB-IoT)). In the description of this project, NB IoT is configured to be a narrow band system that operates on 180 KHz uplink and downlink, so that terminals in the Internet of Things would meet the requirements such as low power consumption, long standby, cost reduction, wide coverage, and others. The first phase of the NB-IoT system has completed basic function designs, including broadcast notification of system information, point-to-point unicast uplink data transmission, and downlink data reception. **Considering multicast requirements for software download, terminal system upgrade, and packet information delivery in the future Internet of Things, it was determined that a new work item was needed to enhance NB-IoT and achieve multicast at the 3GPP RAN #72 plenary meeting held in June 2016 (see non-patent document: RP-161324 New work item proposal: Enhancements of NB-IoT). It was clearly pointed out that multicast transmission in the NB-IoT system is to be implemented on the basis of the features of the existing version 13 LTE SC-PTM.***

EX-1001 ('764 Patent), 1:25-50.

166. Accordingly, a POSITA looking to address SC-PTM in wireless mobile communication systems disclosed by Xu and 3GPP would have thought it obvious to look for ways to handle NB-IoT communications given that Xu is

silent on this issue. A POSITA would thus have been motivated to combine the SC-PTM transmission methods described in Xu with the implementation in NB-IoT disclosed by Fujishiro in order to meet this goal. EX-1006 (Xu), 1:28-30 (“In order to effectively utilize mobile network resources, the 3rd Generation Partnership Project (3GPP) proposes a Multimedia Broadcast/Multicast Service (MBMS).”).

**B. Detailed Application of Xu, RAN72, Fujishiro to the Challenged Claims**

**1. Claim 3**

*i. [3.0] A base station comprising:*

167. To the extent the preamble is limiting, Xu discloses this claim element. Xu discloses a base station (i.e., base station 42).

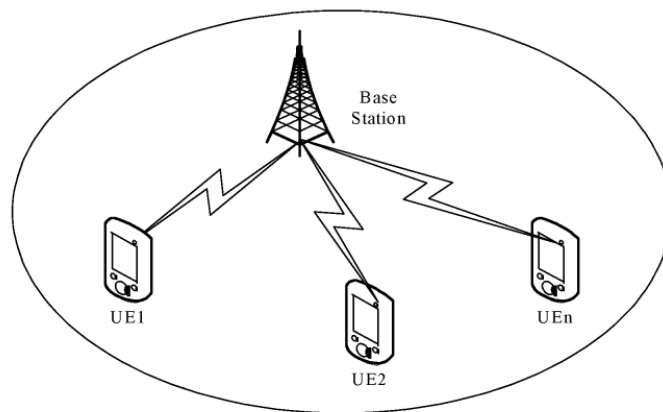


**Fig. 1**

EX-1006 (Xu), Fig. 1.

An embodiment provides a resource configuration system for an SC-

MCCH. FIG. 5 is a resource configuration system for an SC-MCCH according to an embodiment of the disclosure. As shown in FIG. 5, the system may include a *base station 42* and UE 44.

EX-1006 (Xu), 10:63-11:9.

168. Accordingly, Xu discloses this claim element.

ii. *[3.1] transmitting circuitry configured to transmit Single-Cell Multicast Control Channel (SC-MCCH) information; and*

169. Xu discloses this claim element. The BS includes a sending module (*transmitting circuitry*) as shown:

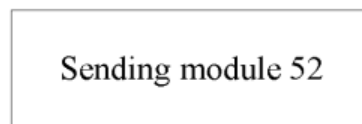


**Fig. 6**

EX-1006 (Xu), FIG. 6.

170. Xu discloses “[a] resource configuration method, system and device for a Single-Cell Multicast Control Channel (SC-MCCH).” EX-1006, Abstract. Xu further discloses that the BS may send configuration information of the SC-MCCH:

*At act S202, a base station may send a system broadcast message. The system broadcast message may contain configuration information of*

*the SC-MCCH configured by the base station.* The configuration information includes an MP of the SC-MCCH, time-domain location information of the SC-MCCH and a Modulation and Coding Scheme (MCS) of the SC-MCCH, and the configuration information may further include at least one of: an RP of the SC-MCCH, configuration information of SC-MCCH change notification information, and a value tag.

EX-1006 (Xu), 7:41-50.

171. Accordingly, Xu discloses this claim element.

*iii. [3.2] generating circuitry configured to generate a second downlink control information (DCI) format indicating an SC-MCCH information change notification, wherein*

172. Xu in view of RAN72 and Fujishiro renders this claim element obvious. Xu discloses that “[t]he SC-MCCH change notification information may be indicated by any one of the following methods: 1) a value tag; and 2) **DCI in a PDCCH.**” EX-1006 (Xu), 16:20-22.

173. Xu further discloses that SC-MCCH may be identified by a first RNTI (Radio Network Temporary Identifier), and a SC-MCCH change notification may be identified by a second RNTI, including an RNTI that is configured to identify a UE or specific use:

In an embodiment of the disclosure, the SC-MCCH may be identified

by a first RNTI; and the SC-MCCH change notification may be identified by a second RNTI.

EX-1006 (Xu), 4:17-20, 8:49-52.

A PDCCH may serve as indication information for parsing PDSCH data...Information transmitted in the PDCCH is called DCI, which may be used for indicating information such as a resource configuration of the PDSCH and an uplink resource grant. A Cyclic Redundancy Check (CRC) at the tail of the PDCCH occupies 16 bit, and may be scrambled by adopted a specific RNTI. *The RNTI may be configured to identify UE or a specific use.*

EX-1006 (Xu), 2:41-53

174. In one embodiment, Xu discloses that, if the DCI is adopted for indicating a change, then a specific RNTI may be used for the SC-MCCH change notification, with the SC-MCCH information being transmitted using a different RNTI:

If the DCI is adopted for indication, a specific RNTI, for example, SM-RNTI=FFFC, may be allocated to the SC-MCCH change notification information at first. Considering that the SC-MCCH is transmitted through a PDSCH and is scheduled through the PDCCH on a frequency domain, it is suggested to pre-allocate an RNTI, for example, SC-MCCH RNTI=FFFB, to the SC-MCCH, which may alternatively be SM-RNTI=FFFB and SC-MCCH RNTI=FFC.

EX-1006 (Xu), 16:36-43.

175. A POSITA would have understood that RNTI=FFFC corresponded to the CC-RNTI and RNTI=FFFB corresponded to SC-RNTI. This equivalence can be seen in the 3GPP standard which shows that a hexa-decimal value of FFFC corresponds with CC RNTI and a hexa-decimal value of FFFB corresponds to SC-RNTI:

**Table 7.1-1: RNTI values.**

| Value (hexa-decimal) | RNTI                                                                                                                                            |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 0000                 | N/A                                                                                                                                             |
| 0001-0960            | RA-RNTI, C-RNTI, Semi-Persistent Scheduling C-RNTI, Temporary C-RNTI, eIMTA-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI and SL-RNTI (see note), G-RNTI |
| 0961-FFF3            | C-RNTI, Semi-Persistent Scheduling C-RNTI, eIMTA-RNTI, Temporary C-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI and SL-RNTI, G-RNTI                     |
| FFF4-FFF9            | Reserved for future use                                                                                                                         |
| FFFA                 | SC-N-RNTI                                                                                                                                       |
| FFFB                 | SC-RNTI                                                                                                                                         |
| FFFC                 | CC-RNTI                                                                                                                                         |
| FFFD                 | M-RNTI                                                                                                                                          |
| FFFE                 | P-RNTI                                                                                                                                          |
| FFFF                 | SI-RNTI                                                                                                                                         |

EX-1012 (TS-36.321), pg. 78-79 (Table 7.1-1).

176. Thus, Xu expressly discloses using different RNTIs for transmitting a SC-MCCH change notification and SC-MCCH.

177. Xu further discloses that the SC-MCCH change notification may be transmitted using DCI format 1C, but does not expressly state the DCI that is used to transmit the SC-MCCH.

Specifically, when an SC-MCCH change notification information is borne on the DCI in the PDCCH of the time-domain subframe, DCI *format 1c may be adopted.*

EX-1006 (Xu), 16:51-53.

178. Xu does, however, disclose that the SC-MCCH may be transmitted separately from the SC-MCCH change notification and may be sent through the DCI of the PDCCH.

At act **802**, UE may receive SC-MCCH information.

The UE may monitor and receive required SC-MCCH information at a corresponding location according to an indication of the configuration information of the SC-MCCH in the system broadcast message. The UE may read the SC-MCCH information after startup or cell reselection/handover to a new cell, and may also monitor the SC-MCCH change notification information according to the configuration information of the SC-MCCH change notification information.

*Frequency-domain scheduling information of the SCMCCH may be sent through the PDCCH of the corresponding subframe and specifically, may be sent through the DCI in the PDCCH.*

EX-1006 (Xu), 17:5-18.

