

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Patent of: Xiaobo Zhang  
U.S. Patent No.: 10,944,527 Attorney Docket No. 50095-0228IP1  
Issue Date: March 9, 2021  
Appl. Serial No.: 16/429,077  
Filing Date: June 3, 2019  
Title: METHOD AND DEVICE FOR MULTI-ANTENNA  
TRANSMISSION IN UE AND BASE STATION

**Mail Stop Patent Board**

Patent Trial and Appeal Board  
U.S. Patent and Trademark Office  
P.O. Box 1450  
Alexandria, VA 22313-1450

**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT  
NO. 10,944,527 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

**TABLE OF CONTENTS**

|             |                                                                                        |           |
|-------------|----------------------------------------------------------------------------------------|-----------|
| <b>I.</b>   | <b>INTRODUCTION .....</b>                                                              | <b>1</b>  |
| <b>II.</b>  | <b>REQUIREMENTS FOR IPR UNDER 37 C.F.R. §42.104.....</b>                               | <b>1</b>  |
|             | <b>A. Grounds for Standing Under 37 C.F.R. §42.104(a).....</b>                         | <b>1</b>  |
|             | <b>B. Challenge Under 37 C.F.R. §42.104(b) and Relief Requested .....</b>              | <b>1</b>  |
|             | <b>C. Claim Construction .....</b>                                                     | <b>2</b>  |
|             | <b>D. Technology Background .....</b>                                                  | <b>3</b>  |
|             | 1. Wireless Network Architecture and Protocols.....                                    | 3         |
|             | 2. Antenna Systems on UE.....                                                          | 11        |
|             | <b>E. Level of Ordinary Skill in the Art.....</b>                                      | <b>12</b> |
| <b>III.</b> | <b>SUMMARY OF THE '527 PATENT .....</b>                                                | <b>13</b> |
|             | <b>A. Brief Description.....</b>                                                       | <b>13</b> |
|             | <b>B. Summary of the Prosecution History of the '527 Patent.....</b>                   | <b>14</b> |
| <b>IV.</b>  | <b>[GROUND 1] – Claims 1-20 are Rendered Obvious By Kim, Dahlman, and Kim-966.....</b> | <b>15</b> |
|             | <b>A. Overview of Kim .....</b>                                                        | <b>15</b> |
|             | <b>B. Overview of Dahlman.....</b>                                                     | <b>18</b> |
|             | <b>C. Overview of Kim-966.....</b>                                                     | <b>19</b> |
|             | <b>D. Combination of Kim, Dahlman, and Kim-966 .....</b>                               | <b>21</b> |
|             | <b>E. Analysis.....</b>                                                                | <b>38</b> |
|             | 1. Claim 1 .....                                                                       | 38        |
|             | 2. Claim 2 .....                                                                       | 64        |
|             | 3. Claim 3 .....                                                                       | 72        |
|             | 4. Claim 4 .....                                                                       | 78        |
|             | 5. Claim 5 .....                                                                       | 82        |
|             | 6. Claim 6 .....                                                                       | 84        |
|             | 7. Claim 7 .....                                                                       | 85        |
|             | 8. Claim 8 .....                                                                       | 86        |
|             | 9. Claim 9 .....                                                                       | 86        |
|             | 10. Claim 10 .....                                                                     | 87        |
|             | 11. Claim 11 .....                                                                     | 87        |
|             | 12. Claim 12 .....                                                                     | 89        |
|             | 13. Claim 13 .....                                                                     | 89        |
|             | 14. Claim 14 .....                                                                     | 90        |
|             | 15. Claim 15 .....                                                                     | 90        |
|             | 16. Claim 16 .....                                                                     | 90        |

|                                                                     |           |
|---------------------------------------------------------------------|-----------|
| 17. Claim 17 .....                                                  | 91        |
| 18. Claim 18 .....                                                  | 91        |
| 19. Claim 19 .....                                                  | 92        |
| 20. Claim 20 .....                                                  | 92        |
| <b>V. PTAB DISCRETION SHOULD NOT PRECLUDE INSTITUTION.....</b>      | <b>92</b> |
| <b>VI. PAYMENT OF FEES – 37 C.F.R. §42.103.....</b>                 | <b>92</b> |
| <b>VII. CONCLUSION.....</b>                                         | <b>93</b> |
| <b>VIII. MANDATORY NOTICES UNDER 37 C.F.R §42.8(a)(1).....</b>      | <b>94</b> |
| <b>A. Real Party-In-Interest Under 37 C.F.R. §42.8(b)(1).....</b>   | <b>94</b> |
| <b>B. Related Matters Under 37 C.F.R. §42.8(b)(2) .....</b>         | <b>94</b> |
| <b>C. Lead And Back-Up Counsel Under 37 C.F.R. §42.8(b)(3).....</b> | <b>95</b> |
| <b>D. Service Information .....</b>                                 | <b>95</b> |

**LIST OF EXHIBITS**

|            |                                                          |
|------------|----------------------------------------------------------|
| APPLE-1001 | U.S. Patent No. 10,944,527                               |
| APPLE-1002 | U.S. Patent No. 10,944,527 File History                  |
| APPLE-1003 | Declaration of Dr. Narayan Mandayam                      |
| APPLE-1004 | U.S. Patent Publication No. 2013/0182594 (“Kim”)         |
| APPLE-1005 | U.S. Patent Publication No. 2015/0195025 (“Kang”)        |
| APPLE-1006 | RESERVED                                                 |
| APPLE-1007 | 4G: LTE/LTE-Advanced for Mobile Broadband, Dahlman, 2014 |
| APPLE-1008 | U.S. Patent Publication No. 2015/0162966 (“Kim-966”)     |
| APPLE-1009 | P.C.T. Publication No. WO 2017/084235 (“Zhang-235”)      |
| APPLE-1010 | U.S. Patent Publication No. 2016/0112099 (“Lee”)         |
| APPLE-1011 | U.S. Patent Publication No. 2019/0387501 (“Park”)        |
| APPLE-1012 | U.S. Patent Publication No. 2010/0202560 (“Luo”)         |
| APPLE-1013 | June Munford Declaration                                 |
| APPLE-1014 | Complaint from April 29, 2024                            |
| APPLE-1015 | Amended Complaint from May 2, 2024                       |
| APPLE-1016 | Proof of service of the complaint (filed May 14, 2024)   |

**LISTING OF CLAIMS**

| <b>Claim 1</b> |                                                                                                                                                                                                                                                                                          |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1.1</b>     | A method for multi-antenna transmission in a user equipment, comprising:                                                                                                                                                                                                                 |
| <b>1.2</b>     | receiving a first radio signal from a base station; and                                                                                                                                                                                                                                  |
| <b>1.3</b>     | receiving a first signaling from the base station;                                                                                                                                                                                                                                       |
| <b>1.4</b>     | wherein the first radio signal is transmitted by K antenna port groups of the base station; the antenna port group includes a positive integer number of antenna port(s);                                                                                                                |
| <b>1.5</b>     | a first antenna port group is one of the K antenna port groups;                                                                                                                                                                                                                          |
| <b>1.6</b>     | the first signaling is used to determine a first time resource pool;                                                                                                                                                                                                                     |
| <b>1.7</b>     | at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;                                                                                                                                        |
| <b>1.8</b>     | the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; |
| <b>1.9</b>     | the K is a positive integer greater than 1.                                                                                                                                                                                                                                              |
| <b>Claim 2</b> |                                                                                                                                                                                                                                                                                          |
| <b>2.1</b>     | The method of claim 1, further comprising: receiving a second signaling; and                                                                                                                                                                                                             |
| <b>2.2</b>     | operating a second radio signal in a first time resource sub-pool;                                                                                                                                                                                                                       |
| <b>2.3</b>     | wherein the operating is receiving from the base station, or the operating is transmitting to the base station;                                                                                                                                                                          |
| <b>2.4</b>     | the second signaling is used to determine the first time resource sub-pool from the first time resource pool; and                                                                                                                                                                        |

|                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>2.5</b>     | the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI and (a) transmitting antenna port(s) of the second radio signal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Claim 3</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>3.1</b>     | The method of claim 2, comprising; monitoring the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; and the second time resource pool includes a positive integer number of time resource block(s);                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>3.2</b>     | or monitoring the second signaling in a second time resource pool and monitoring the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool. |
| <b>Claim 4</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>4.1</b>     | The method of claim 1, further comprising: receiving first information, wherein the first information is used to determine the first antenna port group; or                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>4.2</b>     | transmitting second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| Claim 5 |                                                                                                                                                                                                                                                                                                                      |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5.0     | The method of claim 1, wherein the first time resource pool is discontinuous in time domain; or the first signaling is a semi-static signaling.                                                                                                                                                                      |
| Claim 6 |                                                                                                                                                                                                                                                                                                                      |
| 6.1     | A method for multi-antenna transmitting in a base station, comprising:                                                                                                                                                                                                                                               |
| 6.2     | transmitting a first radio signal to a target receiver; and                                                                                                                                                                                                                                                          |
| 6.3     | transmitting a first signaling to the target receiver;                                                                                                                                                                                                                                                               |
| 6.4     | wherein the first radio signal is transmitted by K antenna port groups of the base station; the antenna port group includes a positive integer number of antenna port(s);                                                                                                                                            |
| 6.5     | the first antenna port group is one of the K antenna port groups;                                                                                                                                                                                                                                                    |
| 6.6     | the first signaling is used to determine a first time resource pool;                                                                                                                                                                                                                                                 |
| 6.7     | at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;                                                                                                                                                                    |
| 6.8     | the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the target receiver of the first signaling in the first time resource pool; and |
| 6.9     | the K is a positive integer greater than 1.                                                                                                                                                                                                                                                                          |
| Claim 7 |                                                                                                                                                                                                                                                                                                                      |
| 7.1     | The method of claim 6, further comprising: transmitting a second signaling; and                                                                                                                                                                                                                                      |
| 7.2     | performing a second radio signal in a first time resource sub-pool;                                                                                                                                                                                                                                                  |
| 7.3     | wherein the performing is transmitting to the target receiver, or the performing is receiving from the target receiver;                                                                                                                                                                                              |

|                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>7.4</b>     | the second signaling is used to determine the first time resource sub-pool from the first time resource pool;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>7.5</b>     | the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI and (a) transmitting antenna port(s) of the second radio signal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Claim 8</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>8.1</b>     | The method of claim 7, comprising: transmitting the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; and the second time resource pool includes a positive integer number of time resource block(s);                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>8.2</b>     | or transmitting the second signaling in a second time resource pool and transmitting the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool. |
| <b>Claim 9</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>9.1</b>     | The method of claim 6, further comprising: transmitting first information, wherein the first information is used to determine the first antenna port group;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>9.2</b>     | or receiving second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Claim 10 |                                                                                                                                                                                                                                                                                              |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.      | The method of claim 6, wherein the first time resource pool is discontinuous in time domain; or the first signaling is a semi-static signaling.                                                                                                                                              |
| Claim 11 |                                                                                                                                                                                                                                                                                              |
| 11.1     | A user equipment (UE) for multi-antenna transmission, comprising:                                                                                                                                                                                                                            |
| 11.2     | a first transceiver, receiving a first radio signal from a base station; and                                                                                                                                                                                                                 |
| 11.3     | a second receiver, receiving a first signaling from the base station;                                                                                                                                                                                                                        |
| 11.4     | wherein the first radio signal is transmitted by K antenna port groups of the base station; the antenna port group includes a positive integer number of antenna port(s);                                                                                                                    |
| 11.5     | the first antenna port group is one of the K antenna port groups;                                                                                                                                                                                                                            |
| 11.6     | the first signaling is used to determine a first time resource pool;                                                                                                                                                                                                                         |
| 11.7     | at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group; the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool; |
| 11.8     | the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; and                                                                                                                                            |
| 11.9     | the K is a positive integer greater than 1.                                                                                                                                                                                                                                                  |
| Claim 12 |                                                                                                                                                                                                                                                                                              |
| 12.1     | The UE of claim 11, comprising: a third receiver, receiving a second signaling; and                                                                                                                                                                                                          |
| 12.2     | a second transceiver, operating a second radio signal in a first time resource sub-pool;                                                                                                                                                                                                     |
| 12.3     | wherein the operating is receiving from the base station, or the operating is transmitting to the base station;                                                                                                                                                                              |

|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>12.4</b>     | the second signaling is used to determine the first time resource sub-pool from the first time resource pool; and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>12.5</b>     | the second signaling is used to determine at least one of occupied frequency domain resources, a MCS, a HARQ process number, a RV, a NDI and (a) transmitting antenna port(s) of the second radio signal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Claim 13</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>13.1</b>     | The UE of claim 12, the third receiver further monitors the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s);                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>13.2</b>     | or the third receiver further monitors the second signaling in a second time resource pool, and the second receiver further monitors the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool. |

| Claim 14 |                                                                                                                                                                                                                                                                                                                      |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14.1     | The UE of claim 11, wherein: the second receiver further receives first information, wherein the first information is used to determine the first antenna port group;                                                                                                                                                |
| 14.2     | or the first transceiver further transmits second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer. |
| Claim 15 |                                                                                                                                                                                                                                                                                                                      |
| 15.0     | The UE of claim 11, wherein the first time resource pool is discontinuous in time domain; or the first signaling is a semi-static signaling.                                                                                                                                                                         |

| Claim 16    |                                                                                                                                                                                                                                                                                                                      |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>16.1</b> | A base station equipment for multi-antenna transmission, comprising:                                                                                                                                                                                                                                                 |
| <b>16.2</b> | a third transceiver, transmitting a first radio signal to a target receiver;<br>and                                                                                                                                                                                                                                  |
| <b>16.3</b> | a second transmitter, transmitting a first signaling to the target receiver;                                                                                                                                                                                                                                         |
| <b>16.4</b> | wherein the first radio signal is transmitted by K antenna port groups of the base station; the antenna port group includes a positive integer number of antenna port(s);                                                                                                                                            |
| <b>16.5</b> | the first antenna port group is one of the K antenna port groups;                                                                                                                                                                                                                                                    |
| <b>16.6</b> | the first signaling is used to determine a first time resource pool;                                                                                                                                                                                                                                                 |
| <b>16.7</b> | at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;                                                                                                                                                                    |
| <b>16.8</b> | the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the target receiver of the first signaling in the first time resource pool; and |
| <b>16.9</b> | the K is a positive integer greater than 1;                                                                                                                                                                                                                                                                          |
| Claim 17    |                                                                                                                                                                                                                                                                                                                      |
| <b>17.1</b> | The base station equipment of claim 16, further comprising: a third transmitter, transmitting a second signaling; and                                                                                                                                                                                                |
| <b>17.2</b> | a fourth transceiver, performing a second radio signal in a first time resource sub-pool;                                                                                                                                                                                                                            |
| <b>17.3</b> | wherein the performing is transmitting, or the performing is receiving;                                                                                                                                                                                                                                              |
| <b>17.4</b> | the second signaling is used to determine the first time resource sub-pool from the first time resource pool;                                                                                                                                                                                                        |

|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>17.5</b>     | the second signaling is used to determine at least one of occupied frequency domain resources, a MCS, a HARQ process number, a RV, a NDI and (a) transmitting antenna port(s) of the second radio signal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Claim 18</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>18.1</b>     | The base station equipment of claim 17, wherein: the third transmitter further transmits the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; and the second time resource pool includes a positive integer number of time resource block(s);                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>18.2</b>     | or the third transmitter further transmits the second signaling in a second time resource pool, and the second transmitter further transmits the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool. |
| <b>Claim 19</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>19.1</b>     | The base station equipment of claim 16, wherein: the second transmitter further transmits first information, wherein the first information is used to determine the first antenna port group;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>19.2</b>     | or the third transceiver further receives second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

| Claim 20 |                                                                                                                                                                  |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 20.      | The base station equipment of claim 16, wherein the first time resource pool is discontinuous in time domain; or the first signaling is a semi-static signaling. |

## **I. INTRODUCTION**

Apple Inc. (“Apple” or “Petitioner”) petitions for IPR of claims 1-20 (“Challenged Claims”) of U.S. Patent No. 10,944,527 (“the ’527 patent”). Evidence presented in this petition demonstrates that the Challenged Claims are unpatentable

## **II. REQUIREMENTS FOR IPR UNDER 37 C.F.R. §42.104**

### **A. Grounds for Standing Under 37 C.F.R. §42.104(a)**

Apple Inc. certifies that the ’527 Patent is available for IPR. The present petition is being filed within one year of service of a complaint against Apple. Apple is not barred or estopped from requesting this review. (APPLE-1016).

### **B. Challenge Under 37 C.F.R. §42.104(b) and Relief Requested**

Petitioner requests institution of IPR and cancellation of the Challenged Claims based on the following grounds.

| <b>Ground</b>   | <b>’527 Patent Claims</b> | <b>§103</b>                                            |
|-----------------|---------------------------|--------------------------------------------------------|
| <b>Ground 1</b> | <b>1-20</b>               | 103 over Kim, Dahlman, and Kim-966 (“The Combination”) |

The ’527 Patent was filed June 3, 2019, and claims priority to Chinese Application No. 201611098328.7. The ’527 Patent’s earliest claimed priority date is December 3, 2016 (“Critical Date”), which Petitioner does not concede.

U.S. Patent Publication No. 2013/0182594 to Kim et al., published July 18,

2013, qualifies as prior art under 35 U.S.C. §102(a)(1).

U.S. Patent Publication No. 2015/0162966 to Kim, et. al., published Jun 11, 2015, qualifies as prior art under 35 U.S.C. §102(a)(1).

*4G: LTE/LTE-Advanced for Mobile Broadband*, a textbook authored by Erik Dahlman, was published in 2014, qualifies as prior art under 35 U.S.C. §102(a)(1). The first two pages of Dahlman note that its publisher, “Academic Press” published this second edition in 2014 with a 2014 copyright notice with a Library of Congress number and an ISBN index. Further, the notice page further refers audiences to store.elsevier.com for additional information on their web site. Its public availability was confirmed in an affidavit by June Munford. APPLE-1013, 7 (citing to MARC record). Ms. Munford confirmed its availability in the Penn State University Library shortly after its initial acquisition on November 7, 2013.

### **C. Claim Construction**

All claim terms should be construed according to the *Phillips* standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. §42.100. Petitioner submits that no claim terms need be construed to resolve issues of controversy in the present Petition. *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011).

## **D. Technology Background <sup>1</sup>**

### **1. Wireless Network Architecture and Protocols**

Long Term Evolution (LTE) networks leverage base stations, or eNodeBs (eNBs), to transmit and receive wireless signals when communicating with User Equipment (UEs), such as mobile phones. APPLE-1007, p.13<sup>2</sup>, 22; APPLE-1003, 0047. Communication between an eNB and UE involves logical channels, transport channels, and physical channels. Logical channels carry specific types of information that is mapped to transport channels for transmission over the air via physical channels. APPLE-1007, p.136; APPLE-1003, 0047.

Multiple-In Multiple-Out (MIMO) architecture uses these techniques by employing multiple transmit and receive antennas. APPLE-1007, pp.89-92. Dahlman's Figure 5.14 shows a simple example of MIMO. APPLE-1003, 0048.

---

<sup>1</sup> In order to assist the Board in analyzing the claims, Petitioner notes that the Technology Background includes a description of how an antenna port, an antenna port group, a time resource pool, and an antenna virtualization vector are used in LTE/5G architectures. While Petitioner submits that no claim construction is required, the description of these objects in LTE/5G architectures offers context that would be known and applied by POSITAs.

<sup>2</sup> All pagination referenced is to the PDF pagination.

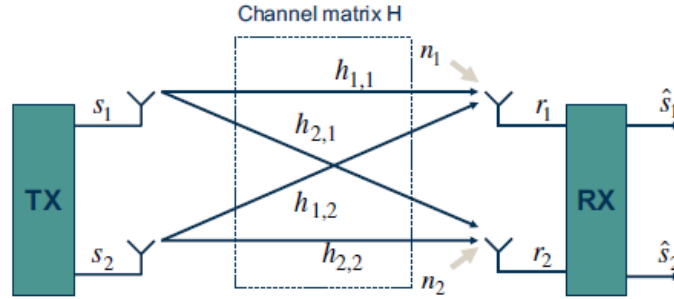


**FIGURE 5.14**

$2 \times 2$  antenna configuration

APPLE-1007, FIG. 5.14.

For downlink (eNB to UE) transmission, LTE can use Orthogonal Frequency Division Multiplexing (OFDM). APPLE-1007, p.37, Chapter 3. OFDM offers more efficient bandwidth by leveraging narrowband subcarriers that are orthogonal, allowing their spectra to overlap without causing inter-subcarrier interference. APPLE-1007, p.40-43. OFDMA (Orthogonal Frequency-Division Multiple Access) extends OFDM to multi-user scenarios by allowing for simultaneous frequency-separated transmissions to and from multiple UEs. APPLE-1007, p.55-59. In the downlink, different subsets of subcarriers can be assigned to different UEs, and similarly in the uplink, different UEs can transmit on different subcarrier subsets. *Id.* An eNB can then dynamically allocate, on a time-frequency basis, its resources to UEs. APPLE-1007, pp.113-116; APPLE-1003, 0049. Dahlman's Figure 3.17 shows examples of multiuser interaction through OFDM schemes.

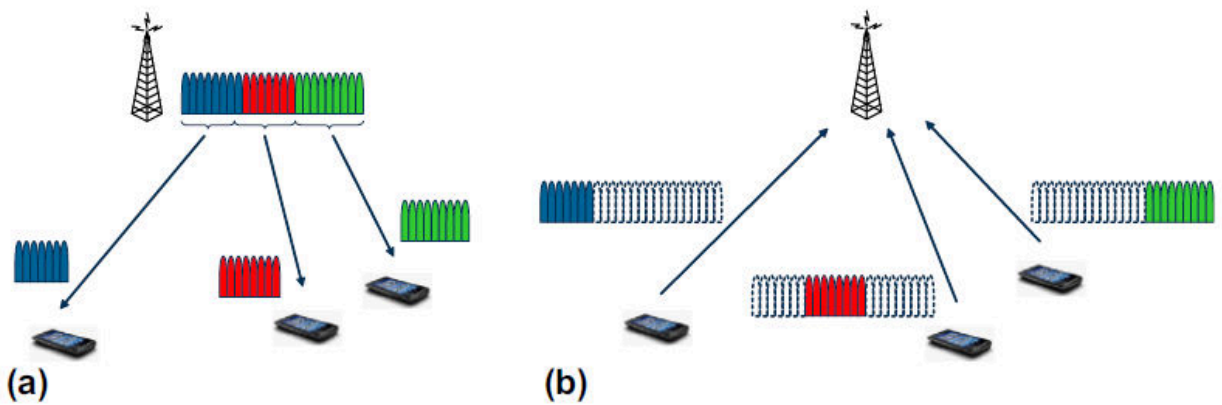


FIGURE 3.17

OFDM as a user-multiplexing/multiple-access scheme: (a) downlink and (b) uplink

APPLE-1007, FIG. 5.14.

In such schemes, each eNB transmits reference signals, such as Cell-Specific Reference Signals (CRS) and Channel State Information Reference Signals (CSI-RS), to monitor the network's performance. For example, a UE can use these reference signals to report Channel Quality Indicator (CQI), Precoding Matrix Indicator (PMI), and Rank Indication (RI) back to the eNB. This feedback is collectively known as Channel State Information (CSI). It allows the eNB to perform channel-dependent scheduling. APPLE-1007, pp.154, 185-190; APPLE-1003, 0050.

CSI-RS is a component of the LTE downlink, specifically designed to enable UEs to measure the downlink channel characteristics. APPLE-1007, pp.177-182. The eNB configures CSI-RS for each UE, specifying parameters such

as periodicity, subframe offset, and the specific resource elements within a resource block pair used for transmission of data signals and control signaling. APPLE-1007, pp.186-190. Dahlman's Figures 10.8 and 10.13 show example configurations of reference symbols within resource blocks. APPLE-1007, FIG. 10.8 and 10.13. These configurations define the number and structure of CSI-RS used by a UE. APPLE-1007, pp.186-190; APPLE-1003, 0051.