179. Although Xu does not expressly disclose SC-MCCH in NB-IoT, Fujishiro does. Fujishiro includes similar disclosures to those of Xu in that Fujishiro

discloses receiving a SC-MCCH change notification separately from the SC-MCCH. Specifically, Fujishiro discloses receiving a notification that system information has been updated via Direct Indication in the NPDCCH:

In step S2, the UE 100 receives the MPDCCH or the NPDCCH from the eNB 200. Each of the MPDCCH and the NPDCCH includes update notification information (Direct Indication) indicating an update of system information (SIB: System Information Block). FIG. 11 is a diagram illustrating the Direct Indication. FIG. 11 (a) illustrates a Direct Indication in the MPDCCH, and FIG. 11 (b) illustrates a Direct Indication in the NPDCCH.... Here, the description will proceed assuming that the SIB20 has been updated. Note that updates are considered rare because the SIB20 includes only the scheduling information of the SC-MCCH.

EX-1010 (Fujishiro 919), pg. 22.

In step S2, the UE 100 receives the MPDCCH or the NPDCCH from the eNB 200. Each of the MPDCCH and NPDCCH includes update notification information (Direct Indication) indicating update of system information (SIB: System Information Block). FIGS. 11A and 11B are diagrams illustrating the Direct Indication. FIG. 11A illustrates the Direct Indication in the MPDCCH, and FIG. 11B illustrates the Direct Indication in the NPDCCH.... Here, it is assumed the SIB20 has been updated, and further explanation is provided.

EX-1011 (Fujishiro 632) ¶92.

FIG. 11B

| Bit                 | Field in Direct Indication information           |
|---------------------|--------------------------------------------------|
| 1                   | systemInfoModification                           |
| 2                   | systemInfoModification-eDRX                      |
| 3, 4, 5, 6,<br>7, 8 | Not used, and shall be ignored by UE if received |

EX-1010 (Fujishiro 919), FIG. 11B.

FIG. 11B

| BIT                 | FIELD IN DIRECT INDICATION INFORMATION           |
|---------------------|--------------------------------------------------|
| 1                   | systemInfoModification                           |
| 2                   | systemInfoModification-eDRX                      |
| 3, 4, 5, 6,<br>7, 8 | NOT USED, AND SHALL BE IGNORED BY UE IF RECEIVED |

EX-1011 (Fujishiro 632), FIG. 11B.

180. Fujishiro discloses that “[t]he update notification information (Direct Indication) may use an existing format or may define a new format.” EX-1011 (Fujishiro 632) ¶102; EX-1010 (Fujishiro 919), pg. 10. A POSITA would have understood that a Direct Indication would be transmitted via DCI format N2, which was used for paging and direct indication. EX-1007 (TS-36.212), pg. 135 (“DCI format N2 is used for for [sic] paging and *direct*

*indication.”).*

181. Similar to Xu, Fujishiro discloses that the SC-MCCH would be transmitted using an SC-RNTI:

In step S3, the UE 100 receives the SIB20 from the eNB 200 via the BCCH. The SIB20 includes information (scheduling information) required for acquiring the SC-MCCH.

EX-1010 (Fujishiro 919), pg. 22.

In step S4, the UE 100 receives SIB20 setting information (SCPTM Configuration) from the eNB 200 via the SC-MCCH based on the SCPTM. In the physical layer, ***SC-RNTI (Single Cell RNTI) is used for SC-MCCH transmission.***

EX-1010 (Fujishiro 919), pg. 22.

In step S3, the UE 100 receives the SIB20 from the eNB 200 via the BCCH. The SIB20 includes information (scheduling information) necessary for acquiring the SC-MCCH.

EX-1011 (Fujishiro 632) ¶93.

In step S4, the UE 100 receives SCTPM setting information (SCPTM Configuration) from the eNB 200 via the SC-MCCH, based on the SIB20. For the SC-MCCH transmission in the physical layer, ***an SC-RNTI (Single Cell RNTI) is used.***

EX-1011 (Fujishiro 632) ¶94.

182. It would have been obvious to a POSITA to apply Fujishiro's method of transmitting an SC-MCCH change notification in an NB-IoT system to Xu. As the '764 Patent acknowledges, the 3GPP RAN #72 plenary meeting held in June 2016 added a new work item to enhance NB-IoT by achieving multicast using existing LTE SC-PTM. EX-1001 ('764 Patent), 1:40-50. A POSITA would thus have been motivated to look beyond the SC-PTM system described by Xu to applications of SC-PTM in NB-IoT such as the one described by Fujishiro. Applying Fujishiro's transmission of SC-MCCH change notification in NB-IoT systems to Xu would therefore have been obvious to a POSITA.
183. Accordingly, Xu in view of RAN72 and Fujishiro renders this claim element obvious.

***iv. [3.3] the transmitting circuitry is configured to transmit, in more than one second subframe, the second DCI format carried on a second narrowband physical downlink control channel (NPDCCH),***

184. Xu in view of RAN72 and Fujishiro renders this claim element obvious. As discussed above, Xu and RAN72 disclose that a base station includes transmitting circuitry (e.g., sending module) and generating circuitry that is configured to generate multiple DCI formats, including the three narrowband

DCI formats N0, N1, and N2. *See* X.B.1.ii- X.B.1.iii. A POSITA would have understood the transmitting circuitry to be capable of transmitting the generated DCI formats.

185. RAN72 discloses that the DCI, which would be in of the three DCI formats N0, N1, and N2, is transmitted via the NPDCCH physical channel:

**Table 6.1-3**

| <b>Control information</b> | <b>Physical Channel</b> |
|----------------------------|-------------------------|
| UCI                        | NPUSCH (format 2)       |
| DCI                        | NPDCCH                  |

EX-1007 (TS-36.212), pg. 131 (Table 6.1-3).

186. Accordingly, a POSITA would have understood that the base station transmitter (e.g., sending module) would have been configured to transmit the second DCI format, i.e., DCI format N2 used to transmit the update notification information via Direct Indication as taught by Xu, RAN72, and Fujishiro, to be transmitted on a second NPDCCH.
187. In view of the teachings of Xu and 3GGP, a POSITA would have understood the transmission of the second DCI format (e.g., DCI format N2) to have been transmitted in more than one second subframe. For example, Xu discloses that the SC-MCCH change notification may be indicated in the configuration information of the SC-MCCH and include a subframe location and repetition

frequency:

*If the DCI is adopted for indication*, a specific RNTI, for example, SM-RNTI=FFFC, may be allocated to the SC-MCCH change notification information at first.... The time-domain location information, for example, a time-domain frame location and *a subframe index, for sending of the SC-MCCH change notification information and a notification information repetition frequency in one MP of the SC-MCCH may be indicated* in the configuration information of the SC-MCCH change notification information on the system broadcast system.

EX-1006 (Xu), 16:36-50.

The time domain location information for sending of the SC-MCCH change notification information *may be indicated in the configuration information of the SC-MCCH change notification information on the system broadcast system*. The time-domain location information may include: a time-domain frame period, *a subframe location and a notification information repetition frequency* in an MP of the SC-MCCH.

EX-1006 (Xu), 18:17-25.

188. RAN72 disclose transmitting the second DCI format (i.e. DCI format N2) in more than one subframe. DCI Format N2 includes a “DCI subframe repetition number” which is “3 bits as defined in section 16.6 of [3GPP TS 36.213].”

EX-1007, Section 6.4.3.3. Section 16.6 of 36.213, referenced by TS-36.212

discloses how a UE searches for NPDCCH transmissions:

An NPDCCH search space  $NS_k^{(L',R)}$  at aggregation level  $L' \in \{1,2\}$  and repetition level  $R \in \{1,2,4,8,16,32,64,128,256,512,1024,2048\}$  is defined by a set of NPDCCH candidates where *each candidate is repeated in a set of  $R$  consecutive NB-IoT downlink subframes* excluding subframes used for transmission of SI messages starting with subframe  $k$ .

EX-1008 (TS-36.213), pg. 367 (Section 16.6).

189. Therefore, Xu and RAN72 disclose transmitting the second DCI format in more than one subframe.

190. Accordingly, Xu in view of Ran72 and Fujishiro renders this claim element obvious.

v. ***[3.4] the generating circuitry configured to generate a first DCI format indicating a resource for a transmission of another SC-MCCH information,***

191. Xu in view of RAN72 renders this claim element obvious. As discussed above, TS-36.212 discloses that a base station should be capable of transmitting multiple DCI formats (e.g., formats 0, 1, 1A, 1B, 1C, 1D, 2, 2A, 2B, 2C, 2D, 3, 3A, 4, 6-0A, 6-0B, 6-1A, 6-1B, and 6-2), including several DCI formats for NB-IoT (e.g., formats N0, N1, and N2). X.B.1.iii. Thus, the generating circuitry disclosed by Xu would have been configured to generate

a first DCI format (e.g., a DCI format distinct from the second DCI format).