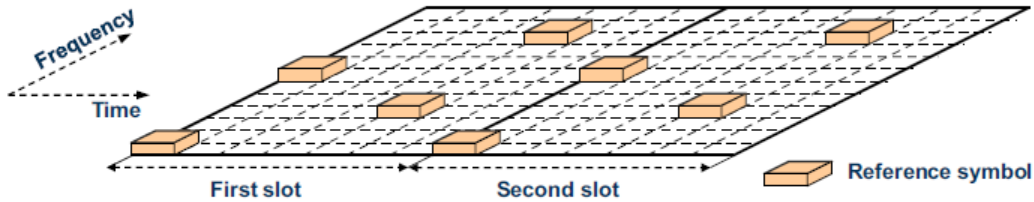


**FIGURE 10.8**

Structure of cell-specific reference signal within a pair of resource blocks

APPLE-1007, FIG. 10.8.

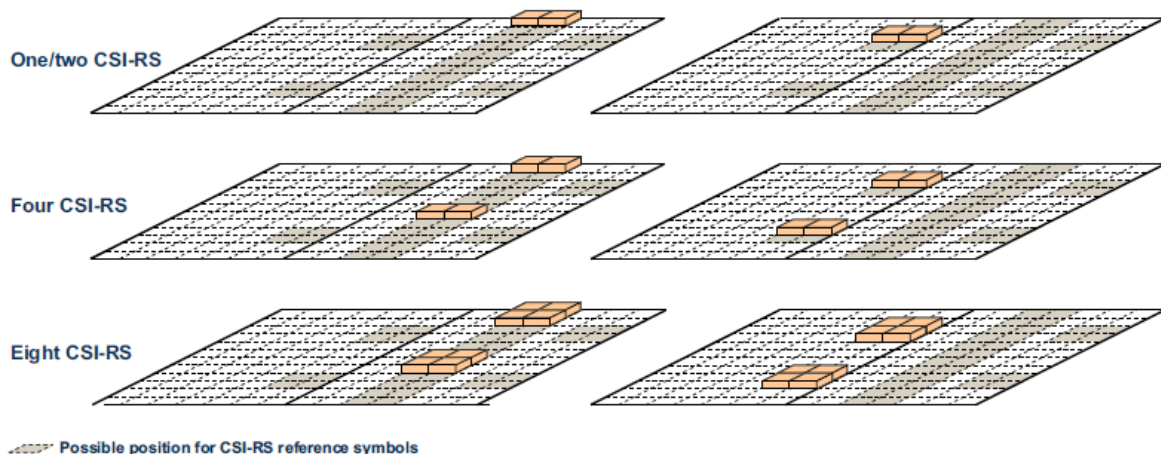


**FIGURE 10.13**

Examples of reference-signal positions for different number of CSI-RS within a cell. In case of a single CSI-RS, the same structure as for two CSI-RS is used

APPLE-1007, FIG. 10.13.

Downlink Control Information (DCI) messages are a mechanism for the eNB to transmit downlink control signaling to the UEs. APPLE-1007, pp.344-350. These DCI messages are carried on the Physical Downlink Control Channel (PDCCH) and the Enhanced Physical Downlink Control Channel (EPDCCH). APPLE-1007, pp.213-219; APPLE-1003, 0052. One PDCCH carries one DCI message. *Id.*

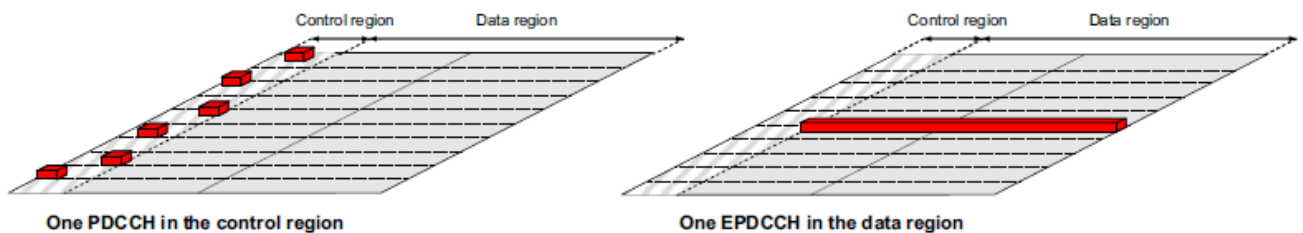


**FIGURE 10.29**

Principal illustration of PDCCH mapping (left) and EPDCCH mapping (right)

APPLE-1007, FIG. 10.29.

Several types of control information (e.g., DCI, MIB, SIB) carry information related to downlink and uplink scheduling assignments, power control commands, and other control information. APPLE-1007, pp.213-219, 355-362. Downlink scheduling assignments inform the UE about the resources allocated for data reception on the Physical Downlink Shared Channel (PDSCH), including details

about resource blocks and the modulation and coding scheme (MCS). APPLE-1007, pp.213-219; APPLE-1003, 0053.

Different DCI formats support different transmission modes and scenarios, and some formats include a field for a Sounding Reference Signal (SRS) request, which can be used to trigger uplink transmissions that aid in channel estimation, and a Downlink Assignment Index (DAI) for Time Division Duplexing (TDD) systems. APPLE-1007, pp.229-239. The specific DCI format used depends on factors such as the cell bandwidth, the number of transmit antennas, and whether cross-carrier scheduling is configured. APPLE-1007, pp.213-219; APPLE-1003, 0054.

The interaction with CSI-RS and DCI messages is used for the LTE system to operate efficiently. APPLE-1007, pp.185-189. For example, a UE's measurements of CSI-RS provide the eNB with information about the downlink channel quality. APPLE-1007, pp.185-189. Based on the reported CSI (CQI, PMI, RI) transmitted in response to the CSI-RS, the eNB can then make informed decisions regarding scheduling and link adaptation (selecting the appropriate modulation and coding scheme). APPLE-1007, pp.341-350. The eNB, in turn, then communicates these scheduling decisions and transmission parameters back to the UE through downlink scheduling assignments within DCI messages. APPLE-1007, pp.229-234. Furthermore, the eNB can dynamically trigger the eNB to obtain up-

to-date channel information on demand. APPLE-1007, pp.291-294. The DCI messages, therefore, act as the communication channel through which the eNB conveys the transmission configurations, often optimized based on the channel information gleaned from the CSI reports that are derived from CSI-RS measurements. APPLE-1007, pp.213-219; APPLE-1003, 0055.

In LTE, the physical structure for transmitting information such as CSI-RS and DCI is organized within a time-frequency grid. APPLE-1007, pp.148-154. As shown in Dahlman's figures below, the fundamental unit in the time domain is the frame. Each frame has a duration of 10 milliseconds and is composed of ten 1 millisecond subframes, with each subframe having two slots. *Id.* In the frequency domain, the system bandwidth is divided into subcarriers, and these, along with the OFDM symbols in the time domain, form the smallest physical resource unit known as a resource element. *Id.*; APPLE-1003, 0056. Different time resources or subframes are assigned to UEs for either uplink (transmission) or downlink (receipt). APPLE-1007, 157-160, 355-362, FIG. 9.7. The time resources can assign windows of time for uplink or downlink (e.g., a Time Division Duplexing scheme). *Id.*

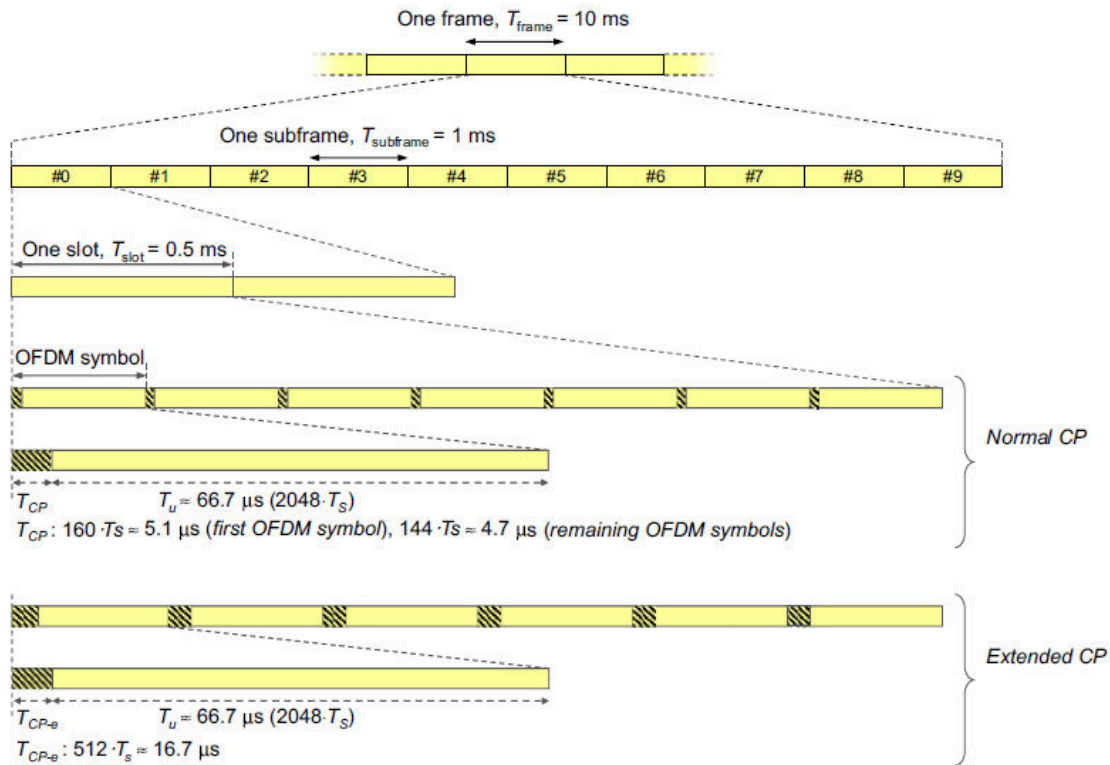


**FIGURE 9.1**

LTE time-domain structure

APPLE-1007, FIG 9.1.

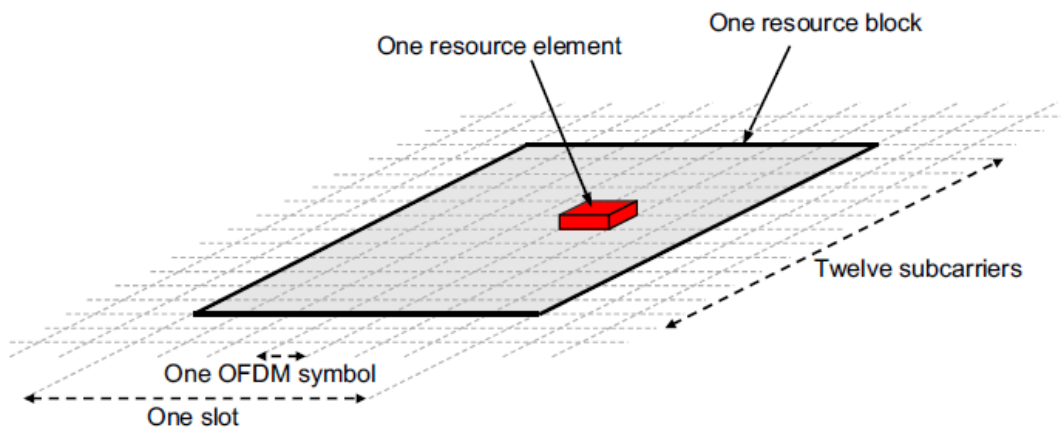


**FIGURE 9.2**

The LTE physical time-frequency resource

APPLE-1007, FIG. 9.2.

## 2. Antenna Systems on UE

As noted above, a UE with a MIMO architecture leverages multiple antennas. A UE can use antenna ports, which are logical ports distinct from physical antennas. APPLE-1007, pp.154-155 (“It should be understood that an antenna port is an abstract concept that does not necessarily correspond to a specific physical antenna”). A UE uses antenna ports to generally relate to signal types rather than physical antennas. APPLE-1007, pp.154-155; APPLE-1003, 0057. For example, in practice each of these antenna ports can correspond to a specific reference signal (e.g., CSI-RS to antenna ports 15-22). *Id.* With this relationship between signals (CSI-RS) and antenna ports (15-22), the “reference signal can be used to estimate the channel corresponding to the specific antenna port.” *Id.*

Antenna ports enable the UE to understand the characteristics of the radio channels experienced by different downlink transmissions. *Id.* Specifically, a UE can assume that two transmitted signals have experienced the same radio channel if they are transmitted from the same antenna port. *Id.* This understanding informs several physical layer procedures like channel estimation using CSI-RS. APPLE-1003, 0058.

Building on this physical-layer foundation, system-level control signaling—such as the Master Information Block (MIB) and System Information Blocks

(SIBs)—provides configuration parameters that allow the UE to operate correctly within the network. APPLE-1007, pp.355-362. These types of signaling are used to convey cell system information to UEs. APPLE-1007, pp.355-362. The cell system information is “repeatedly broadcast by the network and [] needs to be acquired by terminals [UEs] in order for them to be able to access and, in general, operate properly within the network and within a specific cell. The system information includes, among other things, information about the downlink and uplink cell bandwidths, the uplink/downlink configuration in the case of TDD, detailed parameters related to random-access transmission, etc.” APPLE-1007, pp.355-362; APPLE-1003, 0059.

#### **E. Level of Ordinary Skill in the Art**

A person of ordinary skill in the art (“POSITA”) relating to the subject matter of the ’527 Patent as of the Critical Date would have a bachelor’s degree in electrical engineering, computer engineering, computer science, or a similar field, along with two years of experience designing or developing wireless networks, including long-term evolution LTE/4G or 5G new radio (NR) cellular technology. Additional education might substitute for some of the experience, and additional substantial experience might substitute for some of the educational background. APPLE-1003, 0040-0043.

### III. SUMMARY OF THE '527 PATENT

#### A. Brief Description

The '527 patent is directed to Multiple-Input Multiple-Output (MIMO) systems and “a method and device for multi-antenna transmission” within these MIMO systems. APPLE-1001, Abstract. According to the '527 patent, a large amount of signaling overhead is required to service multiple users within a single cell. APPLE-1001, 1:35-45 (“[S]ignaling overhead of wireless resource dynamic scheduling is an urgent problem to be solved in massive MIMO system[s].”). The '527 Patent proposes using a series of CSI-RS for scheduling more efficient communication between a base station and user equipment (UE) in a MIMO system, but these methods were already employed by the prior art. APPLE-1003, 0060.

The '527 patent purports to solve efficiency problems by associating a time resource pool with an antenna port group, enabling a UE to quickly determine the location of the corresponding time resource pool and the antenna virtualization vectors used for receiving signals on the time resource pool. *Id.*, 1:45-2:15. Figure 9 illustrates how a different time resource pool is assigned to each antenna port group for transmitting signals. *Id.*, 16:65-17:6; FIG. 9. But the assignment of antenna ports within particular resource elements or time slots was well known. APPLE-1003, 0061.

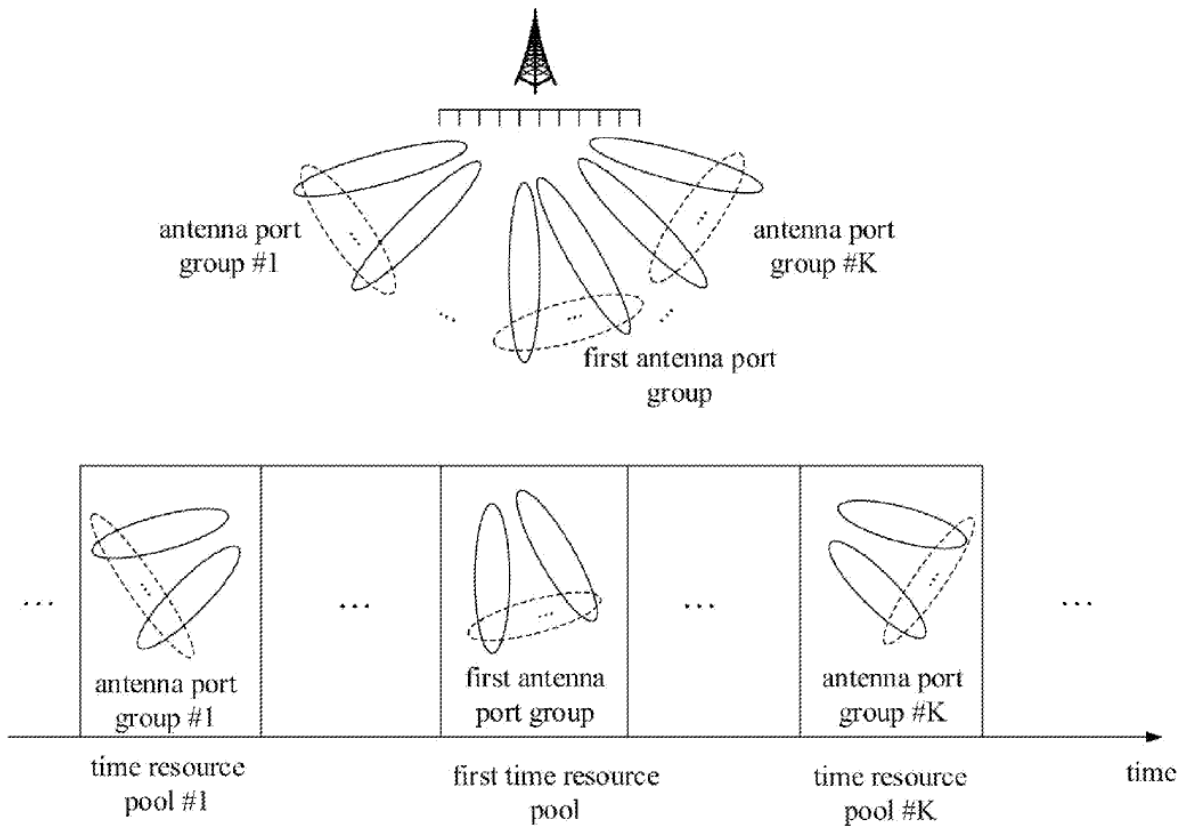


Fig. 9

APPLE-1001, FIG. 9.

When transmitting with multiple antenna ports within an antenna port group, the '527 patent also describes using an antenna virtualization vector to map the physical antennas to the antenna port(s). *Id.*, 2:9-54. For example, the '527 patent describes the base station using a first antenna virtualization vector for transmission, and the UE using a second antenna virtualization vector for receiving the transmission. *Id.*, 4:47-5:21, 18:38-60, 19:45-20:25. These concepts, however, were already taught by the prior art applied in this Petition. APPLE-1003, 0062.

## B. Summary of the Prosecution History of the '527 Patent

U.S. Patent No. 10,944,527 issued on March 9, 2021 from U.S. Patent Application No. 16/429,077 (“the ’077 application”), which was filed on June 3, 2019. *See* APPLE-1002. A rejection was issued on the grounds of §112(b) and Double Patenting. APPLE-1002, 146-157, 115-117. Follow the filing of a terminal disclaimer, and amendments to address the §112(b) rejection, a notice of allowance was issued. APPLE-1002, 72; APPLE-1003, 0063.

**IV. [GROUND 1] – Claims 1-20 are Rendered Obvious By Kim, Dahlman, and Kim-966**

**A. Overview of Kim**

Analogous to the ’527 patent, Kim discloses a MIMO system where a base station transmits signals, such as data and reference signals, through multiple antenna port groups to UEs with a goal to minimize overhead. *Compare* APPLE-1004, 0002-0010, 0016-0017, 0049-0050, 0055, with APPLE-1001, Abstract, 1:35-52, 12:50-61; APPLE-1003, 0064. Kim describes that a UE receives the control signaling to coordinate the receipt of reference signals (e.g., CSI-RS) used to measure a channel state (e.g., the quality of a channel) and eventual improve the channel quality. APPLE-1004, 0007, 0051-0052; APPLE-1003, 0064. In particular, Kim contemplates improvements upon the 3GPP LTE framework introduced with respect to FIGS. 1 and 2. APPLE-1003, 0064 (“All of the Kim’s disclosures are related and informative of both this background and incremental

improvements disclosed by Kim”).

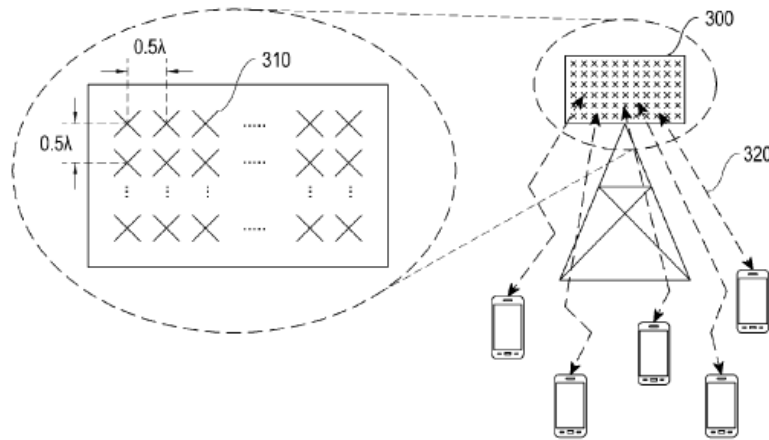


FIG.3

APPLE-1004, FIG. 3.

Kim discloses that the base station (eNB) transmits reference signals, such as CSI-RS, using groups of antennas commonly found in MIMO systems. APPLE-1004, 0080-0081; APPLE-1003, 0065. For example, as shown below, Kim discloses grouping multiple antennas into five groups, where each group has eight antennas. APPLE-1004, 0082-0083; APPLE-1003, 0065. Each group transmits signals within time resources, e.g., at different subframes represented across the x-axis. APPLE-1004, 0060-0061, 0082-0083.

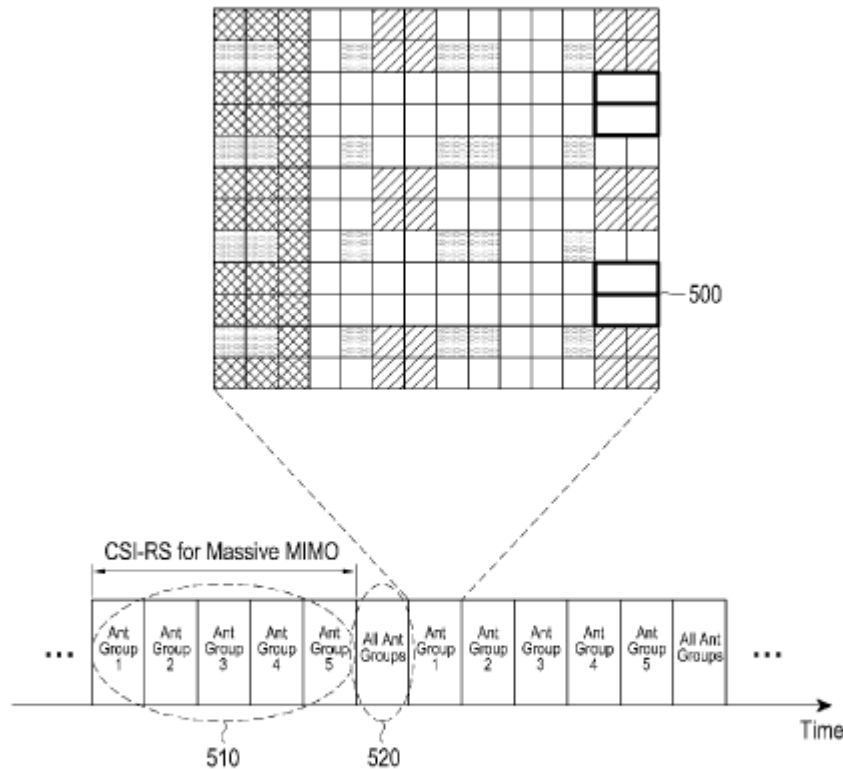


FIG.5

APPLE-1004, FIG. 5.

Kim teaches the use of control information signaling used in receiving CSI-RS signals. Specifically, Kim discloses a base station that “selects UEs to which actual downlink wireless resources are to be allocated, and transmits control information needed for reception of a traffic channel.” APPLE-1004, 0120. Kim seeks to improve coordination between a base station and a UE through use of various techniques including channel reference signals, control information, scheduling, and antenna port coordination. APPLE-1003, 0066.