192. Xu discloses indicating a resource for a transmission of another SC-MCCH information:

By the act, the base station may send the system broadcast message *containing the configuration information of the SC-MCCH configured by the base station*, that is, *the base station may configure the configuration information of the SC-MCCH in the system broadcast message*. By virtue of the solution, a problem that there is no resource configuration method applicable to the SC-MCCH is solved, and resource configuration of the SC-MCCH is implemented.

EX-1006 (Xu), 14:4-11.

193. Xu further discloses sending this information through a DCI carried on a PDCCH:

Frequency-domain scheduling information of the SC-MCCH may be sent *through the PDCCH of the corresponding subframe*, and specifically, may be sent *through the DCI in the PDCCH*.

EX-1006 (Xu), 17:15-18.

194. When the teachings of Xu and RAN72 are combined with those of Fujishiro, a POSITA would have understood that the another SC-MCCH information would have been transmitted using a first DCI format, such as DCI format N1. As discussed above, in X.B.1.ii, Fujishiro discloses that the SC-MCCH is

transmitted in an SC-RNTI, as opposed to the format used for Direct Indication (e.g., Format N2):

In step S4, the UE 100 receives SIB20 setting information (SCPTM Configuration) from the eNB 200 via the SC-MCCH based on the SCPTM. In the physical layer, ***SC-RNTI (Single Cell RNTI) is used for SC-MCCH transmission.***

EX-1010 (Fujishiro 919), pg. 22.

In step S4, the UE 100 receives SCTPM setting information (SCPTM Configuration) from the eNB 200 via the SC-MCCH, based on the SIB20. For the SC-MCCH transmission in the physical layer, ***an SC-RNTI (Single Cell RNTI) is used.***

EX-1011 (Fujishiro 632) ¶94.

195. A POSITA would have understood that the SC-MCCH information have been sent using DCI Format N1 using SC-RNTI. *See* EX-1007 (TS-36.212), pg. 135 (Section 6.4.3.2) (“DCI format N1 is used for the scheduling of one NPDSCH codeword in one cell and random access procedure initiated by a NPDCCH order.”).

196. Accordingly, Xu in view of RAN72 and Fujishiro renders this claim element obvious.

vi. ***[3.5] the transmitting circuitry is configured to transmit, in more than one first subframe, the first DCI format carried on a first NPDDCH<sup>4</sup>,***

197. Xu in view of RAN72 and Fujishiro renders this claim element obvious. As discussed above, Xu and 3GPP disclose that a base station includes transmitting circuitry (e.g., sending module) and generating circuitry that is configured to generate multiple DCI formats, including the three narrowband DCI formats N0, N1, and N2. *See* X.B.1.ii-X.B.1.iii and X.B.1.v.
198. Also, as discussed above in X.B.1.iv, Xu and RAN72 disclose transmitting DCI in multiple subframes. For example, Xu discloses that the SC-MCCH information may be transmitted during a modification period (MP), which may be repeatedly transmitted in a repetition period (RP):

In the embodiment of the disclosure, ***the MP may be used for indicating a period of modification of the SC-MCCH. The RP may be used for indicating a period of repeated sending of the SC-MCCH in one MP.*** The time-domain location information of the SC-MCCH may be used for indicating locations of a radio frame and radio subframe

---

<sup>4</sup> As noted above, there appears to be a typographical error in the claim language.

By all apparent context, in claim element 3.5, “NPDDCH” should read “NPDCCH.”

where the SC-MCCH is located.

EX-1006 (Xu), 11:26-32.

199. Xu's disclosure is consistent with the 3GPP, which discloses that the NPDCCH UE search space is configured to allow a NPDCCH to be transmitted in more than one consecutive subframe. *See* X.B.1.iv. RAN72 further discloses that a change in SC-MCCH modification occurs during a "modification period" where SC-MCCH information is repeated:

Change of SC-MCCH information only occurs at specific radio frames, i.e. the concept of a modification period is used. Within a modification period, the same SC-MCCH information may be transmitted a number of times, as defined by its scheduling (which is based on a repetition period). The modification period boundaries are defined by SFN values for which  $\text{SFN mod } m = 0$ , where  $m$  is the number of radio frames comprising the modification period. The modification period is configured by means of SystemInformationBlockType20.

EX-1009 (TS-36.331), pg. 184 (Section 5.8a.1.2).

200. A POSITA would thus have understood that the transmitting circuitry of the base station (e.g., sending module), is configured to transmit the first DCI format (e.g., DCI format N2) in more than one first subframe on a first NPDCCH.
201. Accordingly, Xu in view of RAN72 and Fujishiro renders this claim element

obvious.

**vii. [3.6] a period of the more than one first subframe is different from a period of the more than one second subframe, and**

202. Xu in view of RAN72 and Fujishiro renders this claim element obvious. For a change notification of MCCH information, both Xu and 3GPP disclose the use of a modification period:

*In the embodiment of the disclosure, the MP may be used for indicating a period of modification of the SC-MCCH.* The RP may be used for indicating a period of repeated sending of the SC-MCCH in one MP. The time-domain location information of the SC-MCCH may be used for indicating locations of a radio frame and radio subframe where the SC-MCCH is located. The MCS may be an MCS of the radio subframe where the SC-MCCH is located. The configuration information of the SC-MCCH change notification information may be used for indicating time-domain location information of the SC-MCCH change notification information, and the time-domain location information of the SC-MCCH change notification information may include: locations of a radio frame and radio subframe where the SC-MCCH change notification information is location.

EX-1006 (Xu), 11:26-40.

Change of MCCH information only occurs at specific radio frames, *i.e. the concept of a modification period is used.* Within a modification

period, the same MCCH information may be transmitted a number of times, as defined by its scheduling (which is based on a repetition period). The modification period boundaries are defined by SFN values for which  $\text{SFN mod } m = 0$ , where  $m$  is the number of radio frames comprising the modification period. The modification period is configured by means of *SystemInformationBlockType13*

EX-1009 (TS-36.331), pg. 177 (Section 5.8.1.3).

203. When a MCCH change notification is sent, RAN72 also discloses that the change notification is transmitted in a separate modification period from the updated MCCH information:

When the network changes (some of) the MCCH information, it notifies the UEs about the change *during a first modification period. In the next modification period, the network transmits the updated MCCH information*. These general principles are illustrated in figure 5.8.1.3-1, in which different colours indicate different MCCH information.

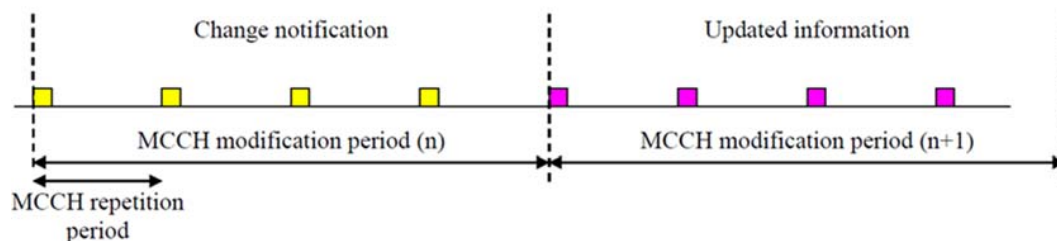


Figure 5.8.1.3-1: Change of MCCH Information

EX-1009 (TS-36.331), pp. 177-78 (Section 5.8.1.3), Figure 5.8.1.3-1.

204. As mentioned above, RAN72 discloses using a similar modification period

for a change in SC-MCCH information. X.B.1.iv. For non-NB-IoT systems RAN72 discloses transmitting the SC-MCCH change notification in the same subframe as the updated SC-MCCH information:

When the network changes (some of) the SC-MCCH information, it notifies the UEs about the change in the first subframe which can be used for SC-MCCH transmission in a repetition period. LSB bit in 8-bit bitmap when set to '1' indicates the change in SC-MCCH. *Upon receiving a change notification, a UE interested to receive MBMS services transmitted using SC-PTM acquires the new SC-MCCH information starting from the same subframe.* The UE applies the previously acquired SC-MCCH information until the UE acquires the new SC-MCCH information.

EX-1009 (TS-36.331), pg. 184 (Section 5.8a.1.3).

205. However, as the '764 Patent explains, this procedure is not possible in an NB-IoT system:

However, in the NB-IoT system, in order to reduce costs, the system based on a narrowband design *does not support transmitting a change indication and scheduling a new SC-MCCH information transmission in the same subframe.* Therefore, when the SC-PTM feature is introduced for the NB-IoT system, a new change notification is needed for the NB-IoT system.

EX-1001 ('764 Patent), 2:34-40.