Kim also teaches the use of precoding schemes to map signals to antenna ports. APPLE-1004, 0051-0052, 0060, 0088, 0096. These precoding schemes vary based on channel quality and the number of available antenna ports. *Id.*; APPLE-1003, 0067. Kim also demonstrates an example mapping of a signal across four antenna ports in FIG. 2. APPLE-1004, 0010-0014, FIG. 2. This mapping and figure is discussed in more detail throughout the petition.

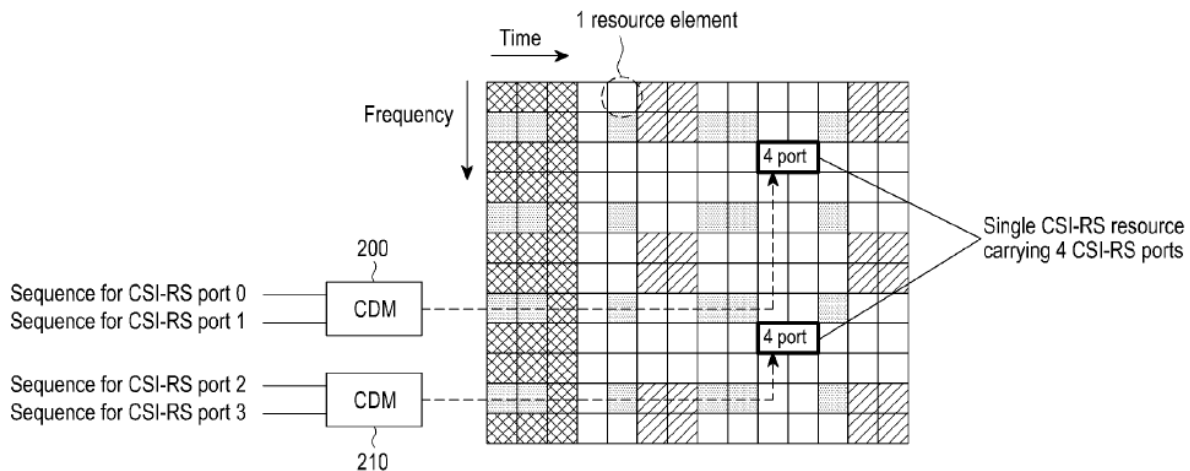


**FIG.2**  
(RELATED ART)

APPLE-1004, FIG. 2.

## **B. Overview of Dahlman**

Dahlman is a textbook covering wireless networks including 4G LTE/LTE-Advanced and is analogous to the '527 Patent. This reference was not only published prior to the Critical Date, but would have been known to a POSITA as teaching the various protocols, configurations, capabilities, and organization of the

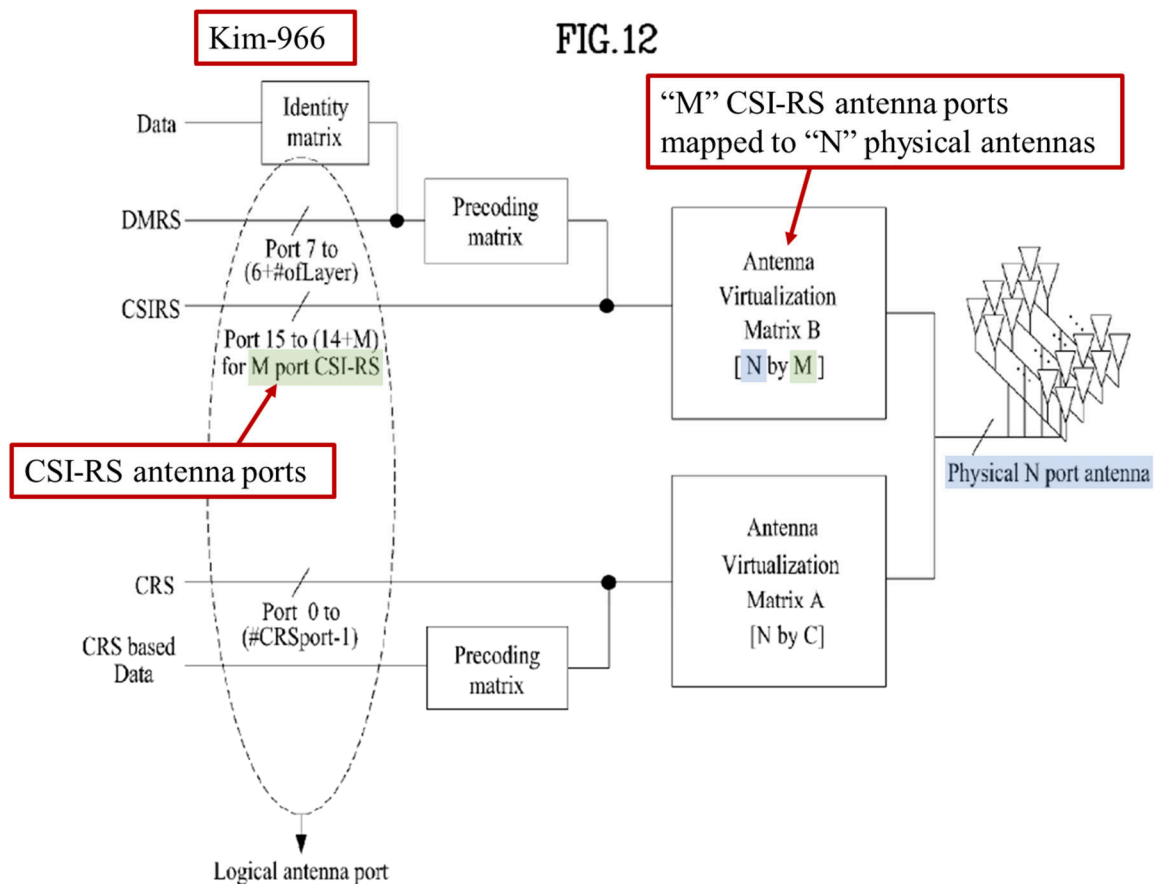
types of networks disclosed in the '527 Patent as well as Kim. An overview of Dahlman's teachings is presented in the Technology Background section. APPLE-1003, 0047-0059, 0068.

### **C. Overview of Kim-966**

Kim-966 describes the use of antenna virtualization to map between antenna ports and physical antennas and is analogous to the '527 Patent. Particularly, Kim-966 addresses the challenges of downlink channel estimation (e.g., CSI-RS) in wireless MIMO communication systems, utilizing numerous transmission antennas. APPLE-1008, FIG. 22, 0090, 0207-0215. Kim-966 describes techniques to mitigate the substantial overhead associated with transmitting Channel State Information Reference Signals (CSI-RS). APPLE-1008, 0003-0004, 0019("overhead may be reduced and a larger number of channel state information-reference signals (CSI-RSs) may be transmitted."), 0087; APPLE-1003, 0069. One such approach involves the transmission of CSI-RS for a limited number of antenna ports ( $M$ ) out of a larger set of available physical antenna ( $N$ ), where  $M$  is less than or equal to  $N$ . APPLE-1008, 0135-0136, 0141; APPLE-1003, 0069.

Central to Kim-966's approach is the utilization of an antenna virtualization matrix, specifically denoted as matrix  $B$ . APPLE-1008, 0135-0136. This matrix  $B$ , characterized by dimensions of  $N$  by  $M$ , is employed for CSI-RS transmission. *Id.* It serves the purpose of mapping CSI-RS originating from  $M$  logical antenna ports

to N physical antennas. APPLE-1008, 0135-0136, 0141, FIG. 12. The matrix B conceptually illustrates this process of antenna virtualization. APPLE-1008, 0134-0136. As an example of this mapping, figure 12 depicts antenna port to physical antenna element mapping. APPLE-1008, FIG. 12; APPLE-1003, 0070.



APPLE-1008, FIG. 12.

The antenna virtualization matrix B contains a collection of vectors that facilitate this mapping. APPLE-1008, 0134-0136, 0141. A POSITA would have understood and found obvious that a matrix would include one or more vectors.

APPLE-1007, p.196(a “matrix  $W$  is a vector of size  $N_A \times 1$ ”); APPLE-1003, 0071.

The signal for the CSI-RS antenna ports is represented by a matrix  $X$ , the signal resulting from antenna virtualization is represented as  $Z = BX$ , where  $Z$  corresponds to the vectors for the  $i$ -th CSI-RS antenna port. APPLE-1008, 0136, 0141; APPLE-1003, 0071. This signifies that the vectors within matrix  $B$  are applied to the signals associated with the  $N$  logical CSI-RS ports, transforming them into signals that are then transmitted over the physical antennas. APPLE-1008, 0134-0136. The teaching demonstrates a relationship between the logical CSI-RS antenna ports, the vectors in the antenna virtualization matrix, and the physical antennas elements used for transmission. APPLE-1003, 0071.

#### **D. Combination of Kim, Dahlman, and Kim-966**

Kim contemplates leveraging a MIMO system “for transmitting a reference signal for effective data transmission and reception, measuring interference, and generating channel state information.” APPLE-1004, 0016.<sup>3</sup> Kim’s system utilizes CSI (e.g., CSI-RS, CIS reports) and control information transmitted between a base station and a UE for the purposes of improving the communication channel characteristics, and thus, improving channel throughput. APPLE-1004, 0019, FIG. 9 and 12; APPLE-1003, 0072.

---

<sup>3</sup> This section is intended to build upon the Technology Overview introducing concepts earlier.

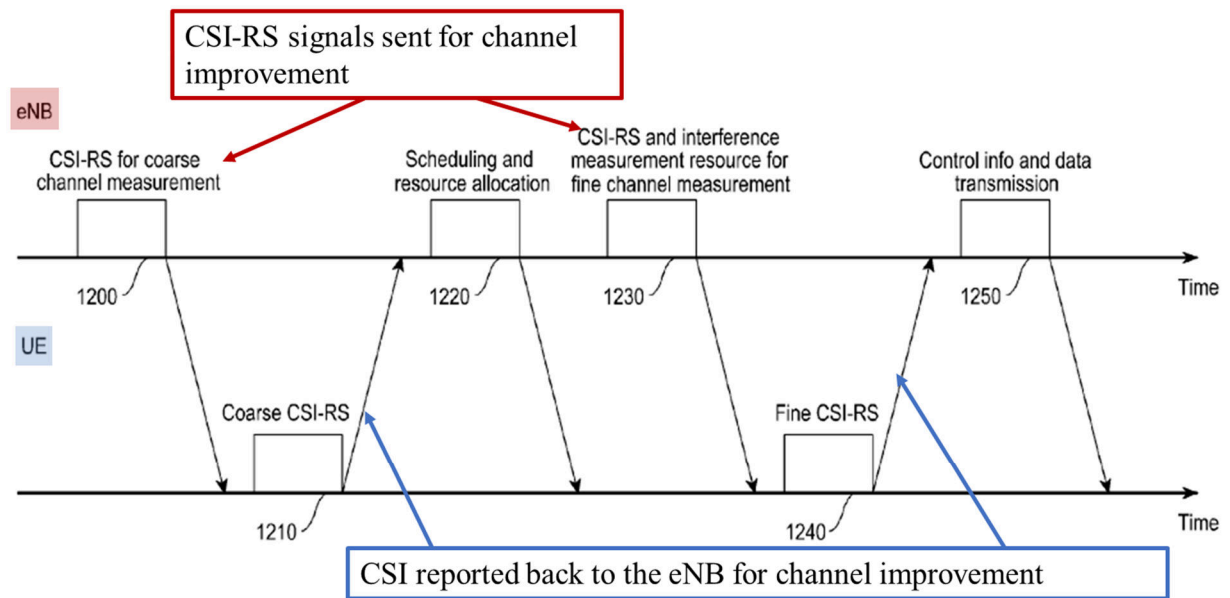


FIG.12

APPLE-1004, FIG. 12.

Specifically, Kim discloses use of “a plurality of antenna groups, transmitting the reference signal (e.g., CSI-RS) to UEs in different time intervals or frequency intervals according to the antenna groups.” APPLE-1004, 0022. With “control information,” Kim coordinates the generation of signals using virtual antenna ports. APPLE-1004, 0009-0014, 0020-0021. In complementary fashion, Kim-966 also coordinates transmission from a “plurality of antennas” in coordination with antenna ports (e.g., CSI-RS antenna ports) through the use of “antenna virtualization matrix[es].” APPLE-1008, 0086-0087, Table 3, 0134-0136; 0207-0215; APPLE-1003, 0073.

Kim

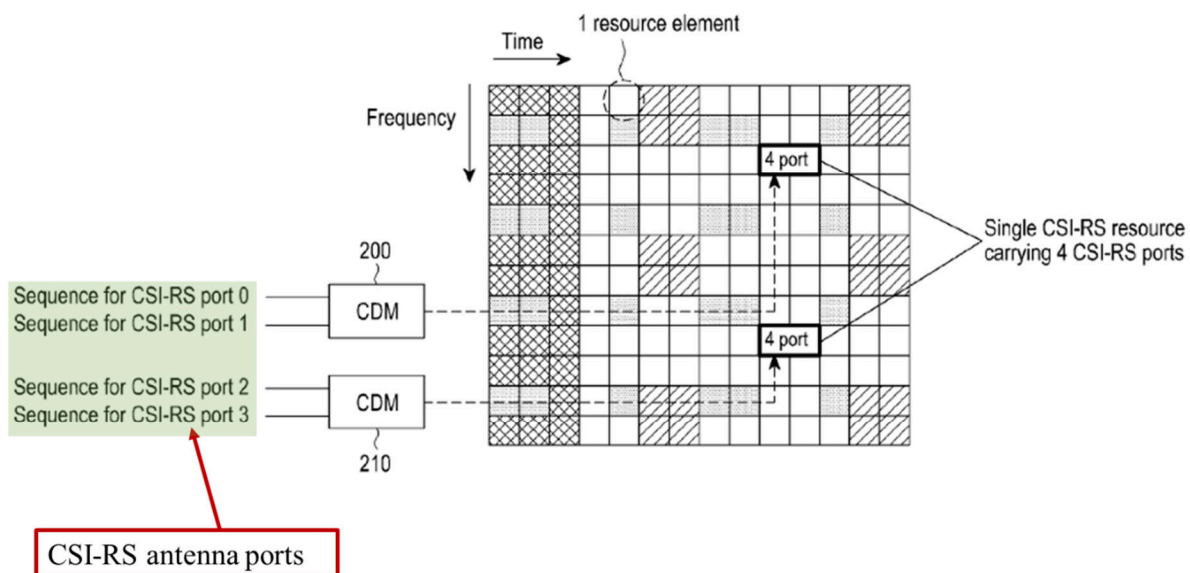
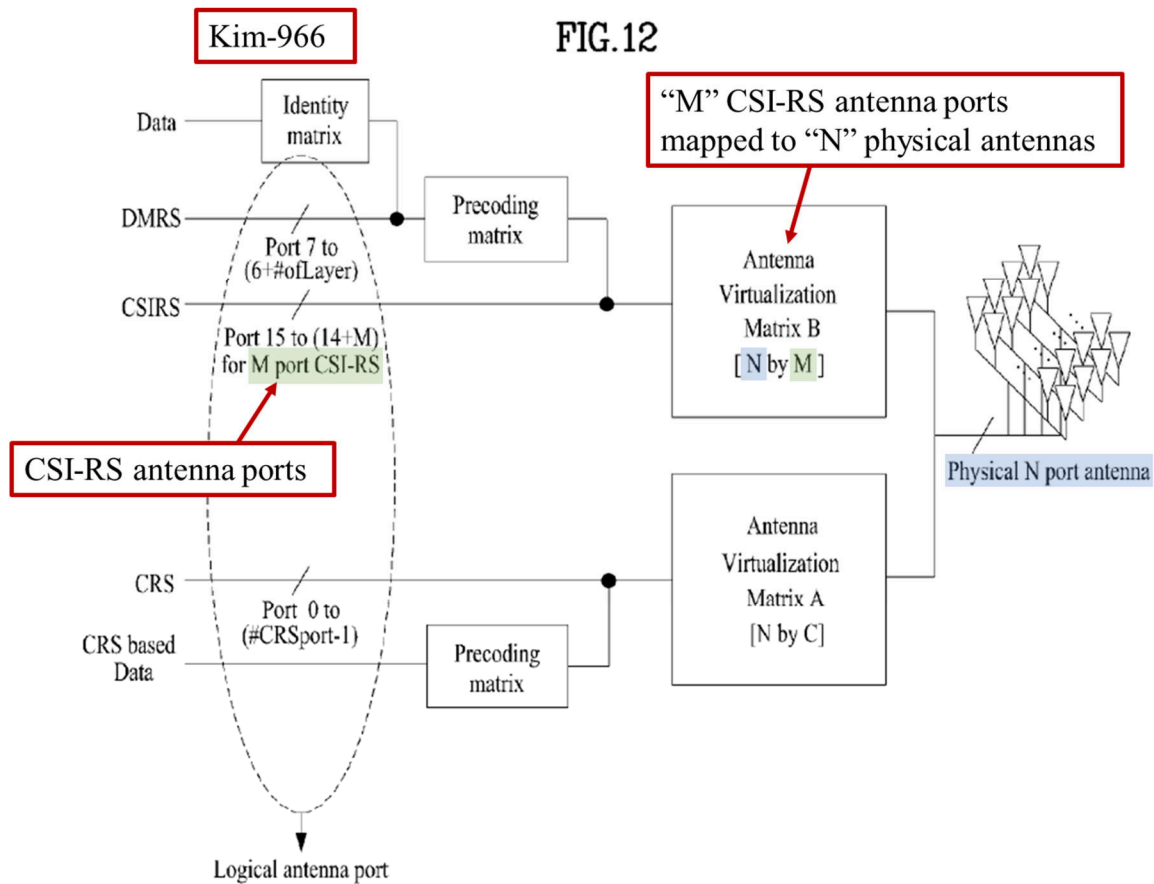


FIG.2  
(RELATED ART)

APPLE-1004, FIG. 2



APPLE-1008, FIG. 12.

Further, as demonstrated in each reference's overview, both Kim and Kim-966 envision operability within known and compatible standards as described by Dahlman—demonstrating that Kim, Dahlman, and Kim-966 clearly operate within the same space. APPLE-1004, 0005-0006; APPLE-1008, 0002, 0042, 0046; *see generally* APPLE-1007; *see* §IV.A-C, II.D (providing an overview of the LTE-Advanced architecture, including the use of reference signals like CSI-RS for CSI acquisition, the use of control information for resource allocation, and the

fundamental time-domain structure of LTE). More specifically, all references describe enabling communications (e.g., CSI-RS) between a base station and UE using multiple antennas in a MIMO architecture. APPLE-1004, 0002-0008; APPLE-1008, 0002, 0042, 0046; APPLE-1003, 0074.

A POSITA would have found it obvious to combine the concepts related to CSI-RS transmission, CSI reports, and antenna virtualization from Kim and Kim-966 within the analogous framework described in Dahlman. APPLE-1003, 0075, 0091. For example, a POSITA seeking to implement or improve the Kim and Kim-966's teachings within the LTE structure would naturally consult a resource like Dahlman that provides an overview of standardized practices and consider how Kim and Kim-966's techniques fit within the established system architecture elaborated on in Dahlman. APPLE-1003, 0075.

Specifically, a POSITA reviewing Kim's disclosure of transmitting CSI-RS using antenna port groups would look to Kim-966 for implementation details regarding the use of an antenna virtualization matrix of vectors to coordinate mapping from Kim's CSI-RS antenna ports to physical antenna elements. APPLE-1003, 0076. Similarly, because of the similar infrastructure used between Kim and Kim-966, a POSITA would have had a reasonable expectation of success in relying on Kim-966 for disclosure of the antenna virtualization matrix that would be used to realize the antenna ports contemplated by Kim. APPLE-1003, 0076.

A POSITA implementing any of the individual mechanisms described through the Combination would have predictably sought to implement these mechanisms within “the known options within his or her technical grasp” such as those defined by the existing LTE structure described in Dahlman. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 421 (2007); APPLE-1003, 0077. The combination would yield the anticipated success of enabling or enhancing the teachings of Kim and Kim-966 regarding channel estimation, resource coordination, antenna virtualization, and channel efficiency within the known techniques and existing LTE-Advanced architecture. *See* II.D, IV.A-C. Such implementation would have been accomplished using existing knowledge held by a POSITA and without requiring inventive genius beyond the ordinary skill in the art. The fact that the Combination operates within the well-established LTE-Advanced framework detailed by Dahlman—a resource representative of “the background knowledge possessed by” a POSITA—provides a strong motivation for their combination. *KSR Int’l Co.*, 418; APPLE-1003, 0077.

Finally, *Virtek* reinforces that a motivation to combine prior art references must exist and cannot simply be based on the fact that the elements were known. *Virtek Vision Int’l ULC v. Assembly Guidance Sys., Inc.*, 97 F.4th 882, 887 (Fed. Cir. 2024). In this scenario, the motivation stems from the functional relationship between reference signal transmission/reception (Kim) and the underlying

communication system's antenna virtualization resources (Kim-966), as part of LTE-Advanced architecture described in Dahlman. APPLE-1003, 0078. A POSITA aiming to utilize the techniques in the Combination would necessarily need to implement them within the LTE structure described by Kim, Dahlman, and Kim-966. The Dahlman textbook itself discusses various reference signal configurations and their placement within subframes, providing an explicit suggestion or motivation to reference Dahlman when implementing the Combination. Therefore, the combination is not arbitrary but driven by the functional necessity of implementing the Combination within the standard architecture described throughout Dahlman, leading to a predictable and beneficial outcome for channel state estimation, resource allocation, and system performance. APPLE-1003, 0078.

Given the disclosures of Kim, Dahlman, and Kim-966, a POSITA would have been motivated to combine them—and found such a combination obvious. APPLE-1003, 0079. For example:

First, a POSITA would have recognized Kim's MIMO system, which has “scores or more” antennas, would benefit from Kim-966's antenna virtualization matrix of vectors, given the noted efficiency improvements available through virtualization relating to managing antenna ports and physical antennas. APPLE-1004, 0016-0024; APPLE-1008, 0134-0136, 0141; APPLE-1003, 0080. Applying

Kim-966's concepts to Kim would thus offer a predictable approach to handling Kim's plurality of antenna ports in a multi-antenna MIMO system. APPLE-1003, 0080. The concept of antenna virtualization was known in MIMO systems and served the purpose of mapping the defined antenna ports to the physical antenna elements. APPLE-1007, 273. A POSITA would have understood and found obvious that this combination would have been accomplished with known elements according to known methods (e.g., control information such as MIB, SIB and CSI-RS) to achieve predictable results. APPLE-1003, 0080. Not only would the methods be predictable because of known techniques described throughout the Petition, but it would have been obvious to implement Kim-966's MIMO LTE compliant methods with Kim's similar MIMO LTE system utilizing the existing elements provided through the LTE standards described in Dahlman. *KSR Int'l Co.* 398, 420-22; APPLE-1003, 0080.

Second, Kim recognizes the challenge of precisely measuring channel state information (CSI) in MIMO, and Kim highlights that these challenges are a consequence of multiple antennas and UEs. APPLE-1004, 0051. With respect to MIMO systems that also have multiple antennas and UEs, Kim-966 describes measuring CSI and improving channel characteristics through CSI reports. APPLE-1008, 0005, 0017. And Kim-966 would have told a POSITA to use the antenna virtualization matrix of vectors contemplated to coordinate the antenna

port groups taught by Kim and Kim-966 with the plurality of transmission antennas used in MIMO. APPLE-1004, 0051, 0060; APPLE-1008, 0136, 0207-0218, FIG. 12, 22. Indeed, Dahlman corroborates this point by demonstrating an example of “antenna virtualization . . . used to map the two-antenna-port signal to four physical antennas.” APPLE-1007, 273. A POSITA would have readily appreciated the applicability of Kim-966’s methods, which employ channel and antenna coordination through shared control information (e.g., antenna virtualization vectors) to improve the adaptability of each channel and thus improve channel and system throughput. APPLE-1008, 0136, 0141; APPLE-1003, 0081. Further, a POSITA would have understood that such antenna virtualization is used so that base stations and UEs can operate agnostic to the number of physical antenna elements available. APPLE-1003, 0081.