206. Thus, in an NB-IoT system, DCI indicating an SC-MCCH change notification ***must*** be transmitted in a different subframe from the DCI indicating a resource for the updated SC-MCCH information. A POSITA would thus have understood that the subframes carrying the change notification and the subframes carrying the scheduling of a new SC-MCCH resource would need to be different. It would thus have been obvious to a POSITA to turn to the solution disclosed by RAN72 for a MCCH change notification. Based on this solution, it would have been obvious for a POSITA to transmit the change notification (i.e. through DCI format N1) in a first set of subframes (i.e., a first modification period) and then transmit information indicating a resource for the SC-MCCH information (i.e. through DCI format N2) in a subsequent and distinct set of subframes (i.e., a second modification period).
207. Accordingly, Xu in view of RAN72 and Fujishiro renders this claim element obvious.

***viii. [3.7] the transmitting circuitry is configured to transmit the another SC-MCCH information with use of the resource indicated by the first DCI format and in accordance with the second DCI format.***

208. Xu in view of RAN72 discloses this claim element. Xu discloses transmitting SC-MCCH configuration information through DCI and carried on a PDCCH:

***Frequency-domain scheduling information of the SC-MCCH may be sent through the PDCCH of the corresponding subframe, and specifically, may be sent through the DCI in the PDCCH.***

The DCI may at least include: scheduling information of the SC-MCCH on the frequency domain. The UE may detect the subframe, indicated in the system message, of the SC-MCCH by adopting the pre-allocated SC-MCCH RNTI, and in case of successful detection, it may represent that the subframe includes the required SC-MCCH information.

EX-1006 (Xu), 17:15-24.

209. Xu discloses that the SC-MCCH information is acquired as a result of the change notification. Figure 12 reproduced below illustrates that after a change notification is sent, a UE receives the changed SC-MCCH information:

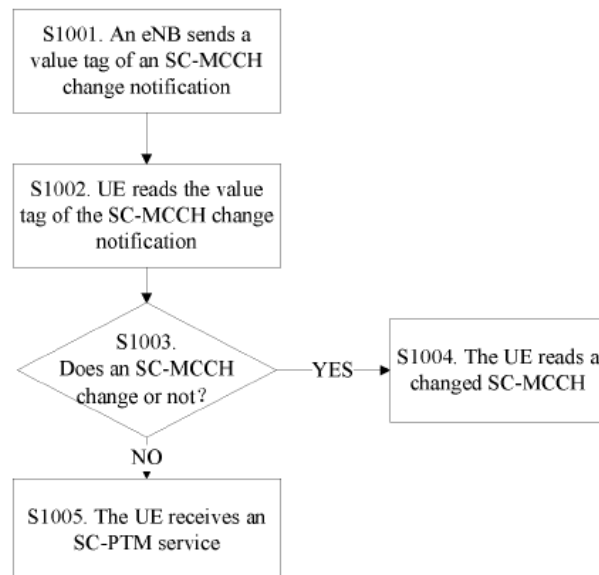


**Fig. 12**

EX-1006 (Xu), FIG. 12.

210. RAN72 similarly discloses that updated SC-MCCH information is transmitted after a change notification:

*Upon receiving a change notification*, a UE interested to receive MBMS services transmitted using SC-PTM acquires the new SC-MCCH information starting from the same subframe.

EX-1009 (TS-36.331), pg. 184 (Section 5.8a.1.3).

211. Accordingly, Xu in view of RAN72 renders this claim element obvious.

212. In view of the foregoing, Xu in view of RAN72 and Fujishiro renders obvious claim 3 of the '764 Patent.

## 2. Claim 4

### *i. [4.0] The base station, according to claim 3, wherein*

213. Xu in view of RAN72 and Fujishiro renders obvious claim 3 as discussed above in X.A.B.1. Accordingly Xu in view of Xu in view of RAN72 and Fujishiro renders this claim element obvious.

### *ii. [4.1] the second DCI format includes a field of multiple bits, and the SC-MCCH information change notification is indicated by the field of the multiple bits, one of the multiple bits indicating that a multimedia broadcast multicast service (MBMS) service is changed.*

214. Xu discloses this claim element. Xu discloses utilizing multiple bits in a SC-MCCH change notification and using one of the multiple bits to indicate that a MBMS service has changed:

SC-MCCH change notification information may indicate more service related information by *adopting two or more bits*. That is, *a service type may be indicated in DCI*, and for example, two bits N are adopted for indication wherein N1 may indicate whether the SC-MCCH changes or not, and *N2 may indicate a changing service type*, for example, N2=1 may indicate that a PS service changes, and N2=0 may indicate that an ordinary service changes. Furthermore, more than two bits in the DCI may be adopted to indicate more change information.

EX-1006 (Xu), 20:9-19.

215. Accordingly, Xu discloses this claim element.

216. In view of the foregoing, Xu in view of RAN72 and Fujishiro renders obvious claim 3 of the '764 Patent.

### 3. Claim 6

#### i. *[6.0] A method performed by a base station comprising:*

217. To the extent the preamble is limiting, Xu discloses a method performed by a base station for the same reasons set forth above in X.B.1.i. Specifically, although the preamble of claim 6 recites a method, as opposed to a base

station apparatus recited in claim 3, Xu discloses that the disclosed base station apparatus performs a method.

***ii. [6.1] transmitting Single-Cell Multicast Control Channel (SC-MCCH) information;***

218. Xu discloses this claim element for the same reasons set forth above in X.B.1.ii. Indeed, claim element 3.1 requires transmitting circuitry to be configured to transmit Single-Cell Multicast Control Channel (SC-MCCH) information, as recited in claim element 6.1.

***iii. [6.2] generating a second downlink control information (DCI) format indicating an SC-MCCH information change notification;***

219. Xu in view of RAN72 and Fujishiro renders this claim element obvious for the same reasons set forth above in X.B.1.iii. Indeed, claim element 3.2 requires generating circuitry to be configured to generate a second downlink control information (DCI) format indicating an SC-MCCH information change notification, as recited in claim element 6.2.

***iv. [6.3] transmitting, in more than one second subframe, the second DCI format carried on a second narrowband physical downlink control channel (NPDCCH);***

220. Xu in view of RAN72 and Fujishiro renders this claim element obvious for

the same reasons set forth above in X.B.1.iv. Indeed, claim element 3.3 requires transmitting circuitry to be configured to transmit, in more than one second subframe, the second DCI format carried on a second narrowband physical downlink control channel (NPDCCH), as recited in claim element 6.3.

**v. [6.4] generating a first DCI format indicating a resource for a transmission of another SC-MCCH information;**

221. Xu in view of RAN72 and Fujishiro renders this claim element obvious for the same reasons set forth above in X.B.1.v. Indeed, claim element 3.4 requires generating circuitry to be configured to generate a first DCI format indicating a resource for a transmission of another SC-MCCH information, as recited in claim element 6.4.

**vi. [6.5] transmitting, in more than one first subframe, the first DCI format carried on a first NPDDCH; and**

222. Xu in view of RAN72 and Fujishiro renders this claim element obvious for the same reasons set forth above in X.B.1.vi. Indeed, claim element 3.5 requires transmitting circuitry to be configured to transmit, in more than one first subframe, the first DCI format carried on a first NPDDCH, as recited in claim element 6.5.

*vii. [6.6] transmitting the another SC-MCCH information with use of the resource indicated by the first DCI format and in accordance with the second DCI format, wherein*

223. Xu in view of RAN72 renders this claim element obvious for the same reasons set forth above in X.B.1.viii. Indeed, claim element 3.7 requires transmitting circuitry to be configured to transmit the another SC-MCCH information with use of the resource indicated by the first DCI format and in accordance with the second DCI format, as recited in claim element 6.6.

*viii. [6.7] a period of the more than one first subframe is different from a period of the more than one second subframe.*

224. Xu in view of RAN72 and Fujishiro renders this claim element obvious for the same reasons set forth above in X.B.1.vii, as this claim element is identical to claim element 3.6. Therefore for at least the foregoing reasons, Xu in view of RAN72 renders obvious claim 6 of the '764 Patent.

## **XI. SECONDARY CONSIDERATIONS DO NO REBUT THE PRIMA FACIE CASE OF OBVIOUSNESS**

225. In my opinion, secondary considerations do not rebut the prima facie case of obviousness for at least two reasons.

226. First, I have not seen any evidence of any secondary considerations to date. As such, I do not believe any such secondary considerations exist. To the

extent Patent Owner seeks to proffer evidence of any secondary considerations in this proceeding, I reserve the right to comment on such evidence.

227. Second, I do not believe that Patent Owner will be able to establish a nexus between any secondary considerations and the Challenged Claims. I have been advised that a nexus does not exist where the alleged secondary considerations result from something other than what is both claimed and novel in the claims.

228. As I have explained above, there is nothing novel in the claims. Indeed, all claim elements are disclosed in the prior art. Thus, I do not see any basis for Patent Owner to assert that there is a nexus between any secondary considerations and the claims.

## **XII. CONCLUSION**

229. My findings and opinions set forth in this Declaration are based on my work and examination to date. I may continue my examinations in view of additional documents or other factual evidence over the course of this proceeding that may necessitate supplementing and/or refining my opinions. I reserve the right to add to, alter, or delete any of my opinions and my Declaration upon discovery of additional information. I reserve the right to

make any changes as necessary.

230. In signing this Declaration, I understand that this Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allowed for cross-examination. I declare that all statements made herein of my knowledge, all statements made on information and belief are believed to be true, and 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.

[SIGNATURE ON COVER PAGE]

## APPENDIX A

### MATERIALS CONSIDERED

| Exhibit # | Description                                                                                    |
|-----------|------------------------------------------------------------------------------------------------|
| 1001      | U.S. Patent No. 10,785,764 (the “’764 Patent”)                                                 |
| 1002      | Prosecution history of the ’764 Patent (“File History”)                                        |
| 1004      | Certified English Translation of U.S. Provisional Application No. 62/372,323 (“Shin 323”)      |
| 1005      | U.S. Patent No. 11,160,094 (“Shin 094”)                                                        |
| 1006      | U.S. Patent No. 10,785,752 (“Xu”)                                                              |
| 1007      | 3GPP TS 36.212 v.13.2.0 (“TS-36.212”)                                                          |
| 1008      | 3GPP TS 36.213 v.13.2.0 (“TS-36.213”)                                                          |
| 1009      | 3GPP TS 36.331 v.13.2.0 (“TS-36.331”)                                                          |
| 1010      | Certified English Translation of U.S. Provisional Application No. 62/372,919 (“Fujishiro 919”) |
| 1011      | U.S. Patent Publication No. 2019/0182632 (“Fujishiro 632”)                                     |
| 1012      | 3GPP TS 36.321 v.13.2.0 (“TS-36.321”)                                                          |
| 1013      | U.S. Provisional Application No. 62/372,323 (“323 Provisional”)                                |
| 1014      | U.S. Provisional Application No. 62/372,919                                                    |
| 1015      | U.S. Provisional Application No. 62/372,324 (“324 Provisional”)                                |
| 1016      | Certified English Translation of U.S. Provisional Application No. 62/372,324 (“Shin 324”)      |
| 1017      | PCT Publication No. WO 2018/030793                                                             |
| 1018      | PCT Publication No. WO 2018/030305                                                             |

**APPENDIX B**

**CURRICULUM VITAE**

**Mark P. Mahon, Ph.D.**  
Teaching Professor  
Pennsylvania State University  
School of Electrical Engineering and Computer Science  
W209A Westgate Bldg.  
Pennsylvania State University  
University Park, PA

## Highlights

Teaching faculty experienced in research and systems development in cellular and mobile wireless networks, wireless local area networks, wireless network security, mobility management, mobile data systems including networks, protocols, and applications, wideband signal processing, modulation theory, algorithms, mathematical/analytical modeling, communication, detection and estimation, and control systems. Pursues funding for and conducts advanced research in computer and mobile networks, theoretical and experimental analysis of communication systems, cellular, wireless, and mobile systems, wideband signal processing, sensors, tracking, localization, and data fusion. Experienced in hardware/software development, data acquisition, integration, and testing, field test planning, preparation, and execution. Extensive programming experience including UI, analysis tools, real-time object-oriented programming, and embedded systems code development in C, C++, python, java, Verilog, RTL, VHDL, HDL, and assembly.

## Education

PhD. Acoustics, The Pennsylvania State University, University Park, PA 16802, 2001  
M.S. Electrical Engineering, The Pennsylvania State University, University Park, PA, 16802, 1991  
B. S. Electronics Engineering, The University of Scranton, Scranton, PA, 18510, 1987

## Employment

**July 2021 – Present:** *Teaching Professor, School of Electrical Engineering and Computer Science, The Pennsylvania State University, University Park, PA 16801*

**June 2018 – June 2021:** *Associate Teaching Professor*

**Aug. 2015 – June 2018:** *Assistant Teaching Professor*

Teach graduate and undergraduate courses in computer science and electrical engineering such as communication networks, mobile networks, neural networks, programming, mathematics, and wireless security. Advise and direct graduate students' MS and PhD research in the areas of wireless and computer networks, network resource allocation and optimization techniques, ultrawide band systems, multiple antenna applications, and wireless security. Guide Schreyer Honors College students' honors theses. HackPSU and BlockChain@PSU faculty adviser, member of graduate advising committees, member of Computer Science Undergraduate Curriculum Committee, member of School of EECS Management Committee, advise undergraduate electrical engineering, computer science, computer engineering, and data science students.

**2003 – Aug. 2015:** *Associate Research Professor, Applied Research Laboratory, Communications, Information, and Navigation Office, The Applied Research Laboratory, The Pennsylvania State University, State College, PA* Principal Investigator, Co-Principal Investigator, Technical lead conducting research on cellular and mobile networks, computer network security, mobile communication systems, data fusion, and wideband signals and image processing with total funding over \$12M.

**2002 – 2003:** *Sr. Systems Engineer, Klein & Stump, Inc., 2120 Washington Blvd. #400, Arlington, VA 22204* Researcher and technical consultant working on wireless communications projects for US Special Operations Command (SOCOM) and Naval Information Warfare Activity (NIWA). Awarded \$150k SBIR for SOCOM advanced signal simulator.

**1991 – 2002:** *Assistant Research Professor, Applied Research Laboratory, Communication Sciences and Technology Division, The Applied Research Laboratory, The Pennsylvania State University, State College, PA 16804* Principal Investigator and researcher conducting research on cellular and mobile networks, wideband signals, tracking and localization, adaptive signal processing, acoustic propagation, sensor systems, remote sensing, and active noise control. Awarded \$750k for development of novel wavelet based wideband signal detection for high altitude sensors.

**1988 – 1989:** *Program Engineer, Central Intelligence Agency, Langley, VA 22101*  
Assisted in the development of algorithms and signal processing systems for novel applications in the areas of RF communications and signal modulation techniques.

### **Detailed Research Experience:**

#### *Current ongoing research:*

Resource allocation and scheduling improvements in NG networks and edge computing; Multiple Input Multiple Output antenna techniques for increased capacity in NG systems; Fast handover techniques using blockchains to reduce mobility interruption times in 5G networks; AI/NN techniques applied to network scheduling and optimization, and mobile robotics for localization and mapping; Automated object detection and 3D mapping using sonar array data. Security vulnerabilities in UWB ranging.

#### *2015 – Present*

Lead graduate and undergraduate student research in wireless communication networks, distributed video processing in cellular systems, UWB ranging, communication systems and security, software defined network security, application of game theory to cyber resiliency, wireless, machine learning, big data analytics, and artificial intelligence for mobile and computer network security and automated detection in acoustic and sonar systems.

#### *2014 – 2015*

Leading internal research and development effort on deep packet inspection for zero day and predictive detection for data networks. Technical performer developing novel deformable wavelet-based contour matching technique for automated object detection in satellite images. Acoustic tracking and identification of drones for area defense system.

#### *2014*

Developed real-time scanner for 802.15.4 (LR-WPAN) protocol deployed on software defined radio platform.

#### *2013-2014*

Technical lead on developing novel mathematical model for analyzing torpedo acoustic threat surrogate systems for US Navy. Experimental lead on disposable, adaptive, high bandwidth fiber-optic undersea communication system for US Navy.

#### *2013*

Implemented a novel matched filter receiver for a unique OFDM signal of interest to facilitate signal detection in a high co-channel interference environment of a wide field of view high altitude receiver and wideband signal set design in highly complex propagation environments for

Department of Defense (DoD).

*2012-2013*

Technical lead for design and implementation of a real-time transmitter/receiver on a software defined radio platform for maritime communication systems (Automatic Information System/Maritime Security).

*2012*

Communications/signal processing technical consultant on Maritime Domain Operations and Unmanned Surface Ship Interdiction study effort for US Navy.

*2011-2012*

Principal Investigator, technical and experimental lead on fiber optic undersea communication system for Advanced Submarine System Development effort for US Navy.

*2011*

Technical lead on mathematical analysis, algorithm development, and implementation of pattern of life signal to noise ratio analysis in high co-channel interference environment for DoD.

Trusted agent for Army Research Lab to review and critically analyze work associated with wideband signaling and passive emissions collection from cell phones. Reviewed contractor data analysis and technical briefings for scientific accuracy and rigor. Advised the sponsor on contractor testing methodologies, procedures, and analysis techniques. Technical lead implementing unique wideband acoustic communication system and specialized signal processing hardware for an acoustic system being utilized in a complex maritime environment for the DoD.