Specifically, Kim-966 describes determined and coordinated patterns of antenna virtualization based on very antennas used in transmission. APPLE-1004, 0018, 0051; APPLE-1008, 0136. Kim-966’s coordination of antenna virtualization occurs through transmitting, to the UE, control information with respect to an antenna virtualization pattern of the UE. APPLE-1008, 0086-0087, Table 3, 0136; APPLE-1003, 0082.

A POSITA would have recognized the use of antenna virtualization described in Kim-966, for the plurality of mobile UEs described in Kim and Kim-

966 as a known technique, compatible with the existing structure of Kim, to achieve the results of improving MIMO systems described in Kim, especially when considering the well-known nature of the increasing number and mobility of UEs around the Critical Date. *Intel Corp. v. PACT XPP Schweiz AG*, 61 F.4th 1373, 1379-81 (Fed. Cir. 2023) (“using the ‘prior art elements according to their established functions’”); APPLE-1003, 0083. Thus, a POSITA would have advantageously leveraged the antenna virtualization matrix of Kim-966 into Kim’s antenna port groups through known techniques of the 3G/LTE architecture (e.g., control information to coordinate communication). For example, Kim-966 teaches that the “antenna virtualization matrix B . . . designated/configured for each UE” by control information. APPLE-1008, 0136, 0086-0087, Table 3. In addition, Kim already disclosed the use of both antenna ports for designated purposes (e.g., CSI-RS) and the use of control information for the coordination of transmissions. APPLE-1004, 0062-0078, 0098-0108, 0119-0126; APPLE-1008, 0083, 0086-0087, Table 3, 0134-0136. Finally, Dahlman corroborates these teachings with details on such control information such as MIB and SIB communication to designate resource allocation. APPLE-1007, pp.355-362. Thus, a POSITA would have had a reasonable expectation of success to include Kim-966’s determination of and coordination of antenna virtualization matrixes with Kim’s CSI-RS antenna ports into Dahlman’s already existing architecture that includes control information for

coordination of such transmissions. APPLE-1003, 0083.

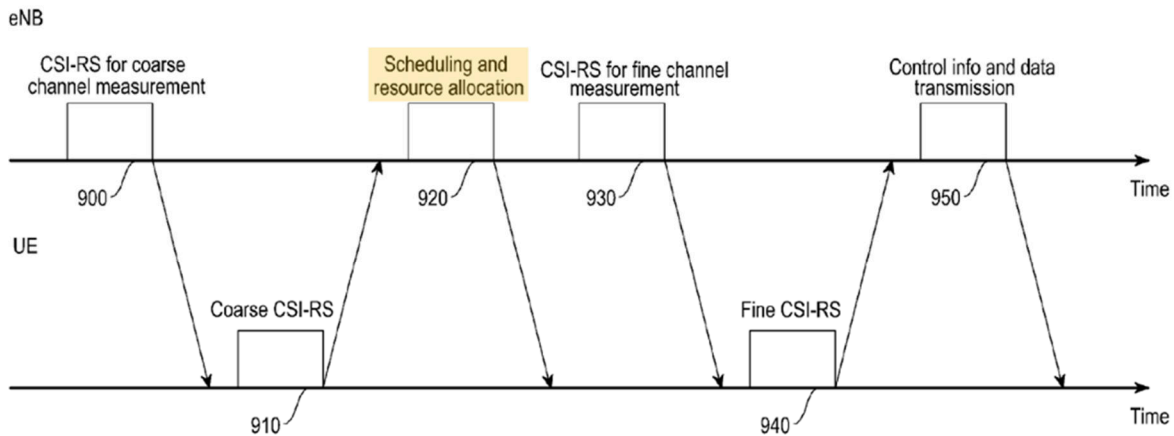


FIG.9

APPLE-1004, FIG. 9.

The Combination would have provided a MIMO system that includes a base station and UE, communicating through various physical antenna and conceptual antenna ports using antenna virtualization vectors. APPLE-1004, 0009-0013; APPLE-1008, 0086-0087, 0136; APPLE-1003, 0084. The communication across the multiple antennas would have been coordinated through Kim and Dahlman's control information, augmented with Kim-966's antenna virtualization vectors. APPLE-1004, 0018-0020, 0065-0078; APPLE-1008, 0084-0087, 0136. By the Critical Date, the concept of using control information to coordinate communication was taught and known in 3G/LTE standards as demonstrated by Dahlman, Kim, and Kim-966. APPLE-1007, 213-119, 157-160; APPLE-1003,

0084.

Third, Kim and Kim-966 describe methods of dividing transmission antennas into groups to transmit CSI-RS within limited resources. APPLE-1004, 0055-0058; APPLE-1008, 0019, 0077, 0078; APPLE-1003, 0085. A POSITA with knowledge of the techniques described in Kim-966 for antenna virtualization matrix, which applies antenna virtualization vectors to antenna port groups (pairs of CSI-RS antenna ports), would have viewed this as an alternative or complementary technique for resource management, and thus consider it obvious to apply Kim-966's antenna virtualization vector with Kim's antenna port groups to manage CSI-RS transmissions for a large number of Kim's antennas and antenna ports. APPLE-1008, 0084-0086; APPLE-1003, 0085.

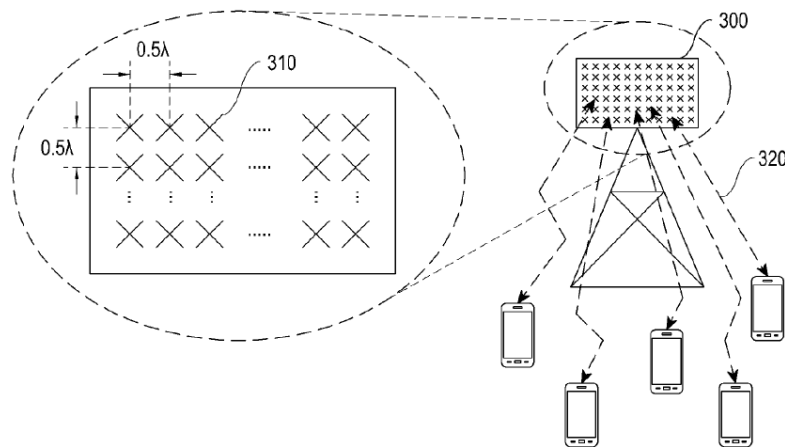
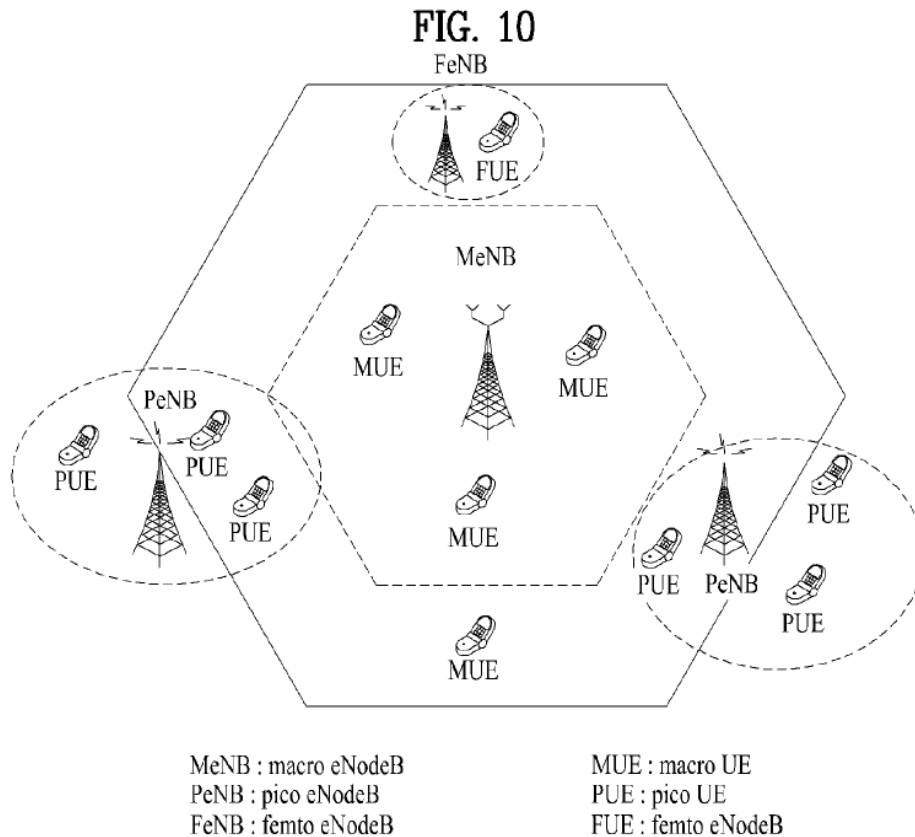


FIG.3

APPLE-1004, FIG. 3.



APPLE-1008, FIG. 10.

Fourth, Kim stresses the importance of backwards compatibility. APPLE-1004, 0054. Kim-966 teaches that the antenna virtualization vectors can be scaled to account for different numbers of available antenna ports and varying physical antenna array sizes. APPLE-1008, 0084-0087, 0136, FIG. 125, 0096. A POSITA would have recognized that using antenna virtualization taught in Kim-966 was, at the Critical Date, a known technique to efficiently manage transmissions using

various physical antenna array sizes, ensuring backwards compatibility. APPLE-1004, 0005-0006, 0054; APPLE-1008, 0084-0087, FIG. 12; APPLE-1003, 0086. As such, POSITA would have readily recognized that that combining Kim and Kim-966 in the architecture corroborated by Dahlman would address a known problem in the field—backwards compatibility. APPLE-1003, 0086.

Fifth, both Kim and Kim-966 are within the field of wireless communication systems, specifically dealing with multiple antenna techniques. APPLE-1004, 0001-0008; APPLE-1008, 0207-0218, FIG. 12, 22; APPLE-1003, 0087. Kim addresses the specifics of CSI-RS in MIMO, and Kim-966 provides general methods for antenna virtualization in MIMO systems. *Id.* Dahlman corroborates the well-established MIMO architecture by describing the same CSI-RS transmissions using multiple antenna ports and physical antennas. APPLE-1007, pp.186-188, Chapter 5. A POSITA would have naturally looked to interrelated teachings within this field. Recognizing that Kim-966's virtualization aims to improve MIMO efficiency and flexibility, a POSITA would have been motivated to combine Kim-966's teachings into Kim, particularly in managing a large number of antenna ports. APPLE-1003, 0087.

Sixth, at the time of the Critical Date, there was a trend towards MIMO systems aimed to increase network capacity and user throughput. APPLE-1004, 0005-0008; APPLE-1008, 0019-0020; APPLE-1003, 0088. There was a clear

market demand and incentive for efficient and scalable methods to manage these complex systems. *KSR Int'l Co.*, 419-20. A POSITA would have been motivated to combine the CSI-RS framework of Kim with the virtualization techniques of Kim-966 in the MIMO systems outlined in Dahlman to develop more efficient and scalable MIMO systems that meet the demands for higher capacity without overwhelming signal overhead. APPLE-1004, 0008, 0014, 0097; APPLE-1008, FIG. 22; APPLE-1003, 0088.

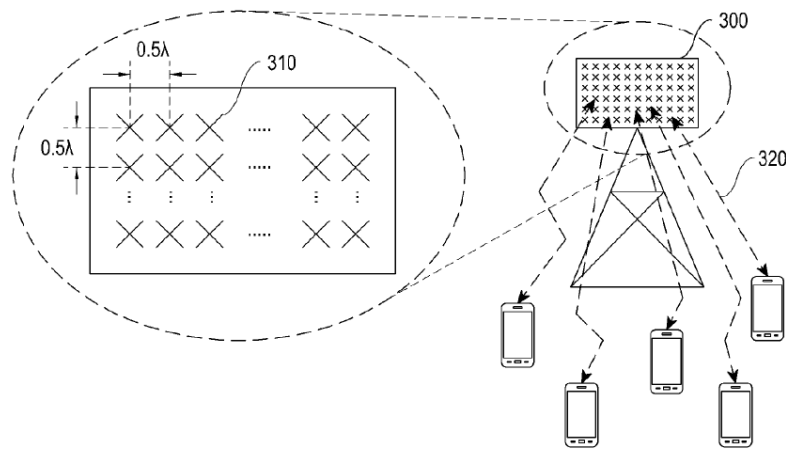
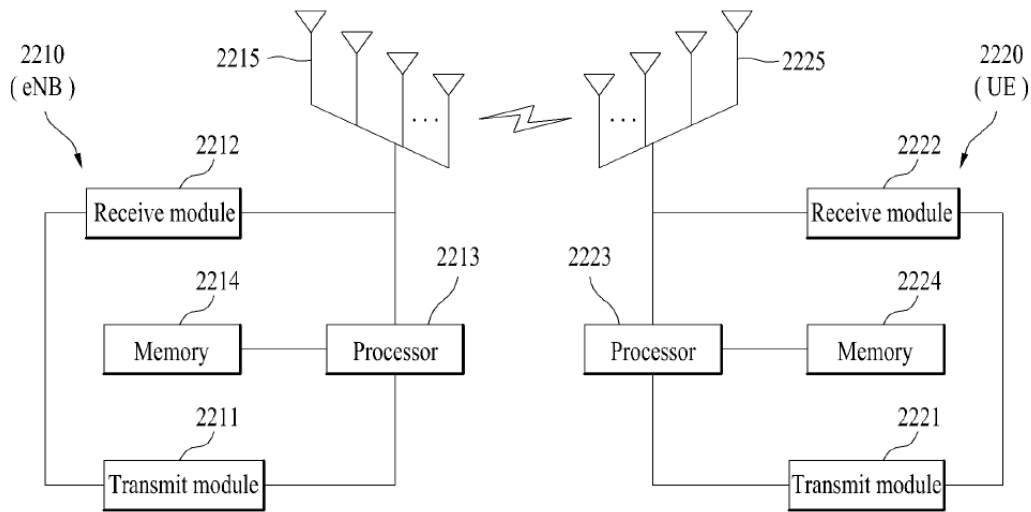


FIG.3

APPLE-1004, FIG. 3.

FIG. 22



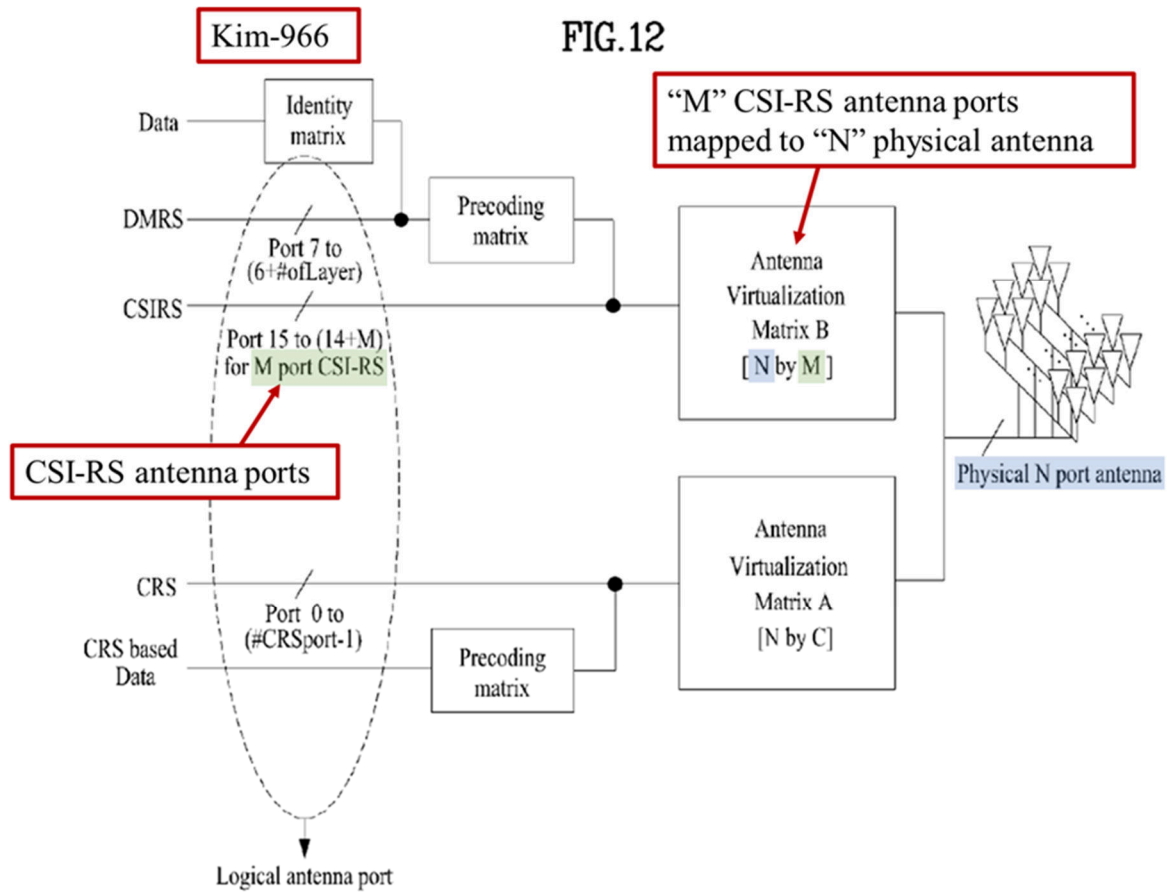
APPLE-1008, FIG. 22.

As discussed above, the Combination would have involved incorporating prior art elements according to known methods to yield predictable results. *KSR Int'l Co.*, 415-21; MPEP 2143; APPLE-1003, 0089. Each of Kim's CSI-RS antenna ports and Kim-966's antenna virtualization matrix, and Dahlman's description of MIMO systems, were well-known by the Critical Date, and thus, their combination would have predictably improved communication channel adaptability and throughput. APPLE-1004, 0006, 0008, APPLE-1008, 0019-0020, 0134-0136; APPLE-1003, 0089. Further, the combination would have involved use of known aspects of the control information for base station and UE communication coordination. APPLE-1003, 0089.

These motivations and discussions are applicable to the following analysis.

APPLE-1003, 0090. Kim, Dahlman and Kim-966 each represent analogous art to the '527 patent in dealing with improvements to 3GPP and LTE architectures.

The following annotated figure from Kim demonstrates the “journey” of the claimed *first signal* (CSI-RS) through the Combination. A first signal (CSI-RS) is transmitted from Kim’s base station on a port group and received on its MIMO UE. Kim’s CSI-RS are transmitted throughout a series of subframes within a first time resource pool. Kim-966 explains that the CSI-RS has an antenna virtualization vector that specifies the MIMO configuration on the UE. Kim explains that the antenna virtualization vector is available to the UE in the time resource pool. With this configuration, the UE can thus interface with a MIMO wireless network. APPLE-1003, 0091.



## E. Analysis

Claims 1-20 are obvious in view of the following ground. APPLE-1003, 0019-0020, 0217.

### 1. Claim 1

**[1.1] A method for multi-antenna transmission in a user equipment, comprising:**

The Combination renders obvious [1.1]. The Combination involves an architecture based on of 3G/LTE technology that allows communication between

base stations and mobile devices (User Equipment (UE)). APPLE-1004, 0002-0017; APPLE-1008, 0002, FIG. 1-4, 22; APPLE-1003, 0092. Indeed, Kim discloses structure “employ[ing] *multiple antennas* based on a Multiple Input Multiple Output (MIMO) scheme, and us[ing] various technologies, such as beam-forming, Adaptive Modulation and Coding (AMC), channel sensitive scheduling, and the like.” APPLE-1004, 0006. Specifically, Kim describes “generating channel state information [for] Multiple Input Multiple Output (MIMO) [*multi-antenna transmission and reception*].” APPLE-1004, 0016, 0017(“Another aspect of the present invention is to provide an effective transmission and reception method in a MIMO system having scores or more transmission antennas.”), 0047(“... an exemplary method of effective transmission and reception of a reference signal in a massive Multiple Input Multiple Output (MIMO) wireless communication system which transmits data by using scores or more transmission antennas will be described.”); APPLE-1003, 0092.

Kim’s architecture describes that the base station and UE have multiple transmit and receive antennas. APPLE-1004, FIG. 3, 0051(“the number of spatial channels which one UE can receive is determined depending on the number of reception antennas owned by the UE and the channel condition.”). Further, a POSITA would have understood and found obvious that in a MIMO architecture both base stations and UEs would have multiple antennas for transmission and

reception. APPLE-1007, Section 5.5, FIG. 5.14; APPLE-1003, 0093. In fact, Dahlman explains that “[t]he term MIMO (Multiple-Input/Multiple-Output) antenna processing is also very often used, although the term strictly speaking refers to all cases of multiple transmit antennas and multiple receive antennas, including the case of combined transmit and receive diversity.” APPLE-1007, p.89; APPLE-1003, 0093.

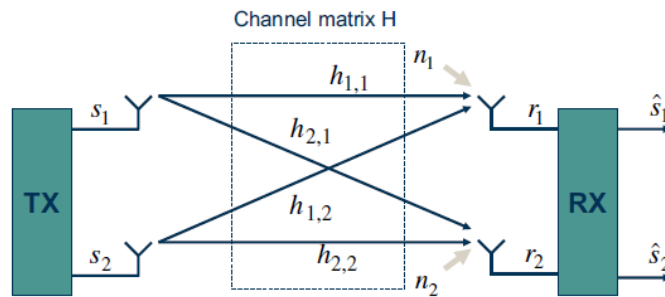


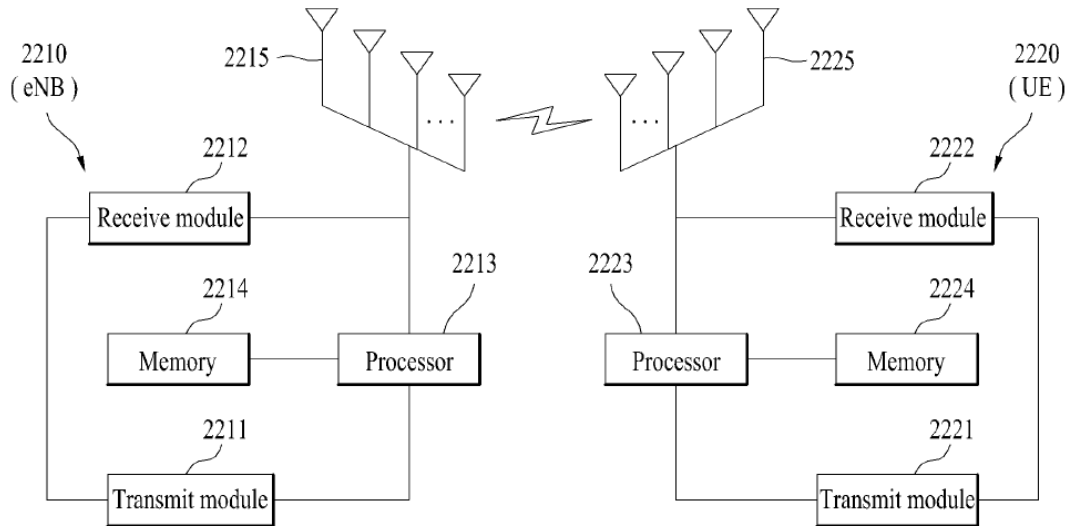
**FIGURE 5.14**

2 × 2 antenna configuration

APPLE-1007, FIG. 5.14.

Similarly, Kim-966 shows the well-known nature of MIMO architecture. For example, Kim-966 describes that the transmission capacity of MIMO increases with the number of transmit and receive antennas associated with each device—a discovery as far back as the 1990s. APPLE-1008, 0209-0214, FIG. 22; APPLE-1003, 0094.

FIG. 22



APPLE-1008, FIG. 22.

Thus, the Combination renders obvious a *user equipment* deploying *multi-antenna transmission*. APPLE-1004, 0016, 0017; APPLE-1008, 0209-0214, FIG. 22; APPLE-1003, 0095.