*2009 – 2010*

Tiger team lead for large unmanned undersea vehicle (UUV) assigned to identify platform induced electromagnetic interference with electronic payload system in the HF and acoustic regimes for the US Navy.

Developed and implemented a novel algorithm to calculate the effective force charge based on muzzle sensor data utilizing MEMS transducers and PIC controller on a portable howitzer for the US Army.

Conducted study and authored Intelligence, Surveillance, and Reconnaissance (ISR) for Unmanned/Minimally Manned Undersea Vehicle (UMUV) report presented to Defense Advanced Research Projects Agency (DARPA).

*2006 – 2009*

Principal Investigator for a multi-year research and FPGA-based engineering prototype development effort in the area of 3G/4G (UMTS/LTE) cellular and wireless (IEEE 802.16 and 802.11) communication systems; Effort consisted of three phases: theoretical and analytical study, proof-of-concept development, and testing, and prototype development for DoD.

*2005-2006*

Technical lead on Information Fusion engine integration into a sandbox enclave at Joint Interagency Task Force South (JIATF-S) to support multi-int data fusion.

*2003 – 2006*

Principal Investigator for multi-year Office of Secretary of Defense sponsored research program in the area of multi-intelligence data fusion as part of the overall initiative of Force Transformation; worked extensively with NGA, DIA, DISA, OSD, all military services, and some coalition components.

2002 – 2003

Pursued funding for research interests in the areas of wireless/wideband communications, wideband systems, source detection/localization, intelligent system of systems design, and data fusion; Awarded Phase I, Small Business Innovative Research contract for Portable Signal Training System by SOCOM (02-013); Technical consultant for Naval Information Warfare Center on Common for High Performance Computing Software Support Initiative's (CHSSI) Electronic Battlefield Environment (EBE) portfolio (Electromagnetic Environmental Effects Toolkit), SBIR, MERIT/TENCAP, TST programs

1998 – 2002

Researcher and principal investigator performed research in large time-bandwidth product (wavelets) source detection and localization – theoretical, analytical, and field testing; CDMA IS-95A/3G cellular communications; Developed mathematical analytical models and included code development of the CDMA air interface physical layer implementing major aspects of the CDMA protocol for test and analysis purposes; Built real-time hardware platform for deploying developed CDMA physical layer code.

1997 – 1998

Principal Investigator in charge of signal processing algorithm and code development, image acquisition and compression, telephony, and user interface design for an experimental remote, autonomous, acoustic rockslide detection for Conrail. Work included algorithm and code development utilizing embedded digital signal processing (DSP) board and development of unique algorithms for real-time monitoring of transducers to create an event detection system.

1991 – 1997

Performed fundamental research in the areas of signal processing algorithm development, acoustic atmospheric propagation, detection, source localization, beamforming, system identification, and active control; Main responsibilities include real-time code development (C, Visual C++, assembly) for signal processing systems, adaptive beamforming, and embedded processing for eight major projects during this time. Multiple DSP platform development; Active Noise Control, feature extraction, data logging and fusion, passive acoustic tracking, beamforming, and analysis for these projects

1988-1989

Assisted in the development of algorithms and signal processing systems for novel applications in the areas of RF communications and signal modulation techniques.

## **Case History:**

*Ericsson Inc. and Nokia of America v. Active Wireless Technologies, LLC. IPR2024-00xx*

Consulting for petitioners Ericsson and Nokia on improvements in system information transmissions in 4G systems. Wrote declaration.

*October 2023 – April 2024, Erise IP; Finnegan, DLA Piper, Husch Blackwell*

*BNR v. ASUSTek/Media Tek/Laird/NXP Inc. Inv. No. 337-TA-1367 (USITC).* Consulting for defendant ASUS on ASUS (Qualcomm-based products) non-infringement and JDG (ASUS/Media Tek/ Laird/ NXP) on Tech DI non-infringement on WiFi wireless devices and semiconductor chips with wireless capabilities related to wireless transmission technologies. Wrote rebuttal report. BNR settled with ASUS and Media Tek; BNR withdrew complaint for NXP.

*September 2023 – April 2024, McKool Smith*

*Daingean Technologies Ltd. v. AT&T, et al, Case No. IPR2024-00309.* Consulting for petitioner AT&T. Technology related to 5G wireless transmissions. Wrote declarations. Case settled.

*August 2023 – December 2023, Greenberg Traurig*

*Atlas Global Technologies, LLC v. Acer Incorporated, No. 2:22-cv-00259 WDTX.* Consulting for defendant Acer. Technology related to wireless transmissions in WiFi networks. No reports. Settled.

*August 2023 – Present, McKool Smith*

*Ericsson v. Lenovo/Motorola, In the Matter of Certain Mobile Phones, Components Thereof, and Products Containing Same, Inv. No. 337-TA-1375 (USITC)*

Consulting for Complainant Ericsson on technology related to 5G cellular signaling technology.

*August 2023 – Present, Caldwell, Cassady and Curry*

*Neo Wireless, LLC v. Ford, et al., Case No. 2:22-MD-03034.* Consulting for plaintiff on technology related to 4G cellular radio access. Wrote infringement reports.

*June 2023 – November 2023, Duane Morris*

*Ericsson, Inc., and Cellco Partnership D/B/A Verizon Wireless v. Woodbury Wireless LLC., IPR 2023-01364.* Consulted for petitioner Verizon. IPR. The technology related to MIMO and minimization of interference. Declaration filed 10/10/23. Case settled.

*January 2023 – April 2023, McKool Smith*

*Ericsson v. Koninklijke KPN N.V., Case No. IPR2023-00582.* Consulting for Petitioner Ericsson. IPR. Technology related to neighbor cell lists in wireless systems. Declaration filed 2/17/23.

*November 2022 – April 2023, Finnegan, Henderson, Farabow, Garrett & Dunner, LLP*

*Qualcomm, Inc. vs. FedEx, Inc., IPR 2022-00585*

Consulting for patent owner FedEx. Wrote IPR declaration. Deposed 4/19/23.

Technology related to sensor information collected by tracking devices.

*October 2022 – November 2023, BC Law Group, P.C.*

*Lionra Technologies Limited v. Apple, Inc. Case No. 6:22-cv-00351-ADA, WDTX*

Consulting for patent owner Lionra. Case dismissed 11/18/23.

*September 2022 – June 2023, Quinn Emanuel, LLP*

*Google LLC v. Sonos, Inc., Inv. No. 337-TA-1330 (USITC)*

Consulting for patent owner Google. Wrote infringement and validity rebuttal reports.

Technology related to voice assistants and smart devices. Deposed 4/14/23. Testified at trial 6/20/23 and 6/23/23.

*September 2022 – August 2023, BC Law Group, P.C.*

*Apple, Inc. vs. Speir Technologies Limited, IPR2022-01512 and -00151*

Consulted for patent owner Speir on UWB localization technology. Wrote IPR declarations. Deposed 10/25/23. Case dismissed 11/18/23.

*August 2022 – Present, Venable, LLP*

*VoIP-Pal.com, Inc. v. Verizon Communications Inc. Case No. 6:21-cv-00672, WDTX*

Consulting for defendant Verizon. Wrote non-infringement report. Deposed 5/17/23.

Technology relates to VoIP in cellular networks.

*July 2022 – November 2023, Quinn Emanuel Urquhart & Sullivan, LLP*  
*Evolved Wireless LLC v. Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc., Case No. 2:21-cv-00033, EDTX.* Technology related to handovers in 4G networks.  
Consulting for defendant Samsung. Wrote non-infringement and validity rebuttal report. Deposed 7/5/23; Testified at trial 11/14/23.

*March 2022 – Dec. 2022, Knobbe, Martens, Olson & Bear, LLP*  
*Jawbone Innovations, LLC v. Amazon.com, Inc., et al.*  
Consulting for petitioner Amazon re: IPR. Case stayed. No reports.  
Technology related to tracking using acoustic arrays.

*May 2022 – Dec. 2022, McKool Smith; Alston Bird*  
*Ericsson Inc. and Telefonaktiebolaget LM Ericsson vs. Apple Inc., Case No. 2:21-cv-376, EDTX*  
Consulted for plaintiff and counter-defendant Ericsson.  
Report on Essentiality and Rebuttal report (FRAND). Deposed 10/4/2022. Testified 12/7/2022. Case settled during trial.  
Broad spectrum of technology related to cellular networks (core network and mobile device)

*March 2022 – Dec. 2022, McKool Smith*  
*Ericsson Inc. and Telefonaktiebolaget LM Ericsson vs. Apple Inc., Inv. No. 337-TA-1299, ITC*  
Consulted for Ericsson. Opening and Rebuttal report. Deposed 10/7/2022. Case settled.  
Technology related to security in cellular systems.