**[1.2] receiving a first radio signal from a base station;  
and**

The Combination renders obvious [1.2]. For example, Kim describes “a UE apparatus for *receiving [from a base station]* a reference signal for generation of channel state information [(CSI)] in a wireless communication system.” APPLE-1004, 0019. The Kim reference signal is a first radio signal, and its UE receives the reference signal *from a base station* that transmits “a CSI-RS [(channel state

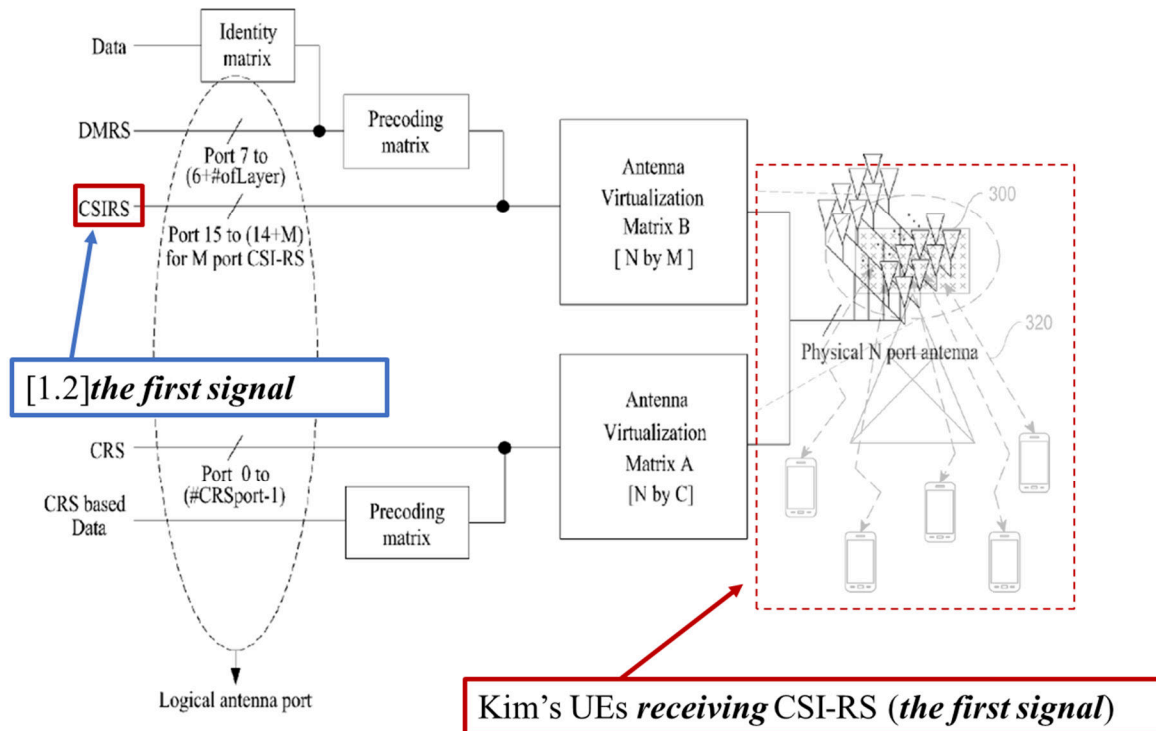
information reference signal)] for a massive MIMO system.” APPLE-1004, 0055, 0021; APPLE-1003, 0096.

Kim’s UEs receive *from a base station* the channel state information reference signal (CSI-RS) (*a first radio signal*) for the purpose of channel optimization. APPLE-1004, 0092-0097; APPLE-1003, 0097. Kim confirms that “[t]he first CSI-RS is a signal [(*a first radio signal*)] which is periodically transmitted and received by a plurality of UEs” for the purposes of each UE measuring the channel conditions. APPLE-1004, 0097.

Thus, a POSITA would have found obvious from the Combination that a UE receives a CSI-RS, and thus, a UE *receiving a first radio signal*. APPLE-1003, 0098.

Kim-966’s figure 12 provides a helpful visual aid in demonstrating some of the various claim elements, particularly those elements related to “the first signal.” In figure 12, Kim-966 shows a representation of the connection from CSI-RS antenna ports generating a CSI-RS to the ultimate transmission of those CSI-RS. Kim’s base station antenna array from figure 3 is overlaid onto Kim-966’s base station antenna array to represent the reception of CSI-RS at the UE (as claimed). The petition will provide the following annotated figure 12 of Kim-966 to demonstrate the claimed elements dealing with the *first radio signal* (claim elements 1.2, 1.4, 1.5, 1.7-1.9). APPLE-1003, 0099.

FIG.12



APPLE-1008, FIG. 12 modified with APPLE-1004, FIG. 3.

**[1.3] receiving a first signaling from the base station;**

The Combination renders obvious [1.3]. Specifically, the Combination renders obvious the UE *receiving* a “system information block” (“SIB”) (*a first signaling*) which can include various types of information such as “information about the allocation of subframes to uplink/downlink and configuration of the special subframe in the case of TDD.” APPLE-1007, pp.358-362. Kim, for example, discloses a UE “*receiving* control information [(*a first signaling*)] ... for controlling the first reference signal receiver.” APPLE-1004, 0021, 0065; APPLE-1003, 0100. Kim further states that this “an eNB should notify a UE of related

control information before transmitting a CSI-RS” and that this “control information is imperative for proper reception of the CSI-RSs.” APPLE-1004, 0065. Dahlman mirrors the necessity of control information for proper reception. APPLE-1007, pp.355-362. For example, Dahlman describes information “which needs to be acquired by terminals [UEs] in order for them to be able to access and, in general, operate properly within the network.” APPLE-1007, pp.355-362.

Based on the disclosure from Kim and Dahlman, a POSITA would have understood and found obvious to implement Kim’s control information, which is received by the UE, as a System Information Block (SIB) (*a first signaling*), as taught by Dahlman, because the SIB is a type of control information sent *from the base station* to the UE (e.g., through a downlink shared channel (DL-SCH)) as described in Dahlman. APPLE-1003, 0101; APPLE-1007, pp.358-362 (“System-Information Blocks (SIBs) that are transmitted using the DL-SCH.”). Thus, a POSITA would have understood and found obvious that *a first signaling* (SIB) is *receive[d] from the base station* by the UE through the DL-SCH. APPLE-1007, pp.358-362; APPLE-1003, 0101.

This is consistent with the ’527 disclosure. For example, later elements of the ’527 patent claims and specification describe *a first signaling* in a manner consistent with Dahlman’s description of SIB. APPLE-1003, 0102; APPLE-1001, 3:62-65 (“the first signaling is carried by a downlink physical layer control channel

(i.e. a downlink channel that can only be used to carry physical layer signaling)").

APPLE-1007, pp.358-362. Elements [1.6] recite "the first signaling is used to determine a first time resource pool" and [2.4] a "signaling is used to determine the first time resource sub-pool from the first time resource pool"—the SIB is used for scheduling including "the allocation of subframes to uplink/downlink and configuration of the special subframe in the case of TDD." APPLE-1007, pp.358-362.

**[1.4] wherein the first radio signal is transmitted by K antenna port groups of the base station; the<sup>4</sup> antenna port group includes a positive integer number of antenna port(s);**

The Combination renders obvious [1.4]. Kim, for example, discloses a CSI-RS (*the first radio signal*) being *transmitted* to a UE *by K antenna port groups of the base station*. APPLE-1004, 0012, 0022, FIG. 2; APPLE-1003, 0103.

Kim teaches that, when transmitting CSI-RS, the "LTE-A system can support signals for one antenna port, 2 antenna ports, 4 antenna ports, and 8 antenna ports." APPLE-1004, 0010. Kim's disclosure demonstrates that the UE receives *the first radio signal* that *is transmitted by* multiple (i.e., *K*) *antenna port groups* of the base station. APPLE-1003, 0104. The concept of CSI-RS transmission through multiple CSI-RS ports is discussed in more detail below.

---

<sup>4</sup> There is no antecedent basis for this term.

In MIMO systems it was common to use multiple antenna ports divided into groups for the transmission of signals—especially for CSI-RS transmissions. APPLE-1004, 0010; APPLE-1008, 0073-0078; APPLE-1003, 0105. Kim illustrates this in FIG. 2, where an example transmission of a CSI-RS uses four assigned CSI-RS antenna ports divided into two antenna port groups.

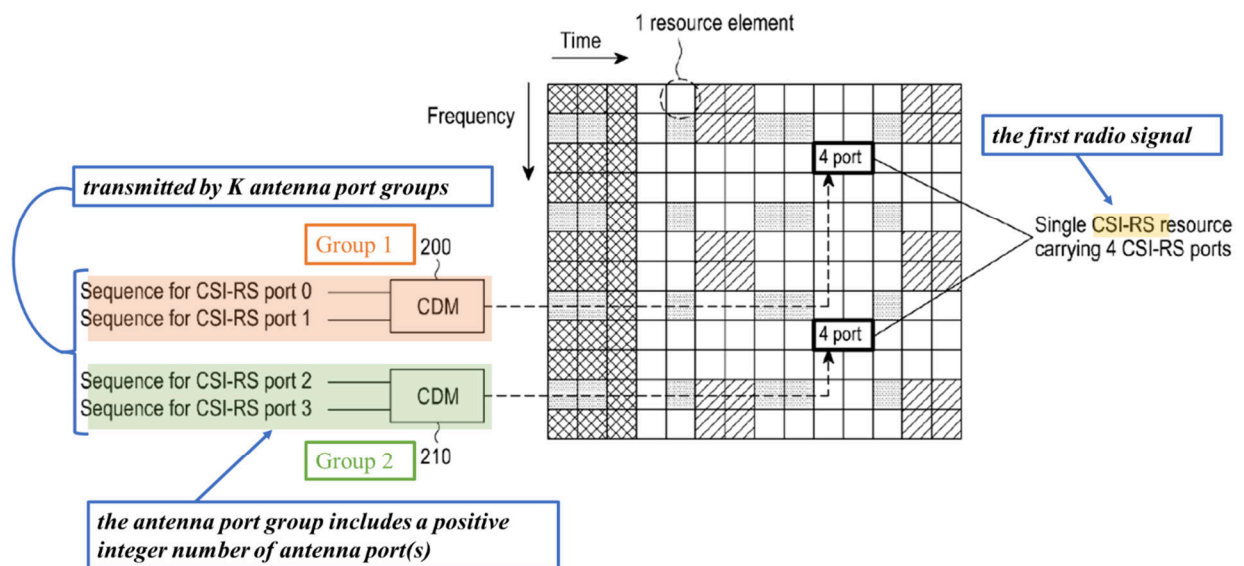


FIG. 2  
(RELATED ART)

APPLE-1004, FIG. 2.

More specifically, Kim's FIG. 2 demonstrates the use of ***K antenna port groups*** (e.g., two antenna port groups in FIG. 2) ***of the base station***, where each antenna port group contains two antenna ports (***the antenna port group includes a positive integer number of antenna port(s)***). APPLE-1004, 0011-0012. In FIG. 2 and the accompanying description, a first antenna port group contains CSI-RS

ports 0 and 1 while a second antenna port group contains CSI-RS ports 2 and 3.

And, in its Fig. 2 example, Kim transmits the CSI-RS signal (*the first radio signal*) using two groups together (*K<sup>5</sup> antenna port groups*). APPLE-1004, 0011-0012; APPLE-1003, 0106.

Kim-966 also describes the well-known use of multiple CSI-RS antenna ports in pairs (*antenna port groups*) for transmission. APPLE-1008, 0074-0078. Specifically, Kim-966 describes the use of eight CSI-RS antenna ports (ports 15-22) in groups of two, where the antenna ports within a group are orthogonalized through the CDM process. APPLE-1003, 0107; APPLE-1008, 0074-0078, 0083; APPLE-1007, p.186(“The antenna ports corresponding to CSI-RS are referred to as antenna port 15 up to antenna port 22 in the LTE specification.”).

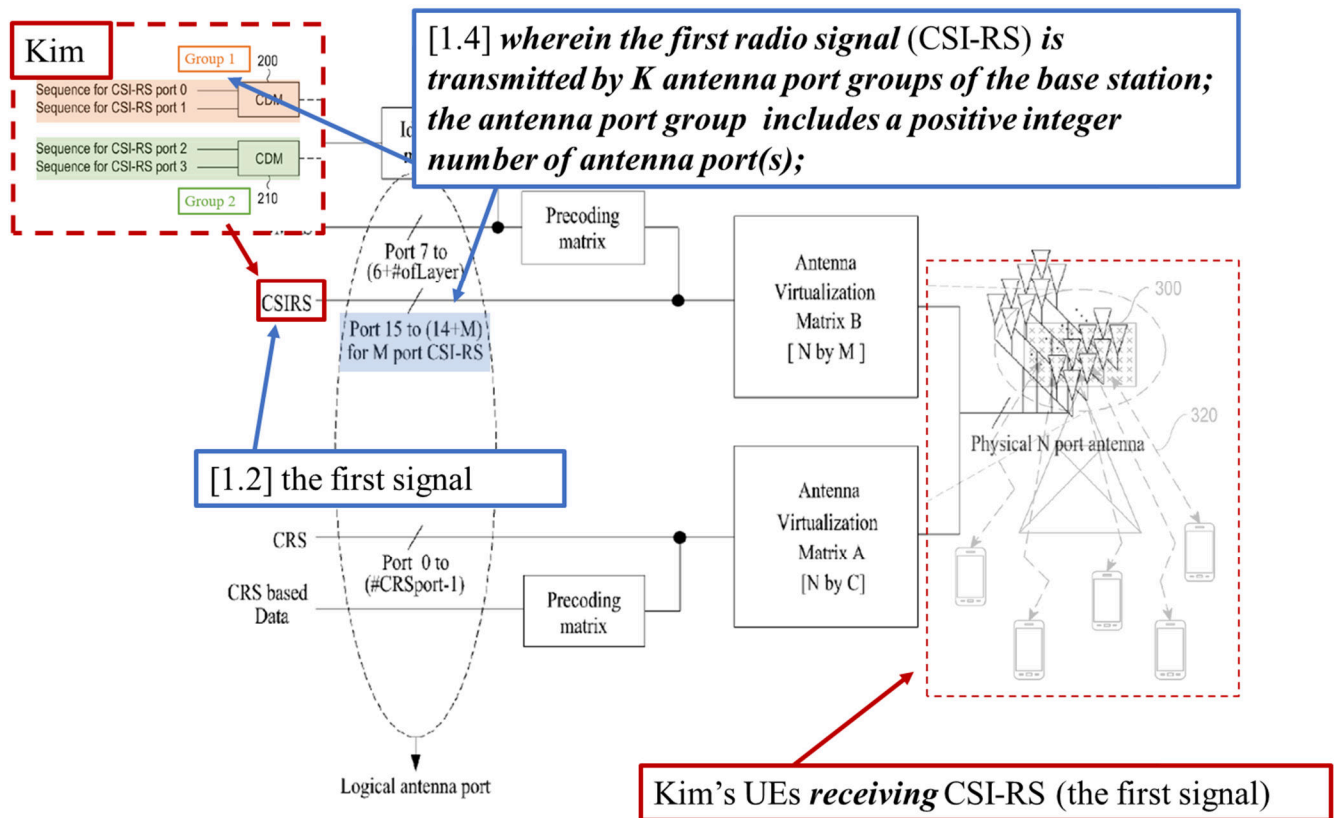
As noted, each of Kim and Kim-966 offers an example of antenna port pairs (*antenna port groups*) used for CSI-RS. Each of these antenna port groups (CSI-RS antenna port groups) use Code Division Multiplexing (CDM), and thus, Kim and Kim-966 provide independent examples of *the first radio signal* (CSI-RS) being *transmitted by K antenna port groups of the base station*. APPLE-1004, 0009-0014; APPLE-1008, 0077; APPLE-1003, 0108. Additionally, the use of CDM involves pairs of antenna ports arranged in antenna port groups, thus each

---

<sup>5</sup> Claim element [1.9] limits K to two or more.

*antenna port group includes a positive integer number of antenna port(s)* (e.g., two antenna ports paired through CDM). APPLE-1004, 0011-0012; APPLE-1007, Section 10.2.3.1, pp.186-188; APPLE-1008, 0104; APPLE-1003, 0108; APPLE-1009, pg. 8 ll. 29-35(“In some embodiments, the CSI-RS may be divided into several groups, and each CSI-RS group may include K antenna ports. In one example, K may be equal to 2”).

Thus, a POSITA would have understood and found obvious from the Combination that when transmitting CSI-RS in a MIMO LTE system, that antenna ports are commonly assigned to transmit CSI-RS across multiple groups where each group includes a pair of antenna ports. APPLE-1003, 0109. And based on the Combination, a POSITA would have further understood and found obvious that *the first radio signal* (a CSI-RS) *is transmitted by K antenna port groups* (e.g., the pairs of antenna ports utilizing CDM); *the antenna port group includes a positive integer number of antenna port(s)*. APPLE-1003, 0109.

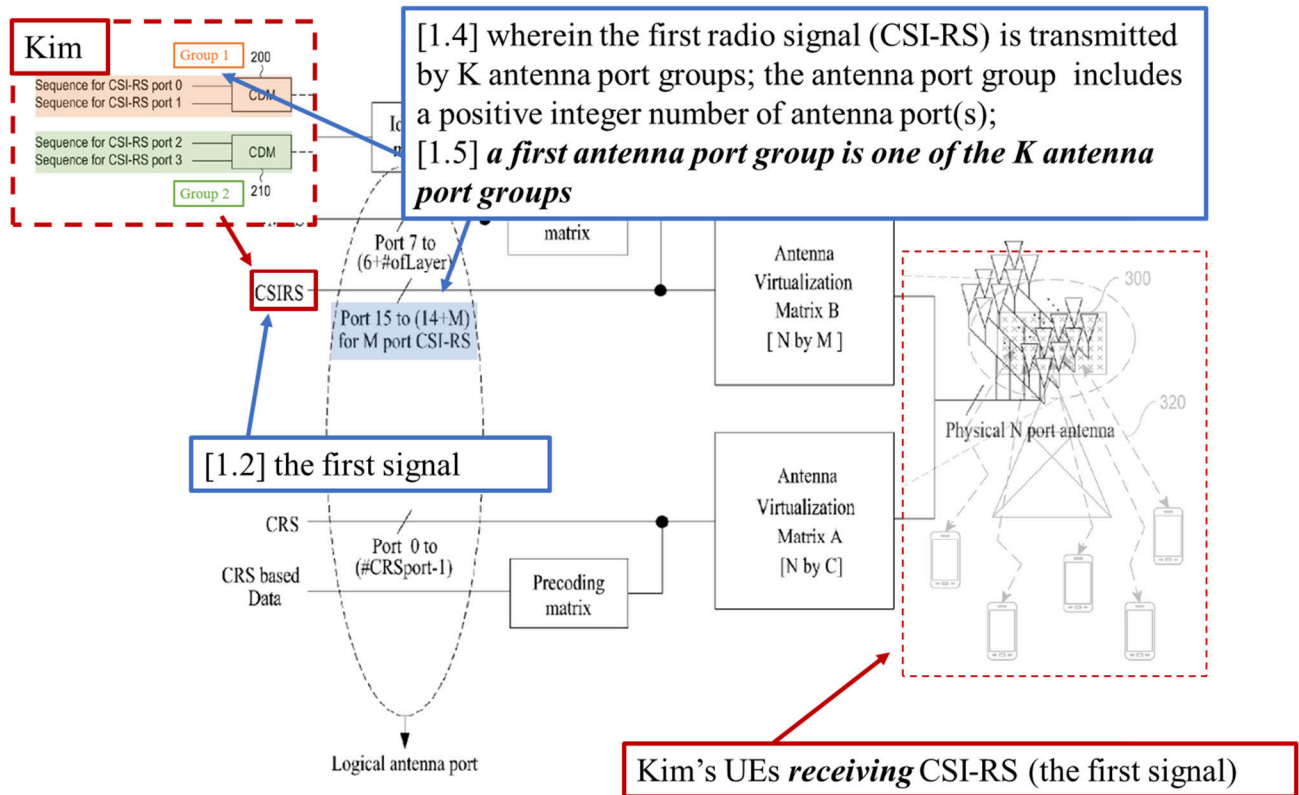


APPLE-1008, FIG. 12 modified with APPLE-1004, FIG. 2 and 3.

**[1.5] a first antenna port group is one of the  $K$  antenna port groups;**

The Combination renders obvious [1.5]. As discussed in [1.4], Kim discloses multiple antenna port groups, for example in figure 2. APPLE-1004, 0011-0012, FIG. 2; APPLE-1003, 0110. A POSITA would have understood and found obvious that one of the multiple port groups is *a first antenna port group* which is *one of the  $K$  antenna port groups* especially given the disclosure of the two antenna ports in Kim's figure 2 and the antenna port groups of Kim-966. APPLE-1004, 0011-0012, FIG. 2; APPLE-1008, 0084-0087; APPLE-1003, 0110.

In other words, of all the allowable CSI-RS antenna ports (*the  $K$  antenna ports*) (e.g., up to a total of eight with defined port numbers 15-22), *a first antenna port group is one of the  $K$  antenna port groups*. APPLE-1004, FIG. 3; APPLE-1007, FIG. 10.13; APPLE-1008, 0084-0087; APPLE-1003, 0111.



APPLE-1008, FIG. 12 modified with APPLE-1004, FIG. 2 and 3.

**[1.6] the first signaling is used to determine a first time resource pool;**

The Combination renders obvious [1.6]. As discussed in [1.3], it would have been obvious to implement Kim’s “control information” using Dahlman’s SIB (*the first signaling*), described also in Kim-966. *See* [1.3]; APPLE-1004, 0065-0072,

0079, 0091; APPLE-1008, 0056; APPLE-1003, 0112. Indeed, Dahlman indicates that SIB “includes information about the allocation of subframes to uplink/downlink and configuration of the special subframe in the case of TDD.” APPLE-1007, pp.358-362; APPLE-1004, 0065, 0065-0072.

Because the SIB assigns time resources or an “allocation of subframes for uplink/downlink,” an SIB would be understood to function as and render obvious as assigning the UE a collection of time intervals (e.g., subframes) or “*time resource pools*.” APPLE-1007, pp.358-362; APPLE-1004, 0060-0061, 0064-0078, 0084; APPLE-1003, 0113. Thus, a POSITA would have understood and found obvious that *the first signaling* (SIB) *is used to determine* an “allocation of subframes to uplink/downlink” (*a first time resource pool*) through an assignment of a Time Division Duplexing (TDD) configuration. APPLE-1003, 0113. The TDD configuration would identify a series of subframes available for uplink and downlink (*a first time resource pool*). Shown in Dahlman’s annotated figure 9.7 below, a particular configuration for TDD would establish a “pool” (Dahlman’s “allocation of subframes”) of the downlink and uplink subframes (*time resources*) assigned to a UE. APPLE-1004, 0061, 0069; APPLE-1007, pp.358-362, FIG. 9.7; APPLE-1003, 0113.

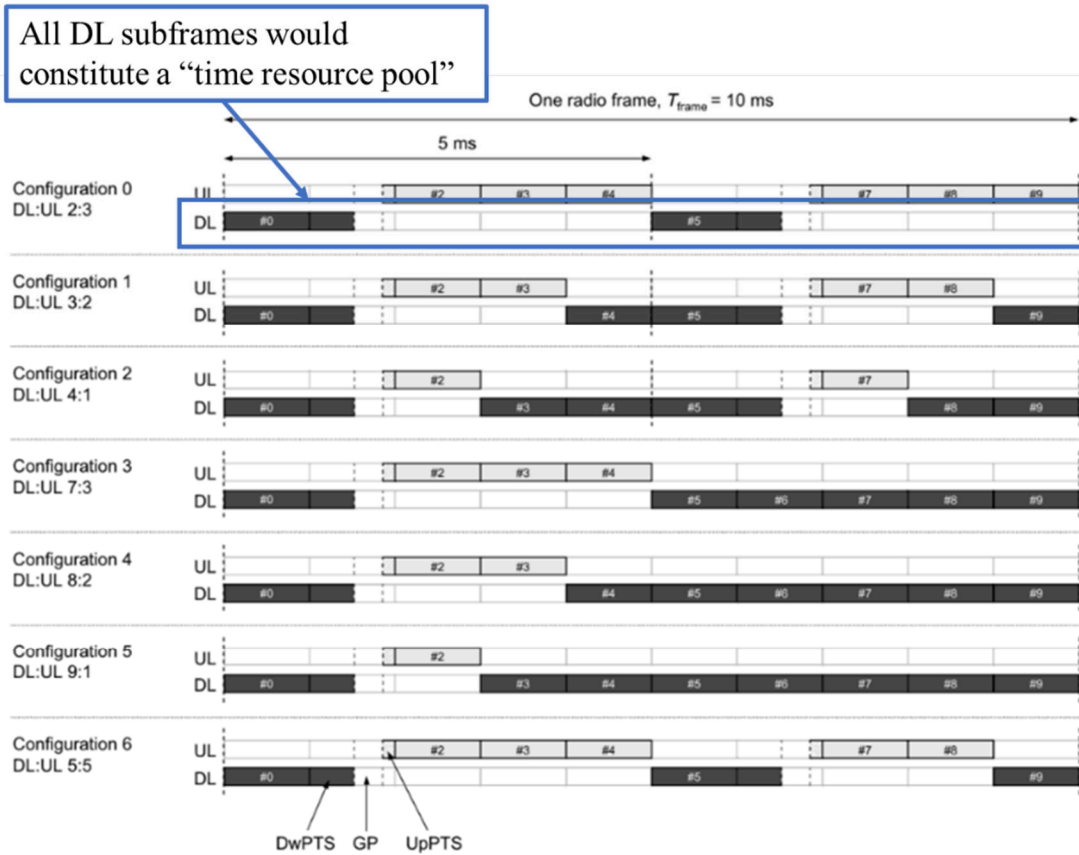


FIGURE 9.7

Different downlink/uplink configurations in case of TDD

APPLE-1007, FIG. 9.7.