*January 2022 – March 2023, Duane Morris*  
*Telecom Network Solutions v. AT&T Inc., et al, Case No. 2:21-cv-415 and Verizon Communications Inc., et al, Case No 2:21-cv-416, EDTX*  
Consulted for defendants AT&T and Verizon on Invalidity. Case settled; no reports filed.  
Technology related to QoS in cellular networks.

*September 2021 – December 2021, Duane Morris, LLP*  
*KAIFI LLC v. Verizon Wireless, Case No. 2:20-cv-280-JRG, EDTX*  
Consulted for defendant Verizon. Wrote Non-Infringing Alternatives and Non-Infringement reports. Deposed 12/15/21. Case settled. Technology related to cellular and WiFi enablement with cellular systems.

*September 2021 – December 2021, Quinn Emanuel, LLP*  
*L2 Mobile Technologies, LLC v. Google, Case No. 6:21-cv-358, WDTX*  
Consulted for defendant Google. Wrote reply Claim Construction brief. Case settled.  
Technology related to control signaling in cellular systems.

*August 2021 – May 2022, McKool Smith*  
*Godo Kaisha IP Bridge I v. Ericsson, Case No. 2:21-cv-00213-JRG, EDTX*  
Consulted for defendant Ericsson. IPR and Claim Construction declarations.  
Technology related to signaling in OFDM systems.

*July 2021 – August 2021, Quinn Emanuel, LLP*  
*Finesse Wireless, LLC v. Nokia, et al., Case No. 2:21-CV-00063-JRG, EDTX*  
Consulted for defendant Nokia on claim construction. Wrote declaration and deposed on 8/17/21.  
Technology related to coding techniques in wireless systems.

*June 2021 – Dec 2021, Knobbe, Martens, Olson & Bear, LLP*  
*Vocalife LLC v. Amazon.com, Inc., et al., Case No. 2:20-cv-00401-JRG-RSP, EDTX*  
Consulted for defendant Amazon on claim construction. Stayed pending sister case outcome.  
Technology related to echo cancelation and signal enhancement in acoustic systems.

*March 2021 – Sept 2021, Wilson Sonsini*

*Lenovo Holding Co, Inc., et al. v. InterDigital Technology Corp.*

IPR. Consulted for InterDigital. Wrote three declarations. Deposed 7/27/21.

Technology related to control signaling in cellular systems.

*January 2021 – May 2021, Winston & Strawn, LLP*

*Ericsson, Inc. v. Samsung Electronics, Ltd., ITC*

Consulted for plaintiff. Settled May 2021. No deposition. No declaration filed.

Patents dealt with antenna arrays for 5G/4G base stations, access point signaling, bearer handling.

*November 2020 – June 2021, Sheppard Mullin*

*Hong Kong uCloudlink v. SIMO Holdings, Inc. and Skyroam, Inc., Case No. 18-cv-05031-EMC,*

*NDCA.* Consulted for plaintiff uCloudlink on infringement and validity. Deposed (3/26/21). Case settled. Virtual SIM technology.

*August 2019 – August 2020; June 2021 – Sept 2021 McKool Smith/Irell & Manella*

*Optis Wireless Technology, LLC et al. v. Apple, Inc., EDTX, Civ No. 2:19-cv-66*

Consulted for plaintiff Optis. Infringement and validity analysis/reports, IPR. Deposed 06/01/20 and testified at trial 8/3/20 – 8/9/20. Re-trial for damages 8/10/21 – 8/16/21.

*March 2019 – May 2020 Gibson, Dunn, & Crutcher, LLP*

*Sol IP v. AT&T, Ericsson, Nokia, Verizon, and Sprint, EDTX, Case No. 2:18-cv-526*

Consulted for defendants on patents involving LTE downlink cell search and synchronization signaling. Invalidity, non-infringement analysis/reports, claim construction. No deposition, case settled.

*2016 – March 2019 Sidley Austin, LLP*

*Huawei v. Samsung, NDCA*

*Case No. 3:16-cv-02787-WHO*

Consulted for plaintiff Huawei on original complaint and for defendant Huawei on counterclaims on patents involving control channel signaling, network access, and security. Assisted claim construction, IPR petition and preliminary response, wrote validity and non-infringement reports. Deposed 6/20/18, 7/19/18. Case settled.

*2016 Russ, August & Kabat*

*Core Wireless v. Apple, Court of Northern California, Case No. 6:14-cv-752-JDL*

Consulted for plaintiff on patents associated with core network signaling. Wrote infringement and validity reports and rebuttals. Performed source code review and conformance testing. Deposed (8/12/2016). Patent was dropped during down select before trial.

*2015 - 2016 Hueston & Hennigan*

*Core Wireless v. LG Electronics, Court of Eastern Texas, Case No. 2:14-cv-911-JRG-RSP (lead case), Case No. 2:14-cv-912-JRG-RSP (consolidated)*

Consulted for plaintiff on patents on cellular user interface. Present at jury trial (3/2016) and participated in mock jury trial (2/10/2016). Wrote rebuttal expert report on validity and deposed (12/11/2015). Wrote infringement report regarding cellular protocols. Performed source code review and conformance testing. Core Wireless prevailed.

*2015 Bunsow De Mory Smith & Allison*

*Core Wireless v. LG Electronics, Court of Eastern Texas, Case No. 2:14-cv-911-JRG-RSP (lead case), Case No. 2:14-cv-912-JRG-RSP (consolidated) and Core Wireless v. Apple, Case No. 6:14-cv-752-JDL*

Consulted for plaintiff on patents associated with core network signaling. Wrote declarations on claim construction. Prepared tutorial to be presented to court. Case handed off to Hueston & Hennigan.

## Case Testimony History:

*October 2023 – April 2024, Erise IP; Finnegan, DLA Piper, Husch Blackwell*  
*BNR v. ASUSTek/Media Tek/Laird/NXP Inc. Inv. No. 337-TA-1367 (USITC).* Consulting for defendant ASUS on ASUS (Qualcomm-based products) non-infringement and JDG (ASUS/Media Tek/ Laird/ NXP) on Tech DI non-infringement. Wrote on WiFi wireless devices and semiconductor chips with wireless capabilities related to wireless transmission technologies. Wrote rebuttal report. Deposed 2/8/24. BNR settled with ASUS and Media Tek; BNR withdrew complaint before hearing.

*November 2022 – April 2023, Finnegan, Henderson, Farabow, Garrett & Dunner, LLP*  
*Qualcomm, Inc. vs. FedEx, Inc., IPR 2022-00585*  
Consulting for patent owner FedEx. Wrote IPR declaration. Deposed 4/19/23.  
Technology related to sensor information collected by tracking devices.

*September 2023 – June 2023, Quinn Emanuel, LLP*  
*Google LLC v. Sonos, Inc., Inv. No. 337-TA-1330 (USITC)*  
Consulting for patent owner Google. Wrote infringement and validity rebuttal reports.  
Technology related to voice assistants and smart devices. Deposed 4/14/23. Testified 6/20-23/23.

*September 2022 – November 2023, BC Law Group, P.C.*  
*Apple, Inc., vs. Speir Technologies Limited, IPR2022-01512 and -00151*  
Consulted for patent owner Speir on UWB localization technology. Wrote IPR declarations. Deposed 10/25/23. Case dismissed 11/18/23.

*August 2022 – Present, Venable, LLP*  
*VoIP-Pal.com, Inc. v. Verizon Communications Inc. Case No. 6:21-cv-00672, WDTX*  
Consulting for defendant Verizon. Wrote non-infringement report. Deposed 5/17/23.  
Technology relates to VoIP in cellular networks.

*July 2022 – November 2023, Quinn Emanuel Urquhart & Sullivan, LLP*  
*Evolved Wireless LLC v. Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc., Case No. 2-21-cv-00033, EDTX.* Technology related to handovers in 4G networks.  
Consulting for defendant Samsung. Wrote non-infringement and validity rebuttal report. Deposed 7/5/23; Testified at trial 11/14/23. Jury found for defendant on all counts.

*March 2022 – December 2022, McKool Smith*  
*Ericsson Inc. and Telefonaktiebolaget LM Ericsson vs. Apple Inc., Inv. No. 337-TA-1299, ITC*  
Consulting for Ericsson. Opening and Rebuttal report. Deposed 10/7/2022. Testified 12/7/2022. Case settled during trial.

*May 2022 – December 2022, McKool Smith; Alston Bird*  
*Ericsson Inc. and Telefonaktiebolaget LM Ericsson vs. Apple Inc., Case No. 2:21-cv-376, EDTX*  
Consulting for plaintiff and counter-defendant Ericsson.  
Report on Essentiality and Rebuttal report. Deposed 10/4/2022. Case settled.