Given the well-known nature of TDD configurations of the type shown in Fig. 9.7 of APPLE-1007, a POSITA would have understood and found obvious *the first signaling* (SIB), which “includes information about the allocation of subframes to uplink/downlink and configuration” using TDD configurations. APPLE-1003, 0114. Further, a POSITA would have understood and found obvious that these uplink or downlink subframes represent time resources and thus the SIB *is used to determine a first time resource pool*. APPLE-1003, 0114.

This mapping is consistent with the '527 Patent disclosure relating *a first time resource pool* with a collection of subframes. The '527 Patent describes the assignment of time resources is accomplished through a “time resource pool” which is formed of “subframes,” where a set of these can make a “sub-pool.” APPLE-1001, 16:4-12(“the subframe #3 and #7 in the first time resource pool {#1, #3, #5, #7} consists of the first time sub-pool”); FIG. 4-9. Based on the plain language of the claim and in light of the specification,. A POSITA would have understood that “time resources” refers to periods or slots of time, such as a collection or pool of subframes. APPLE-1003, 0115. *See also* APPLE-1006, p.116(applicant stating, during prosecution, that “one having ordinary skill in the art of wireless and cellular communication understands that different time slots (also referred to commonly as ‘time resources’) are grouped together into ‘pools’ and selected for certain transmissions.”).

Thus, a POSITA would have understood and found obvious that the SIB is *the first signaling which is used to determine a first time resource pool* consisting of the downlink or uplink subframes assigned to the UE through TDD configurations. APPLE-1003, 0116.

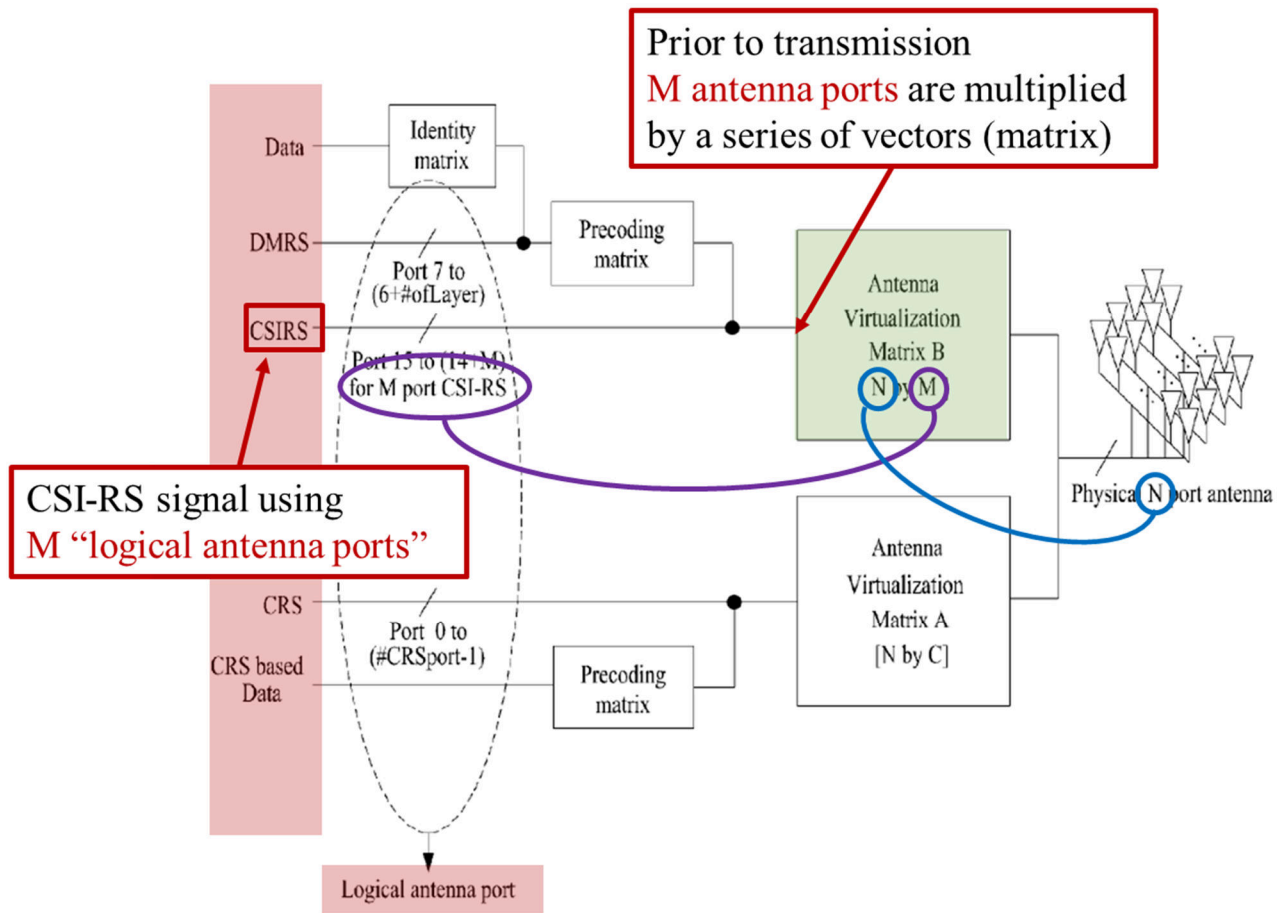
**[1.7] at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;**

The Combination renders obvious [1.7]. By way of background, Kim

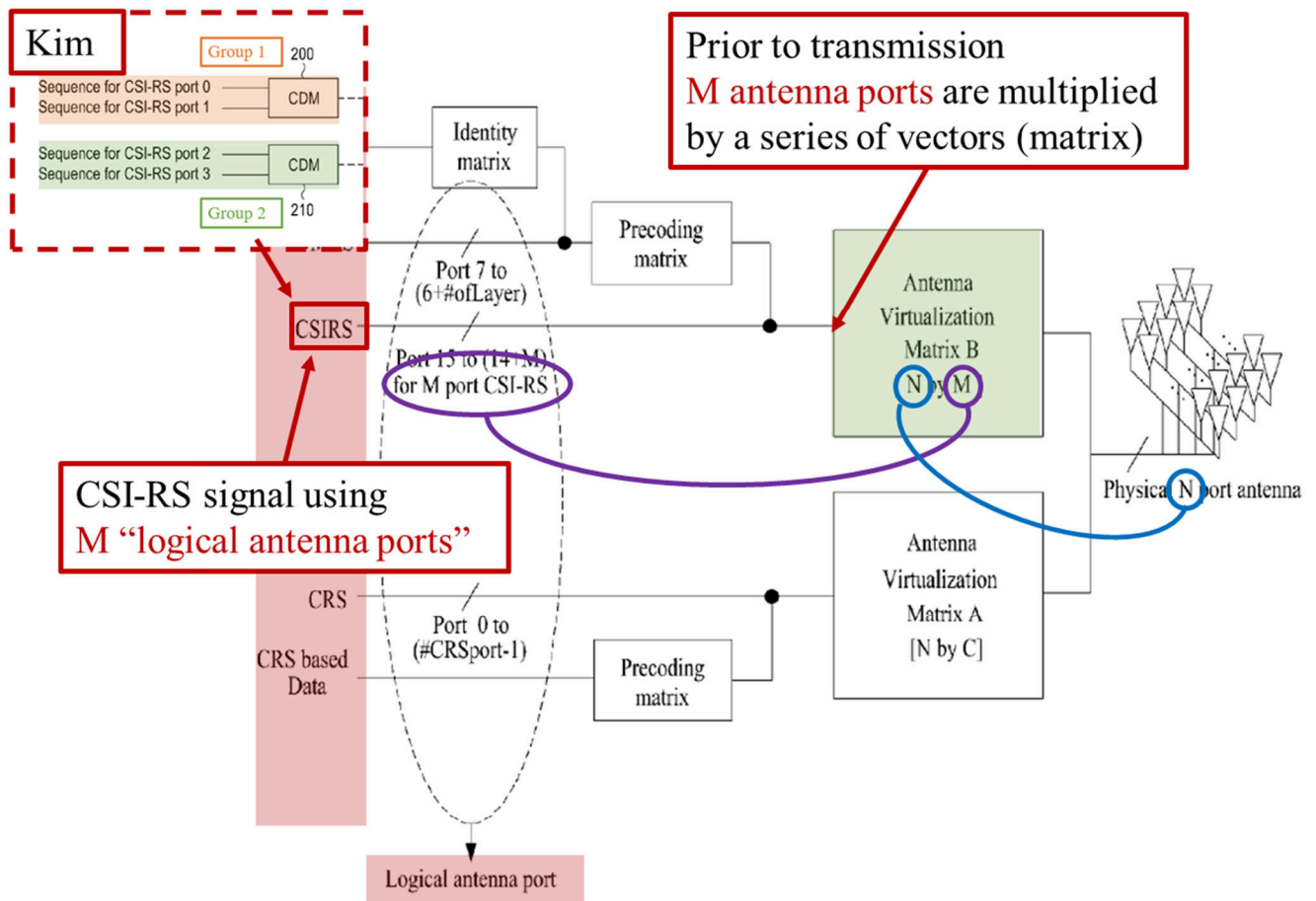
discusses the need for mapping of antenna port signals to transmission antenna.

APPLE-1004, 0017(“transmission and reception method in a MIMO system having scores or more transmission antennas.”), 0051(“A proper precoding [mapping] scheme is applied to a plurality of transmission antennas, so as to enable simultaneous transmission to the plurality of transmission antennas.”). Such a mapping provides for transmission using “the plurality of transmission antenna” because each of the antenna ports, prior to transmission, coordinates with a physical antenna for transmission. APPLE-1004, 0051; APPLE-1003, 0117.

Kim-966 provides further details of how to implement the necessary coordination between antenna ports and physical antenna through the use of an “antenna virtualization matrix.” APPLE-1008, 0016, 0086-0087, Table 3, 0136. Kim-966’s antenna virtualization matrix provides a specific example for mapping antenna ports (e.g., CSI-RS antenna ports) to physical antenna elements APPLE-1008, 0016, 0086-0087, Table 3, 0136, FIG. 12; APPLE-1007, 273(“antenna virtualization is used. . . to map the two-antenna-port signal to four physical antennas.”); APPLE-1003, 0118. One such example appears in Fig. 12 of Kim-966, which demonstrates how several signals transmitted from a system leverage an antenna virtualization matrix (collection of antenna virtualization vectors) for mapping an antenna port to the physical antennas precisely before transmission. APPLE-1008, FIG. 12, 0136, 0141; APPLE-1003, 0118.



APPLE-1008, FIG. 12.



APPLE-1008, FIG. 12 and APPLE-1004, FIG. 2.

Kim's physical antenna array would leverage Kim-966's representation of a variable number of ports and antennas. APPLE-1004, 0051; APPLE-1008, FIG. 12, 0136; APPLE-1003, 0119. In this combination, Kim-966's demonstration of an *antenna virtualization vector* leverages the association of antenna ports to physical antenna. APPLE-1004, 0052; APPLE-1008, FIG. 12, 0136.

Kim-966's antenna virtualization matrix would include one or more of *a first and a second antenna virtualization vector* that would be *associated with* an

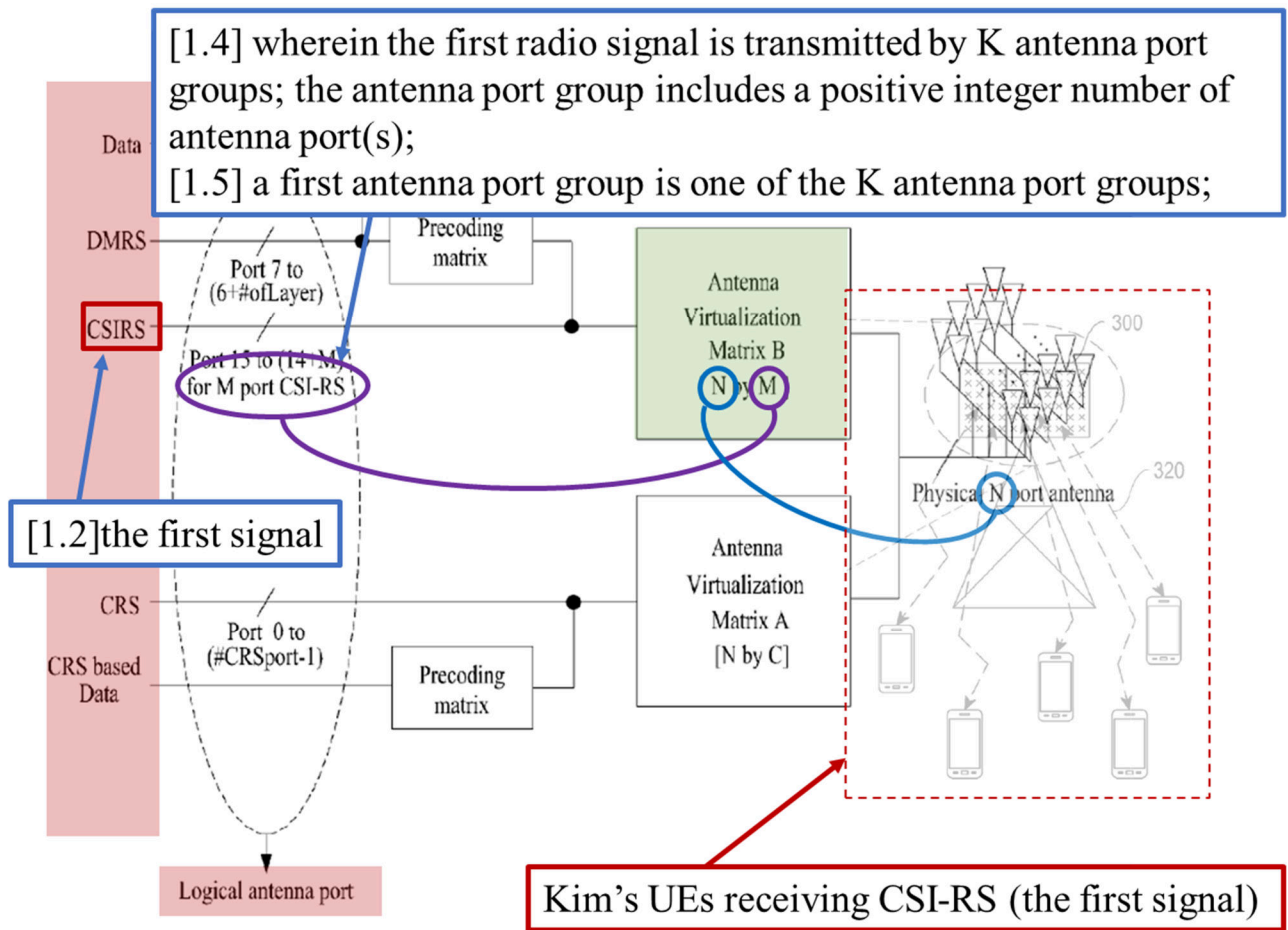
*(the first) antenna port group* (e.g., CSI-RS antenna port group pairs). APPLE-1007, 196(a “matrix  $W$  is a vector of size  $N_A \times 1$ ”); APPLE-1004, FIG. 2, 0011-0013; APPLE-1008. Kim-966 demonstrates in detail the grouping of standard’s designated CSI-RS antenna ports (15-22) into CDM groups, where each group includes two antennas (each pair being an *antenna port group*). See [1.4]; APPLE-1008, 0074-0079, 0083; APPLE-1004, 0011-0013, FIG. 2: APPLE-1007, 189-190. Thus, each of these pairs, when subject to a CDM process, provide an output signal representing the CSI-RS *antenna port group*. *Id.* The output from the process, that is, the CSI-RS antenna port group, is then multiplied by an antenna virtualization vector (part of the antenna virtualization matrix of Kim-966’s figure 12). APPLE-1003, 0120.

As another example, Kim-966 discloses that “a signal after antenna virtualization may be represented as  $Z=[z_1, z_2, \dots, z_N]=B*X$ ” where “ $z_i$  denotes a precoding vector for the  $i$ -th CSI-RS antenna port” (the “precoding vector” being another example of *a first or a second antenna virtualization vector*). APPLE-1008, 0136; APPLE-1003, 0121.

The Combination of Dahlman and Kim-966 demonstrate that antenna virtualization, used to map the standard defined virtual antenna ports to the number of available physical antenna of a device, was a well-known concept prior to the Critical Date. Because the association of antenna ports to physical antenna through

virtualization was a fundamental concept in MIMO (demonstrated in disclosure above), a POSITA would have found obvious from the Combination that ***at least one of a first antenna virtualization vector and a second antenna virtualization vector*** (used for transmission of the first signal in [1.2] and [1.5]) ***is associated with the first antenna port group***. APPLE-1003, 0122. The above mapping is consistent with the '527 Patent which states that “the mapping coefficients from the multiple physical antennas to the antenna port(s) constitute an antenna virtualization vector for the antenna virtualization.” APPLE-1001, 2:34-38;

Below a brief recap of the elements with an accompanying figure to put into context the individual elements of the claim. APPLE-1003, 0123.



APPLE-1008 modified with APPLE-1004, FIG. 3.

The above annotated figure demonstrates the “journey” of the claimed *first signal* (CSI-RS). The first signal (CSI-RS) is transmitted using the known CSI-RS antenna port pairs (*antenna port groups*). At least one of those antenna port groups is associated with a single antenna virtualization vector (for example, a vector within Kim-966’s “antenna virtualization matrix” or, as another example, Kim’s “precoding vector” that results from applying virtualization, as discussed above). The base station uses or “associates” the CSI-RS *antenna port group* with an

*antenna virtualization vector (at least one of a first or second)* for transmission.

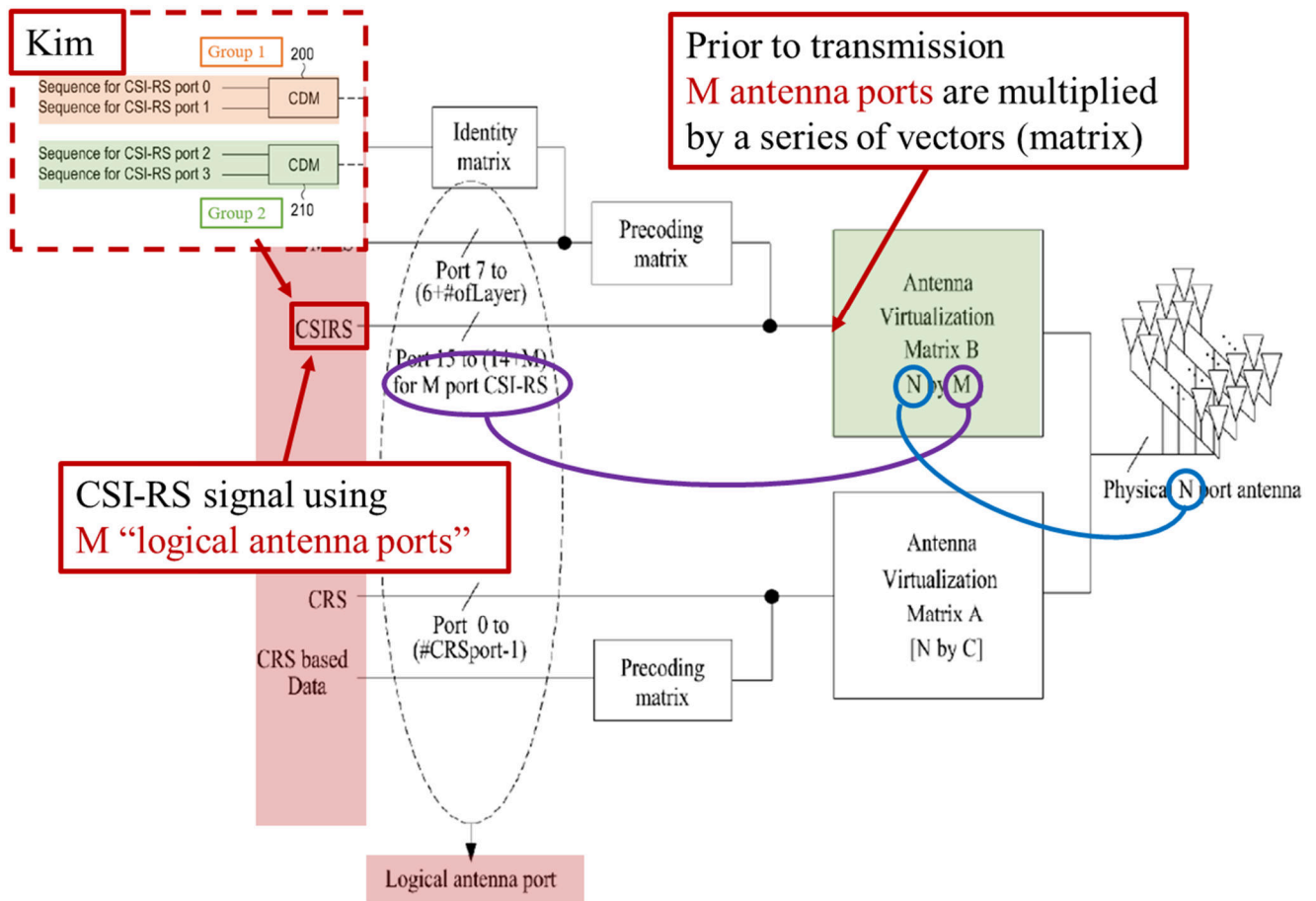
This allows a system to be agnostic to the number of antennas the system may have. Thus, the claimed UE “receives” *the first signal* [1.2]...*transmitted by K antenna port groups* [1.4]....at least one of those groups (*a first antenna port group*) associated with *an antenna virtualization vector* [1.5 and 1.7]. APPLE-1003, 0124.

**[1.8] the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool; the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; and**

The Combination renders obvious [1.8]. As discussed in [1.7], *antenna virtualization vectors* are used to map signals from antenna ports to physical antennas. *See* [1.7]. As discussed in [1.6], *the first time resource pool* defines a collection of subframes for UE reception. *See* [1.6]. *The antenna virtualization vector* being “*available*” for use by the *UE in the first time resource pool* allows for the UE to properly receive signals transmitted with multiple antenna port groups. APPLE-1004, 0065; APPLE-1003, 0125.

Specifically, Kim-966 describes using information transmitted to the UE about the CSI-RS configuration to determine the number of antenna ports being used. APPLE-1008, 0086-0087, Table 3; APPLE-1003, 0126. In this configuration

information, the “antenna virtualization matrix  $B$  [] used for CSI-RS transmission. . . may be designated/configured for each UE.” APPLE-1008, 0136, *see also* 0141 (“eNB establishes  $K$  CSI-RS transmission configurations and assigns an antenna virtualization matrix  $B$ , to each configuration” and the “eNB may inform the UEs of only some CSI-RS transmission configurations efficient for the UEs among  $K$  CSI-RS transmission configurations”). Thus, in designating the antenna virtualization vector “for each UE” and informing/transmitting such configuration information to the UE, the *antenna virtualization vector is available to the user equipment in the first time resource pool*. APPLE-1008, 0086-0087, Table 3, 0136. This “availability” allows the UE to use the antenna virtualization for proper reception of the signal. *Id.* Because reception at the UE occurs during a downlink subframe, the *antenna virtualization vector is available to the user equipment in the first time resource pool*. APPLE-1003, 0126.



APPLE-1008, FIG. 12.

Kim-966's figure above demonstrates that a *first antenna virtualization vector* is *available to the base station in the first time resource pool* because the base station uses the antenna virtualization vector to transmit the signal. Conversely, because the antenna virtualization vector is assigned to the UE, the *second antenna virtualization vector* is *available to the UE in the first time resource pool*. APPLE-1003, 0127.

Hence, a POSITA would have understood and found obvious, in light of

Kim-966's teaching of configuration information (including an antenna virtualization matrix including multiple vectors for each antenna port) that is informed to the UE for proper reception of CSI-RS, that ***the second antenna virtualization vector*** (used to transmit the first signaling (CSI-RS) to the UE) ***is an antenna virtualization vector available to the user equipment***. Indeed, this information enables proper reception at the UE. Finally, because the antenna virtualization vector would indicate the number of CSI-RS antenna ports used (e.g., 2, 4, or 8) and the number of antenna ports used would affect ***the second antenna virtualization vector*** which is ***available***, through Kim-966's configuration information, ***to the UE in the first time resource pool***. APPLE-1003, 0128.

**[1.9] the K is a positive integer greater than 1.**

The Combination renders obvious [1.9], for example, through disclosure of multiple antenna port groups. For context, in [1.3] ***the first radio signal is transmitted by K [2 or more] antenna port groups***. APPLE-1004, 0009-0014, 0056-0060, FIG.4; APPLE-1003, 0129. Kim-966 furthers this understanding through an example of four antenna port groups, each group containing two antennas. APPLE-1008, 0074-0079, 0083(CDM groups).

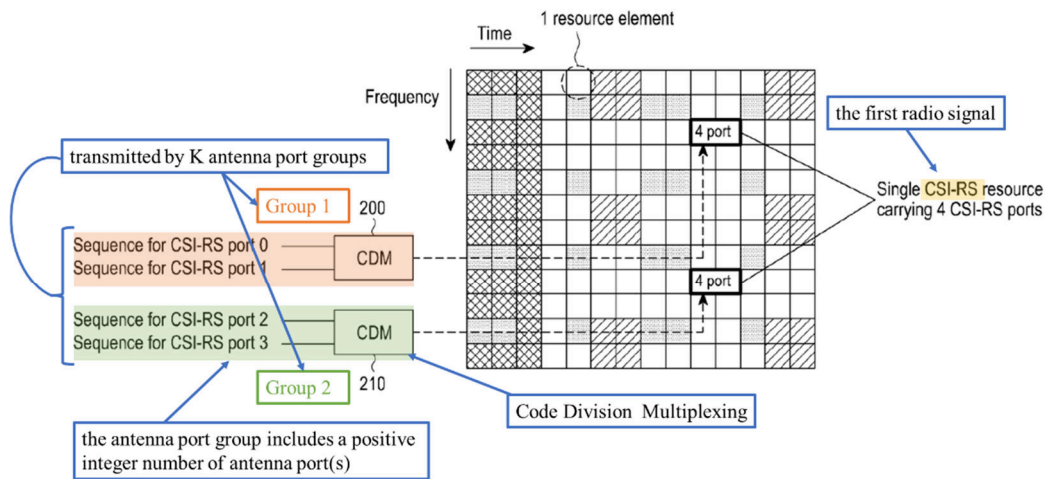


FIG. 2  
(RELATED ART)

APPLE-1004, FIG. 2.

Additionally, a POSITA would have understood and found obvious that in transmission of CSI-RS, the use of multiple antenna port groups was well-known in the art. For example, shown above in FIG. 2, Kim teaches antenna port groups ( $K$  (2 or more) antenna port groups where  *$K$  is a positive integer greater than 1*). Each of Kim and Kim-966's groups has two transmission antennas. APPLE-1004, 0010, FIG. 2; APPLE-1008, 0084-0087, 0136; APPLE-1003, 0130.

## 2. Claim 2

### [2.1]

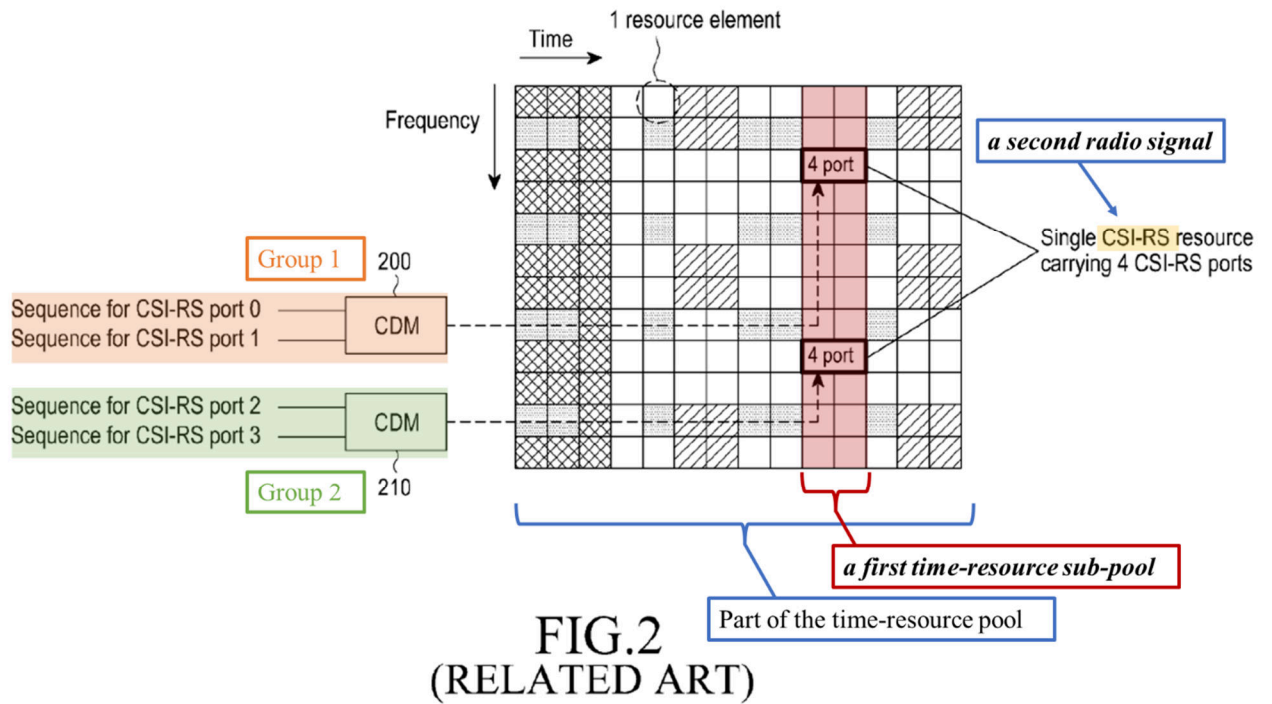
The Combination renders obvious [2.1]. For example, Kim discloses the UE receiving control information through PDCCH signals. APPLE-1004, 0065-0079, 0107. Kim teaches and a POSITA would have understood and found obvious that the PDCCH messages carrying the control information are transmitted periodically

throughout the frames and subframes. *Id.*; APPLE-1004, 0010, 0107; APPLE-1003, 0131; APPLE-1007, FIG. 13.7, Chapter 13. Thus, the UE *receiv[es] a second signaling* which is “information imperative for reception of the second CSI-RS may be transmitted through a Physical Downlink Control Channel (PDCCH).” APPLE-1004, 0107; APPLE-1003, 0131.

## [2.2]

The Combination renders obvious [2.2]. For example, Kim discloses receiving a CSI-RS in a MIMO system in a period of OFDM symbols (*a first time resource sub-pool*). APPLE-1004, FIG. 2, 0009-0014; APPLE-1003, 0132. In light of Kim’s disclosure and the knowledge demonstrated by Dahlman, a POSITA would have understood and found obvious that when receiving *a second radio signal* (a second CSI-RS), that this second CSI-RS would *operat[e]* (be transmitted or received as explained in [2.3]) in *a first time resource sub-pool* because the CSI-RS is transmitted within specific time resources (OFDM symbols) within a particular downlink subframe. APPLE-1004, FIG. 1-2, 11, 0009-0014, 0109-0114; APPLE-1007, Section 10.2.3.1, pp.186-189(CSI-RS periodicity), FIG. 10.13; APPLE-1003, 0132. Thus, at least some of the time resources (OFDM symbols) of a subframe would have been understood and obvious to a POSITA as constituting *a first time resource sub-pool*. APPLE-1003, 0132. Specifically, the *first time resource pool* is all downlink subframes and the *first time resource sub-pool* is a

portion of those downlink frames assigned for CSI-RS as shown in figures 1 and 2 of Kim and Dahlman's FIG. 10.13. APPLE-1001, FIG. 4; APPLE-1004, FIG. 2; APPLE-1007, Section 10.2.3.1, pp.186-189, FIG. 10.13; APPLE-1003, 0132.



APPLE-1004, FIG. 2.

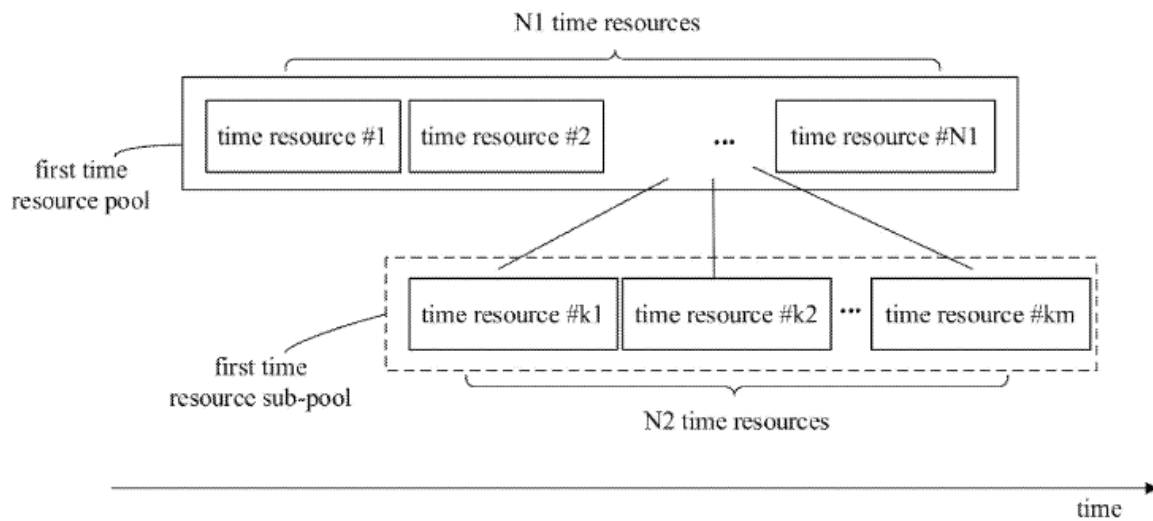


Fig. 4

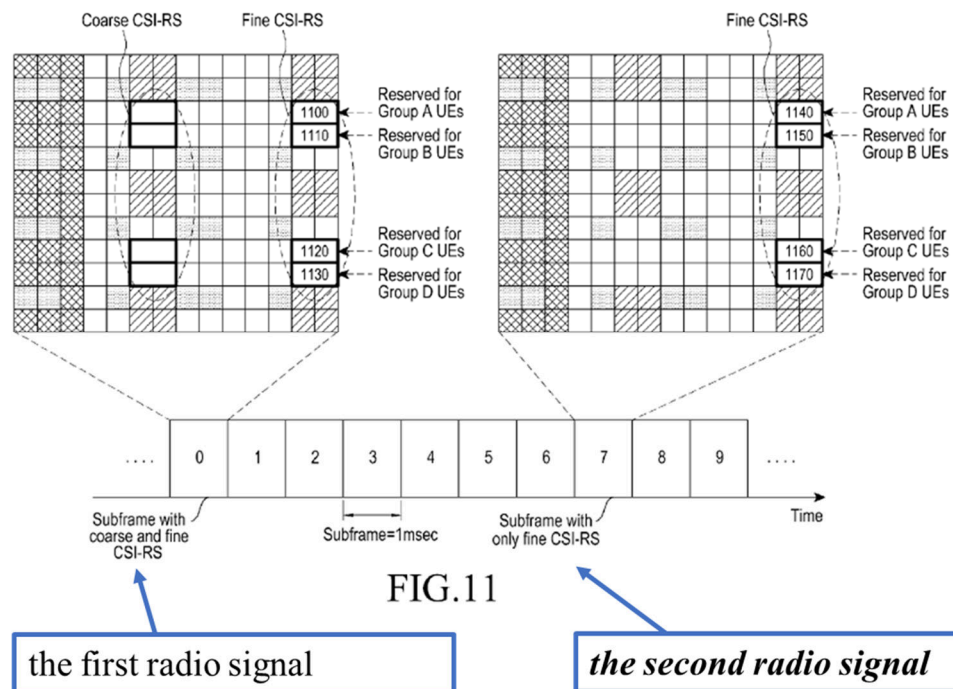
APPLE-1001, FIG. 4.

As shown above, a POSITA would have understood and found obvious that the time resource pool, consisting of downlink subframes available to the UE, would have various numbers of time-resource sub-pools in which CSI-RS transmissions are received. APPLE-1003, 0133; APPLE-1001, FIG. 4; APPLE-1004, FIG. 2; APPLE-1007, Section 10.2.3.1, pp.186-189, FIG. 10.13. This mapping is consistent with the specification, for example in figure 4 and the accompanying description. APPLE-1001, 15:25-40; FIG. 4; APPLE-1003, 0133.

[2.3]

The Combination renders obvious [2.3]. Specifically, Kim demonstrates that *operating is one of receiving . . . the second radio signal (CSI-RS) from the base station*. For example, Kim “illustrates a transmission of first CSI-RSs and second

CSI-RSs for respective subframes” and the UE *receiving* from the base station these CSI-RS. APPLE-1004, 0036; APPLE-1003, 0134. Kim discloses that in a later point in time (a later subframe) a second CSI-RS is transmitted by the base station and received by the UE. The subsequent CSI-RSs serve to further refine the channel. APPLE-1004, 0110, FIG. 11-12. For example, in FIG. 11 below, a first and a second CSI-RS signal are transmitted at two points in time. The second CSI-RS is *the second radio signal*. APPLE-1003, 0134.



APPLE-1004, FIG.11.

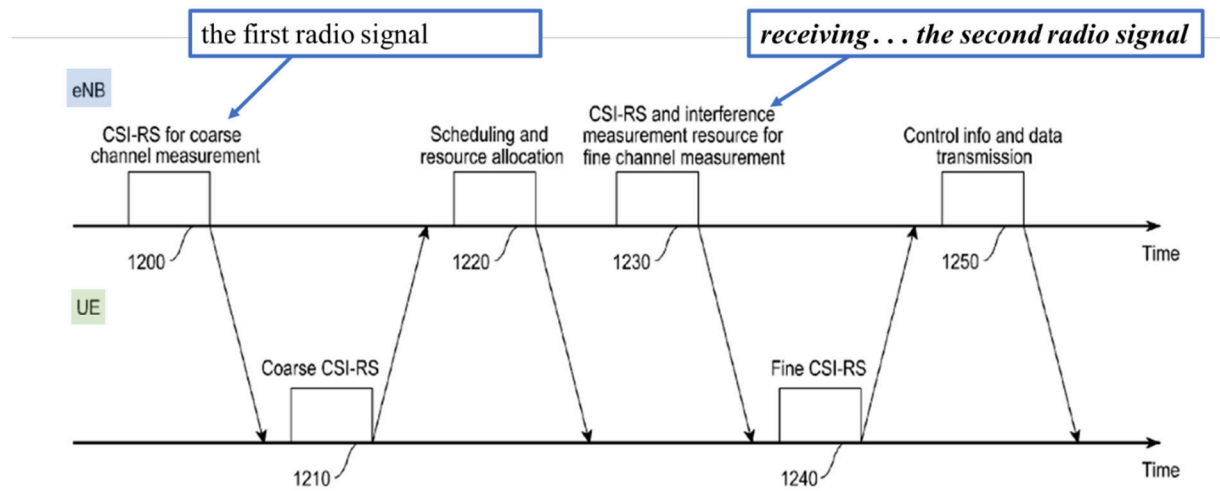


FIG.12

APPLE-1004, FIG.12.

[2.4]

The Combination renders obvious [2.4]. For example, Kim discloses the UE receiving scheduling and control information in a PDCCH (*the second signaling*). APPLE-1004, FIG. 1, 12, 0018-0021, *See* [1.6]; APPLE-1003, 0135. Kim teaches the well-known concept that control information is repeatedly sent to UEs (e.g., in the control region). APPLE-1004, 0100 (discussing a second transmission of “control information”), 0120, FIG. 9, 12. Indeed, a POSITA would have understood and found obvious that multiple PDCCHs, can exist in the control region of a subframe. APPLE-1003, 0135.

Kim discloses that the base station transmits to the UE “control information” that relates the “actual downlink wireless resources to be allocated” and is “needed

for reception of a traffic channel to the selected UEs.” APPLE-1004, 0018, 0065-0072, 0079, 0091. Moreover, “[i]n order to receive the second CSI-RSs, the eNB should transfer control information for receiving the second CSI-RSs to the UE.” APPLE-1004, 0100; APPLE-1003, 0136. Kim’s control information includes “information on a time interval” such as OFDM symbols in “which the second CSI-RS is transmitted.” APPLE-1004, 0100-0108. An example of the *time resource sub-pool* with respect to a portion of the *first time resource pool* is annotated below in Kim’s figure 2. As shown below and discussed in [1.6], Kim’s figure 2 shows a single subframe which is a part of the larger *first time resource pool*. APPLE-1003, 0136.

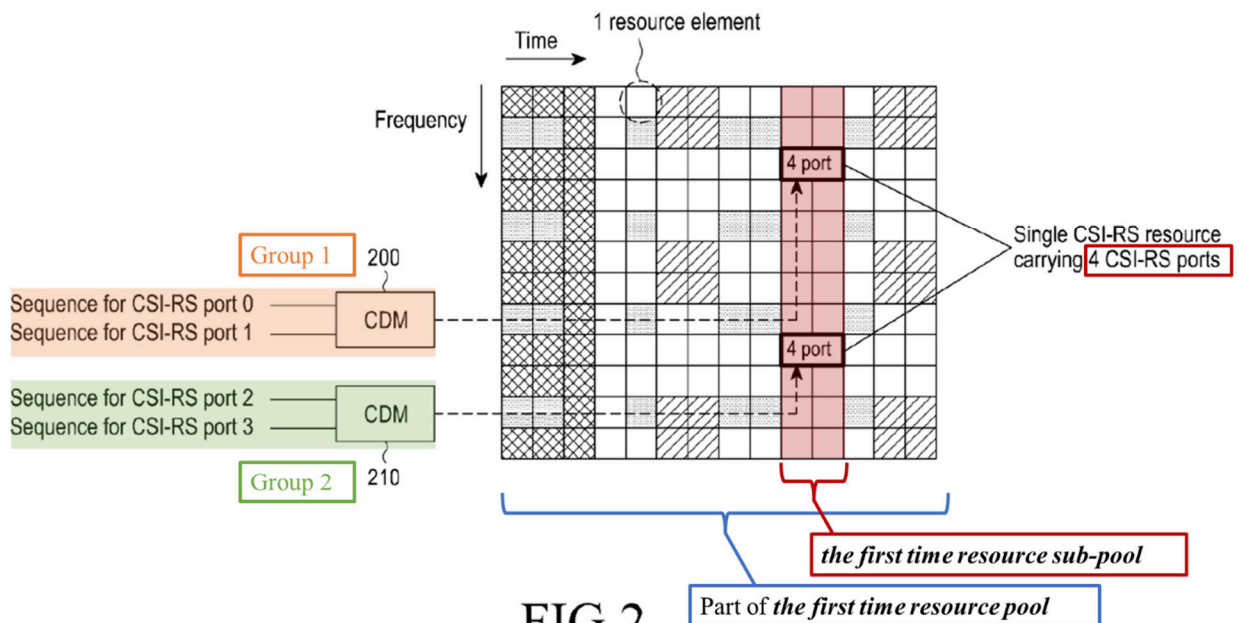


FIG.2  
(RELATED ART)

APPLE-1004, FIG 2.

Therefore, the Kim's control information (*the second signaling*) that identifies "a time interval (i.e., a subframe) to which the second CSI-RS is transmitted;" determines *the first time resource sub-pool from the first time resource pool*. APPLE-1003, 0137. In other words, *the second signaling* (Kim's "control information needed for reception") *is used to determine the first time resource sub-pool* (a period of OFDM symbols during which CSI-RS are received at the UE) *from the first time resource pool* (all downlink subframes assigned in TDD). APPLE-1003, 0137.

## [2.5]

The Combination renders obvious [2.5]. For example, a POSITA would have understood and found obvious that Kim's control information (*the second signaling*) contains the elements recited in [2.5]. APPLE-1004, 0098-0108; APPLE-1003, 0138. Specifically, Kim discloses that the control information (*the second signaling*) includes "[i]nformation on a frequency band (i.e., an RB) to which the second CSI-RS is transmitted" or an *occupied frequency domain resources*. APPLE-1004, 0102. Additionally, Kim discloses "[i]nformation on the number of transmission antenna ports through which the second CSI-RS is transmitted" or *(a) transmitting antenna port(s) of the second radio signal*. APPLE-1004, 0105; APPLE-1003, 0138.

Thus, a POSITA would have understood and found obvious that the

subsequently received control information (*the second signaling*) received at the UE is *used to determine at least one of occupied frequency domain resources, an MCS [modulation and coding scheme], a HARQ process number, an RV [redundancy version], an NDI and (a) transmitting antenna port(s) of the second radio signal.* APPLE-1003, 0139.

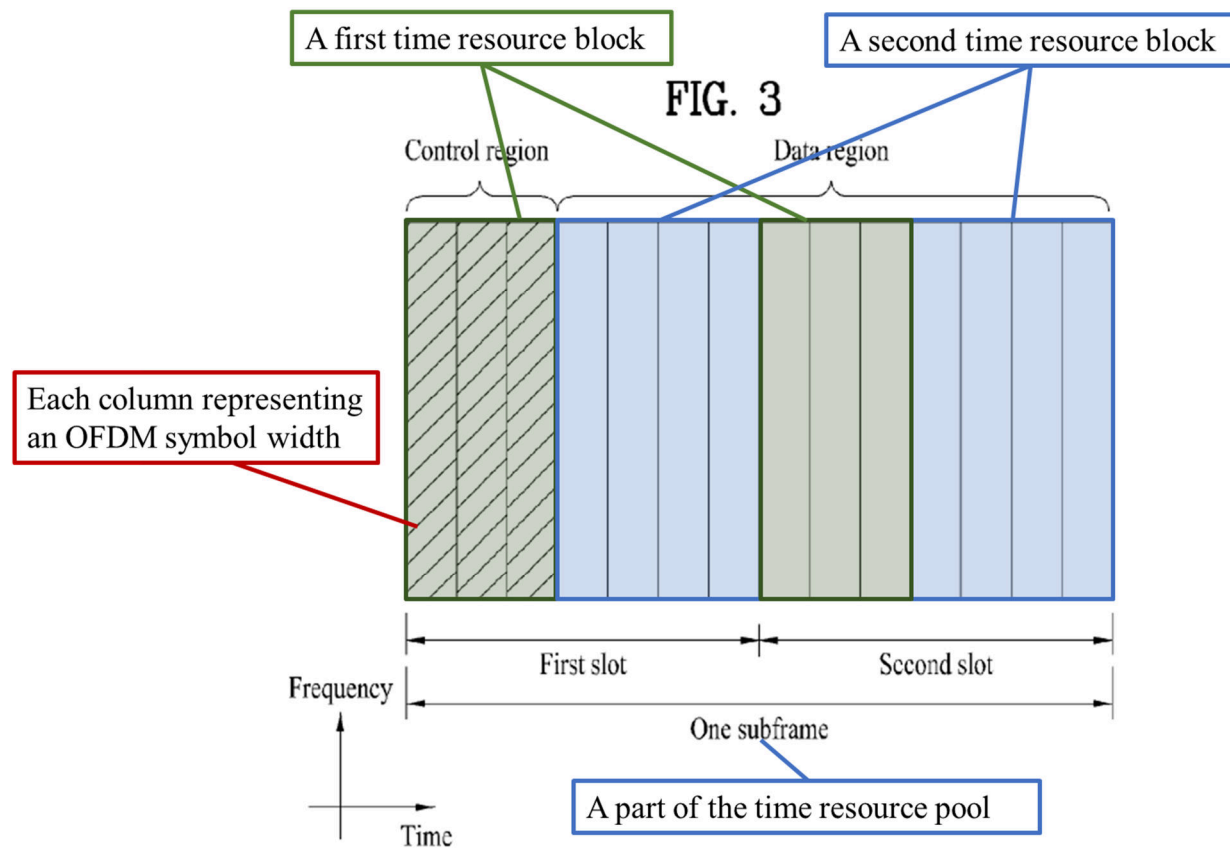
### 3. Claim 3

#### [3.1]

The Combination renders obvious [3.1]. Where [1.6] establishes a first time resource pool, [3.1] defines *a second time resource pool . . . that includes a positive integer number of time resource block(s)*. The '527 Patent describes “time resource blocks” as a collection of “M symbols in the target time resource pool.” APPLE-1001, 16:20-42. Each of the symbols in the “time resource block” are OFDM symbols. *Id.* Thus, a “time resource block” is a sub-collection of one or more OFDM symbols within a time resource pool. APPLE-1001, 16:20-42, FIG. 7; APPLE-1003, 0140.