*September 2021 – December 2021, Duane Morris, LLP*  
*KAIFI LLC v. Verizon Wireless, Case No. 2:20-cv-280-JRG, EDTX*  
Consulted for defendant Verizon. Wrote Non-Infringing Alternatives and Non-Infringement reports. Deposed 12/15/21. Case settled.

*July 2021 – August 2021, Quinn Emanuel, LLP*  
*Finesse Wireless, LLC v. Nokia, et al., Case No. 2:21-CV-00063-JRG, EDTX*  
Consulted for defendant Nokia on claim construction. Technology related to noise in the front-end of receiver. Deposed on 8/17/21.

*March 2021 – Sept 2021, Wilson Sonsini*

*Lenovo Holding Co, Inc., et al. v. InterDigital Technology Corp.*

IPR. Consulted for InterDigital. Technology related to control signaling in cellular systems. Wrote three declarations. Deposed 7/27/21.

*November 2020 – June 2021, Sheppard Mullin*

*Hong Kong uCloudlink v. SIMO Holdings, Inc. and Skyroam, Inc., Case No. 18-cv-05031-EMC,*

*NDCA.* Consulted for plaintiff uCloudlink on infringement and validity. Technology related to virtual SIM. Deposed 3/26/21.

*August 2019 – August 2020; June 2021 – Sept 2021 McKool Smith/Irell & Manella*

*Optis Wireless Technology, LLC et al. v. Apple, Inc., EDTX, Civ No. 2:19-cv-66*

SEPs – Consulted for plaintiff Optis on control channel MIMO switching, control channel information fields. Infringement and validity analysis/reports, IPR. Deposed 06/01/20 and testified at trial 8/3/20 – 8/9/20. Testified at re-trial for damages 8/10/21 – 8/16/21.

*2016 – March 2019 Sidley Austin, LLP*

*Huawei v. Samsung, NDCA*

*Case No. 3:16-cv-02787-WHO*

Consulted for plaintiff Huawei on original complaint and for defendant Huawei. Assisted claim construction, IPR petition and preliminary response, wrote validity and non-infringement reports. Deposed 6/20/18, and 7/19/18.

*2016 Russ, August & Kabat*

*Core Wireless v. Apple, Court of Northern California, Case No. 6:14-cv-752-JDL*

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*2015 - 2016 Hueston & Hennigan*

*Core Wireless v. LG Electronics, Court of Eastern Texas, Case No. 2:14-cv-911-JRG-RSP (lead case),*

*Case No. 2:14-cv-912-JRG-RSP (consolidated)*

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## **Teaching:**

### Courses:

- CSE 516 (Mobile Networks): Redesigned the course to integrate latest developments in mobile network architecture design. The course now includes signaling, control, and protocol issues unique to 4G/5G architectures addressing eMBB, mMTC, and URLLC use cases critical to IoT and future wireless network development and future NG networks.
- CSE 514 (Communication Networks)
- CSE 590 (Colloquium)
- CMPEN 462 (Wireless Communication Systems and Security): Created and designed this course to address a gap in the wireless communications area focusing on security. This course is included in the cybersecurity computational foundations minor.
- EE 456 (Introduction to Neural Networks): This course is intended to address the need for EE and CMPEN students to be exposed to the principles associated with artificial intelligence with a focus on the integration of physics-based approaches.
- CMPEN/EE 362 (Communication Networks)
- CMPSC 263 (Blockchains and Modern Web Development): This course is ‘module’ driven and

designed to provide students with a broad range of academic backgrounds an opportunity to learn about blockchains and cryptography. Under supervision, students in the Distributed Ledger Society teach the modules including theory and practice in the areas of programming, math, and cryptography.

- ACS 505 (Experimental Techniques in Acoustics)
- MATH 141 (Calculus with Analytical Geometry II)
- CMPSC 101 (Programming in C++)

#### **Publications:**

Rublein, Mehmeti, Mahon, and LaPorta, “Impact of Client Choice on Distributed Resource Allocation in Edge Computing”, *The 33<sup>rd</sup> International Conference on Computer Communications and Networks (ICCCN 2024)*, IEEE and IEEE Communication Society, July 29 – 31, 2024, Big Island, Hawaii, USA.

Rublein, Mehmeti, Mahon, and LaPorta, “Improved Methods of Task Assignment and Resource Allocation with Preemption in Edge Computing Systems”, *IEEE Transactions on Parallel and Distributed Computing*. Submitted July 2023.

Sorensen, Mahon, Mehmeti, and LaPorta, QoE-Analysis of 5G Network Resource Allocation Schemes for Competitive Multi-User Video Streaming Applications, *IEEE Conference on Vehicular Technology*, Florence, Italy, June 2023.

Sorensen, Mehmeti, Mahon, LaPorta, and Cao, “EQMS: An Improved Energy-Aware and QOE-aware Video Streaming Policy across Multiple Competitive Mobile Devices”, *Wireless Networks: The Journal of Mobile Communication, Computation and Information*, Dec. 2022.

Sorensen, Mehmeti, Mahon, Qui, Chan, Qui, and LaPorta, “Optimal Resource Allocation for Crowdsourced Image Processing”, *IEEE Transactions on Mobile Computing*. June 2022.

Sorensen, Mehmeti, Mahon, La Porta, Cao, “Mutli-User Competitive Energy-Aware and QoE-Aware Video Streaming on Mobile Devices”, *ACM Proceedings of the QoS and Security for Wireless and Mobile Networks (Q2SWinet) Symposium collocated with Modeling, Analysis, and Simulation of Wireless and Mobile Systems (MSWIM 2020)*, Alicante, Spain, Nov. 2020.

Sorensen, Mehmeti, Mahon, Qui, Chan, and LaPorta, “Optimal Resource Allocation for Crowdsourced Image Processing”, *IEEE International Conference on Sensing and Networking (IEEE SECON 2020)*, Como, Italy, June 2020.

Swanson, Mahon, Norris, and Mast, “Atmospheric Multipath Resolution Using Spread Spectrum Acoustic Signals”, *Proceedings of Meetings on Acoustics*, September 2017.

Aquaviva, Mahon, Einfalt, and LaPorta, “Optimal Cyber-Defense Strategies for Advanced Persistent Threats: A Game Theoretic Approach,” *2017 International Symposium on Reliable and Distributed Systems*, Hong Kong, China, September 27 – 29, 2017.

Young, Mahon, and Wyckoff, “Automated Information Management,” Chap. 12, *Mathematical Techniques in Multisensor Data Fusion*, Hall, David L., Artech House Inc., Mar 2004

Mahon, Sonstebly, and Wenchel, “Application of Non-Orthogonal Waveletes for Geolocation,” *Radiolocation and Direction Finding Symposium*, Southwest Research Institute, San Antonio, Texas, 2-4 Nov. 1999.

Myers, Lovette, Kilgus, Giannini, Swanson, Reichard, Mahon, Mast, "A Java-based Information System for Wayside Sensing and Control," *Proc. of the 1998 ASME/IEEE Joint Railroad Conference*, 1998, pp. 135-147.

Swanson, Mast, Mahon, "Atmospheric Multipath Resolution Using Spread Spectrum Acoustic Signals," *Proceedings of the 133<sup>rd</sup> Meeting of the ASA*, June 15-20, 1997.

Mahon, Swanson, "Acoustic Holography as an Active Control Measurement Tool," *Proceedings of Active 95, The 1995 International Symposium on Active Control of Sound and Vibration*, Newport Beach, CA, July 1995, pp. 673-684.

Mahon, Sibul, Valenzuela, "A Sliding Window Update for the Basis Matrix of the QR Decomposition," *IEEE Transactions on Signal Processing*, May 1993, pp. 1951-1953.

Mahon, Sibul, Valenzuela, "An Alternative Updating Scheme for the QR Algorithm as Applied to Adaptive Beamforming," *Proc. 25<sup>th</sup> Annual Conf. on Info. Sciences and Systems*, Johns Hopkins University, Baltimore, MD, March 1991, pp. 193-199.

#### **Awards/Honors:**

Senior Member IEEE

2001 Formal citation letter from National Reconnaissance Office (NRO) for experimental work with mobile wireless systems

2001 Formal citation letter for excellence in software development from the NRO for work associated with mobile wireless systems.

2000 Formal citation letter from NRO for development of wavelet course presented at NRO Technology Symposium

1997 Invited session chair of "Signal Processing in Acoustics: General Signal Processing," Noise-Con '97, 133rd meeting of the ASA.

1996 Simowitz Citation Acoustics Department PSU for outstanding publication by a graduate student

1995 Invited co-chair of "Transducers for Active Control of Sound and Vibration," Active 95, Active Noise Control Conference

1993 Simowitz Award Acoustics Department PSU for outstanding publication by a graduate student

1987 Dr. A. J. Cawley Award for Excellence in Electronics Engineering by Physics/EE Department University of Scranton