Kim-966's figure 3 is annotated below to show an example of a single subframe with two time resource blocks. A first time resource block includes the first three OFDM symbols of each slot. A second time resource block includes the remaining four OFDM symbols of each slot. Here, *the second time resource pool* (a subframe) *includes a positive integer number of time resource block(s)*.

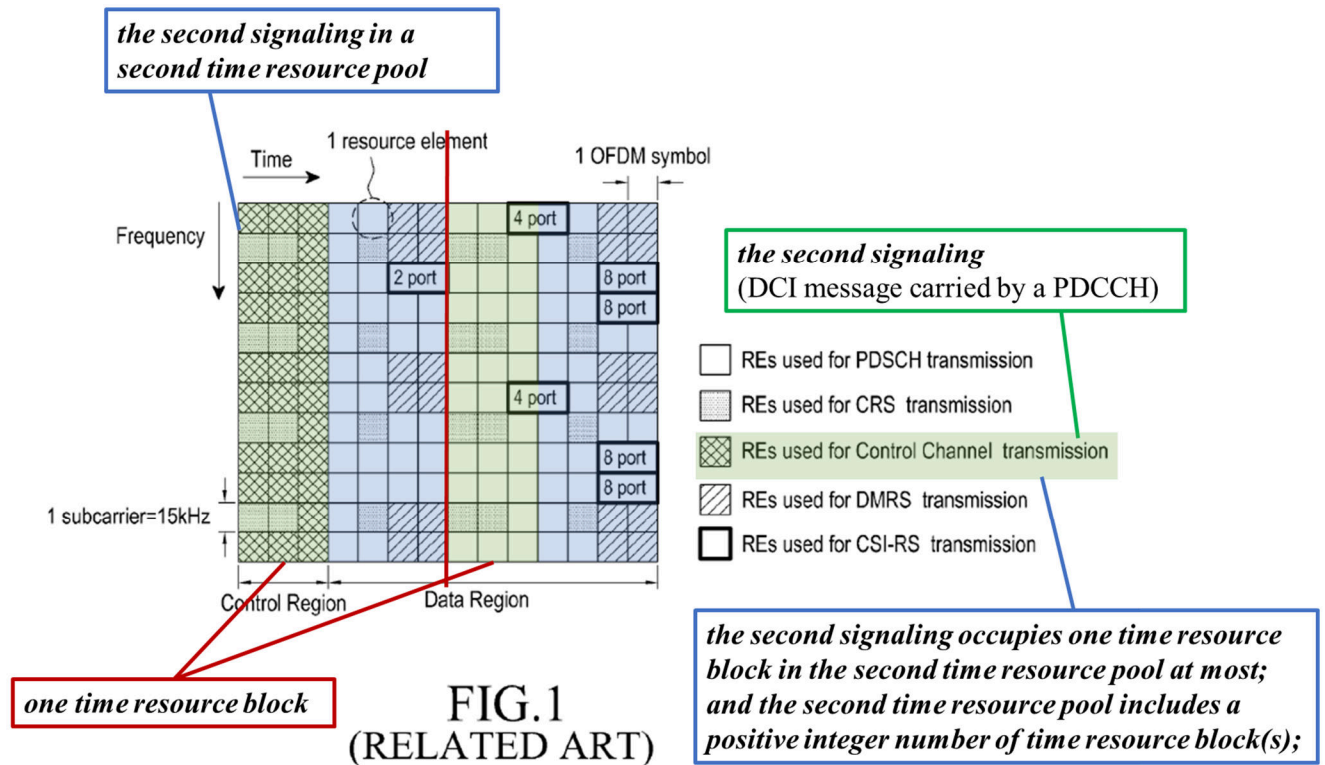
APPLE-1003, 0141.



APPLE-1008, FIG. 3.

Kim teaches *monitoring the second signaling* (the DCI messages in a PDCCH) *in a second time resource pool* (DCI messages received in any of the downlink subframes). APPLE-1004, 0009-0010, FIG. 1. Specifically, Kim shows, in figure 1, that the control information (PDCCH) is received in the first three OFDM symbols (control region) of a subframe (part of the example *time resource block*). APPLE-1004, 0009-0011, FIG. 1; APPLE-1003, 0142. The “Control Channel” of figure 1 is where the Physical Downlink Control Channel (PDCCH)

messages (*the second signaling*) are sent. APPLE-1004, 0010. Thus, a UE *monitor[s] the second signaling in a second time resource pool*.



APPLE-1004, FIG. 1.

Because the control information is located within particular OFDM symbols within a subframe, a POSITA would have understood and found obvious that the UE would be *monitoring the second signaling* (a PDCCH carrying a DCI) *in a second time resource pool* (a number of downlink subframes). APPLE-1004, FIG. 1; APPLE-1003, 0143.

Further, *the second signaling* or DCI message is within (*occupies*) *one time resource block in the second time resource pool at most* because a POSITA would

have understood and found obvious that the *time resource block* aligns to at least part of the well-known “control information” region of the time resource block. APPLE-1003, 0144. Specifically, the time resource block is a subset of the physical resource block that aligns at least partially with the control information region. APPLE-1004, FIG. 1; APPLE-1007, FIG. 10.29; APPLE-1003, 0144. For example, compare Dahlman’s teaching of the “control region” to Kim-966’s figure 3. *Id.* Even if were not obvious that Kim had disclosed a *time resource block* with *the second signaling* that *occupies one time resource block in the second time resource pool at most*, to a POSITA aware of Kim’s disclosure, it would nevertheless have been obvious to have had a second signaling occupy at most one time resource block. Among other reasons, it would have been obvious that such a configuration would have yielded improved efficiencies, as a POSITA would have known that it was more efficient to involve fewer transmission units and that this would logically extend to just one transmission unit. Indeed, a POSITA would have considered this design choice for more efficient communications through minimized overhead. *See* § IV.D(discussing market need demonstrated in Kim and Kim-966 for more efficient communications). APPLE-1003, 0144.

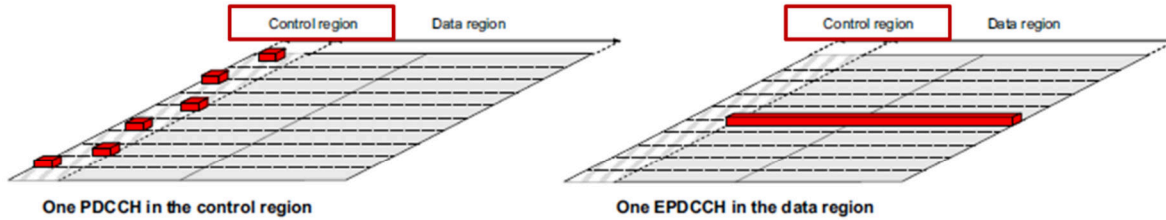
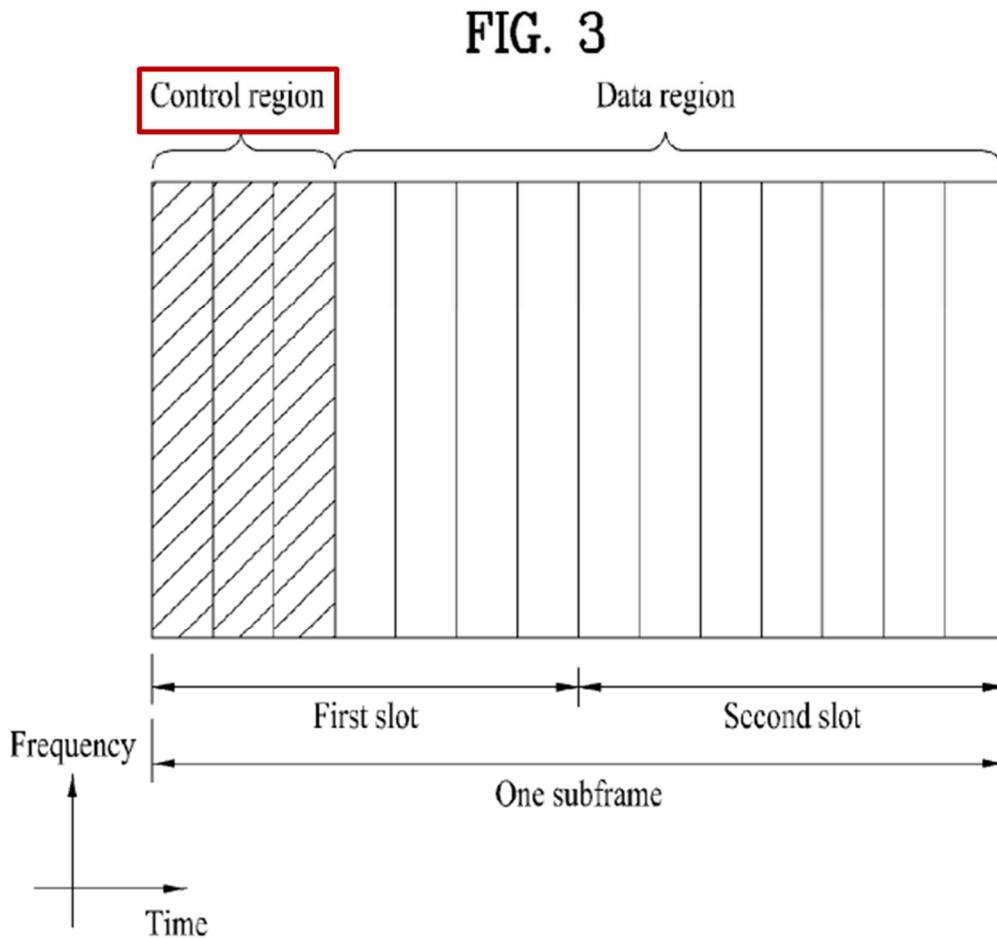


**FIGURE 10.29**

Principal illustration of PDCCH mapping (left) and EPDCCH mapping (right)

APPLE-1007, FIG. 10.29.

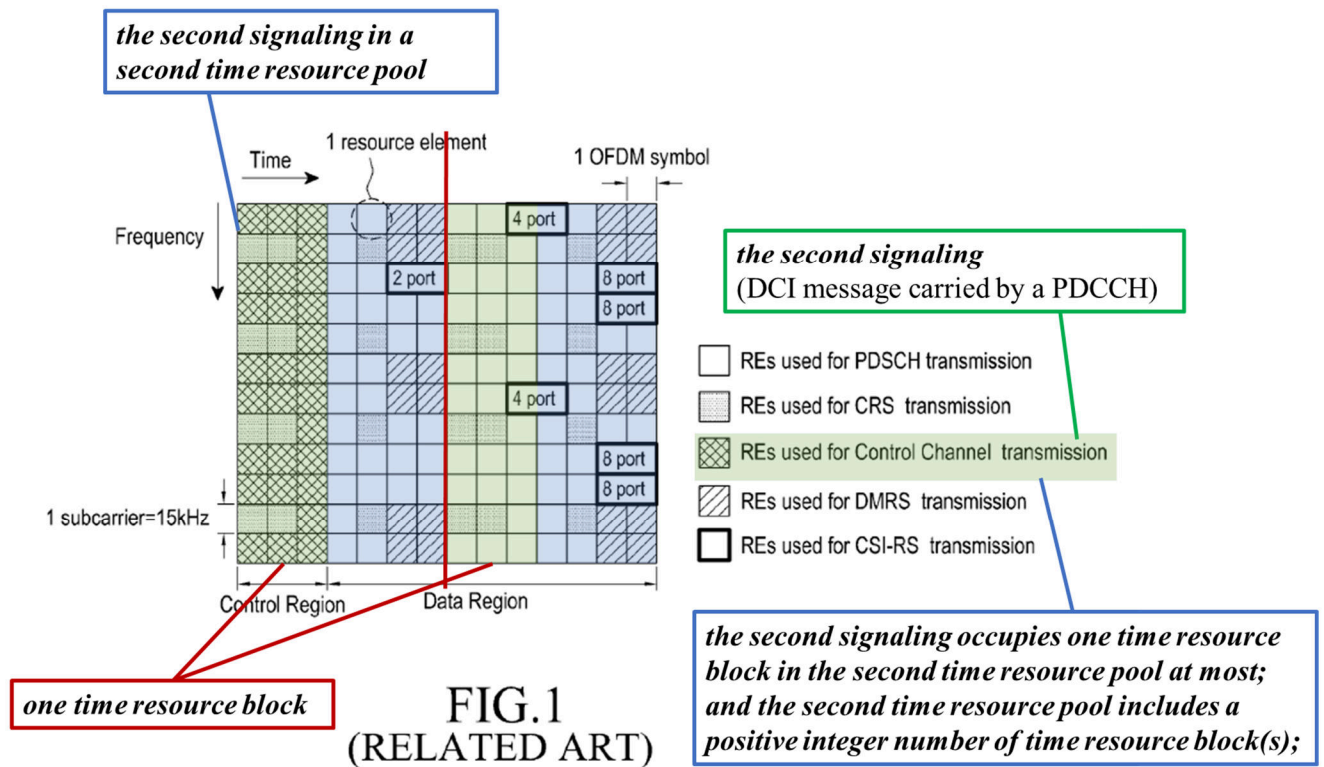


APPLE-1008, FIG. 3.

Additionally, the DCI message would only be sent or updated if necessary,

meaning that some control regions would not have DCI messages. An example “time resource block” composing several control regions therefore, may only have a single DCI message. Therefore, a POSITA would have understood and found obvious that the DCI message (*the second signaling*) can *at most* occupy the first three OFDM symbols of a subframe (*time resource block*). APPLE-1003, 0145.

Thus, the Combination renders obvious that the UE is monitoring for the second signaling (a PDCCH carrying a DCI) in a second time resource pool (a subframe), wherein the second signaling occupies one time resource block (the annotated “green” time resource block in Kim’s figure 1) in the second time resource pool at most because a PDCCH will only arrive in the first three OFDM symbols of a subframe; and the second time resource pool includes a positive integer number of time resource block(s) (the first and second time resource blocks annotated in Kim’s figure 1). APPLE-1003, 0146.



APPLE-1004, FIG. 1.

### [3.2]

Element [3.2] is separated by an “or” and thus, satisfying element [3.1] satisfies all of claim 3. APPLE-1003, 0147.

## 4. Claim 4

### [4.1]

The Combination renders obvious [4.1]. For example, Dahlman teaches that, among other things, the UE can receive system information in the form of a Master-Information Block (MIB) (*receiving first information*) which can indicate the antenna ports used. APPLE-1007, pp.355-362. Dahlman describes that the MIB is transmitted using the broadcast Channel (BCH). APPLE-1007, pp.355-357. By

“detecting what transmit-diversity scheme is used for BCH, a terminal [UE] can indirectly determine the number of cell-specific antenna ports within the cell.”

APPLE-1007, pp.355-357. Thus, when a UE receives MIB in a BCH (*receiving first information*), *the first information is used to determine the first antenna port group*. APPLE-1007, pp.355-357; APPLE-1003, 0148.

Dahlman further explains that the MIB (the “*first information*” in claim 3) and the SIB (the “*first signaling*” in claim 1) are collectively received by the UE as part of overall “system information.” APPLE-1007, pp.355-357 (explaining that the MIB carries “a limited amount of system information” and the subsequent SIB carries the “main part of system information”). APPLE-1003, 0149.

#### [4.2]

The Combination renders obvious [4.2]. For example, Kim discloses the *transmission* from the UE to the base station of a CSI-RS report (*second information*) used to refine communications with the UE. APPLE-1004, 0080-0134. “[A] UE should precisely measure the channel state and the size of interference and transmit effective channel state information [(*second information*)] to an eNB by using the measured information.” APPLE-1004, 0052; APPLE-1003, 0150.

Specifically, Kim’s “channel state information” report (*second information*) is a standardized process elaborated on by Dahlman. APPLE-1004, 0119-0126.

Dahlman describes the “channel state information” or “CSI report consists of Channel-Quality Indicator (CQI), Precoding Matrix Indicator (PMI), and Rank Indicator (RI).” APPLE-1007, p.292. Of these indications, the RI and PMI coordinate to report back the preferred channels (antenna ports) based on the received CSI-RS. APPLE-1007, 197, 292-293, 341-344; APPLE-1003, 0151. Thus, the second information (CSI Report) provides information used *to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups*. APPLE-1003, 0151.

Kim teaches that this transmission of *second information* back to the base station is used to refine the communication channel. Indeed, Kim describes the refinement and selection of channels through multiple CSI-RS signals sent to the UE and multiple reports from the UE. APPLE-1004, 0090-0097, 0120-0126; FIG. 9, 12; APPLE-1003, 0152.

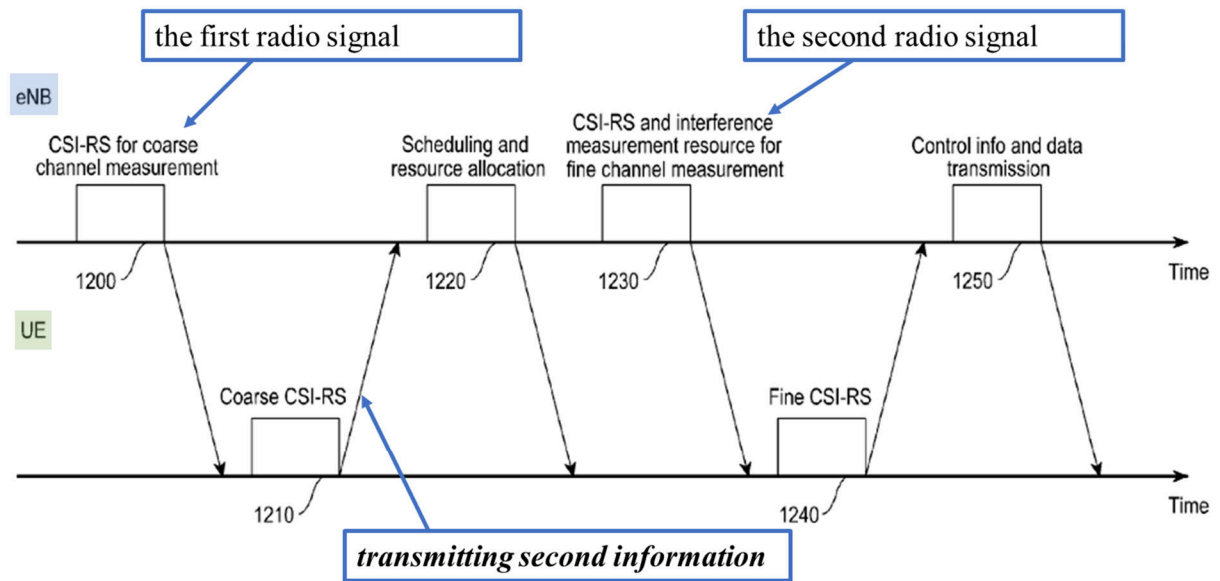


FIG.12

APPLE-1004, FIG. 12.

Thus, a POSITA would have understood and found obvious that when the UE transmits a report about the CSI-RS (*transmitting second information*) back to the base station, the CSI report includes antenna port information that is *used to determine K1* (where *K1 is a positive integer*) *antenna port group(s)*. APPLE-1004, FIG. 2, 0009-0014, FIG. 12. This is because, for example, the RI indicates the channel quality based on antenna port groups. APPLE-1007, pp.197, 292-293, 341-344; APPLE-1003, 0153.

Therefore, *the second information* (CSI report) *is used to determine K1 antenna port group(s)* (the number of antenna port groups being used in CSI-RS transmission, e.g., 2, 4, or 8); *the K1 antenna port group(s) belong(s) to the K*

*antenna port groups* (the total number of CSI-RS ports allowed by the LTE standard, e.g., 8 antenna ports (4 antenna port groups)); *the first antenna port group* (antenna ports 15 and 16 or Kim's CSI-RS ports 0 and 1) *is one of the K1 antenna port group(s); the K1 is a positive integer.* APPLE-1003, 0154.

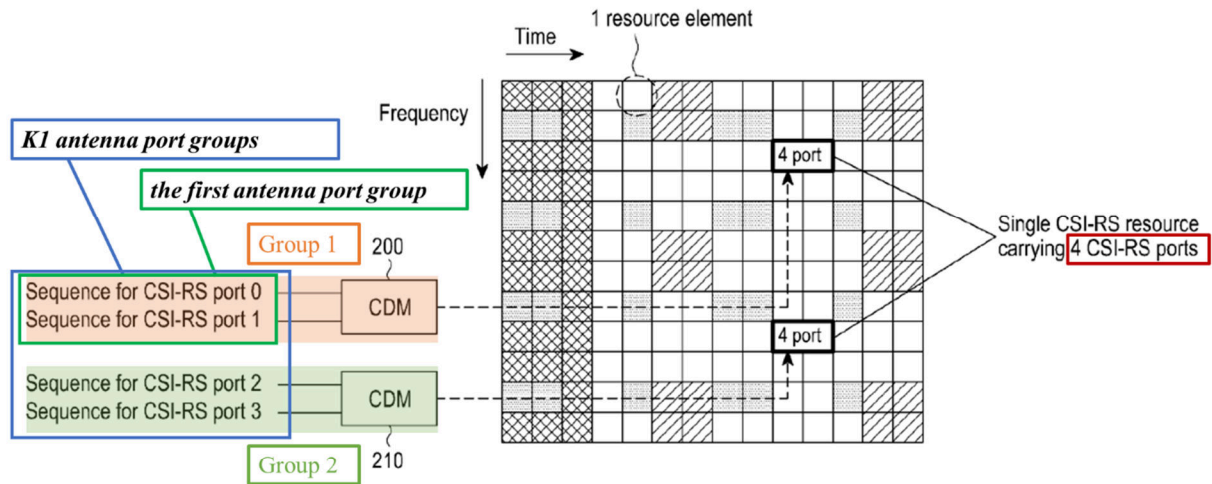


FIG.2  
(RELATED ART)

APPLE-1004, FIG. 2.

## 5. Claim 5

### [5.0]

The Combination renders obvious [5.0]. For example, Kim discloses several of the elements in [5.0] which are each separated by “or” and thus satisfying only one element will satisfy [5.0]. APPLE-1003, 0155.

First, a POSITA would have understood and found obvious that the first signaling of [1.3] or the SIB assigned time resources, for example through TDD. APPLE-1004, 0062-0079, FIG. 9, 12 (showing alternating uplink and downlink subframes). Thus, in various configurations of TDD, *the first time resource pool is discontinuous in time domain* as demonstrated by Dahlman's figure 9.7 where the downlink subframes (collectively the *first time resource pool*) are separated into periods separated by uplink subframes and is thus the collection of downlink subframes are *discontinuous in the time domain*. APPLE-1003, 0156.

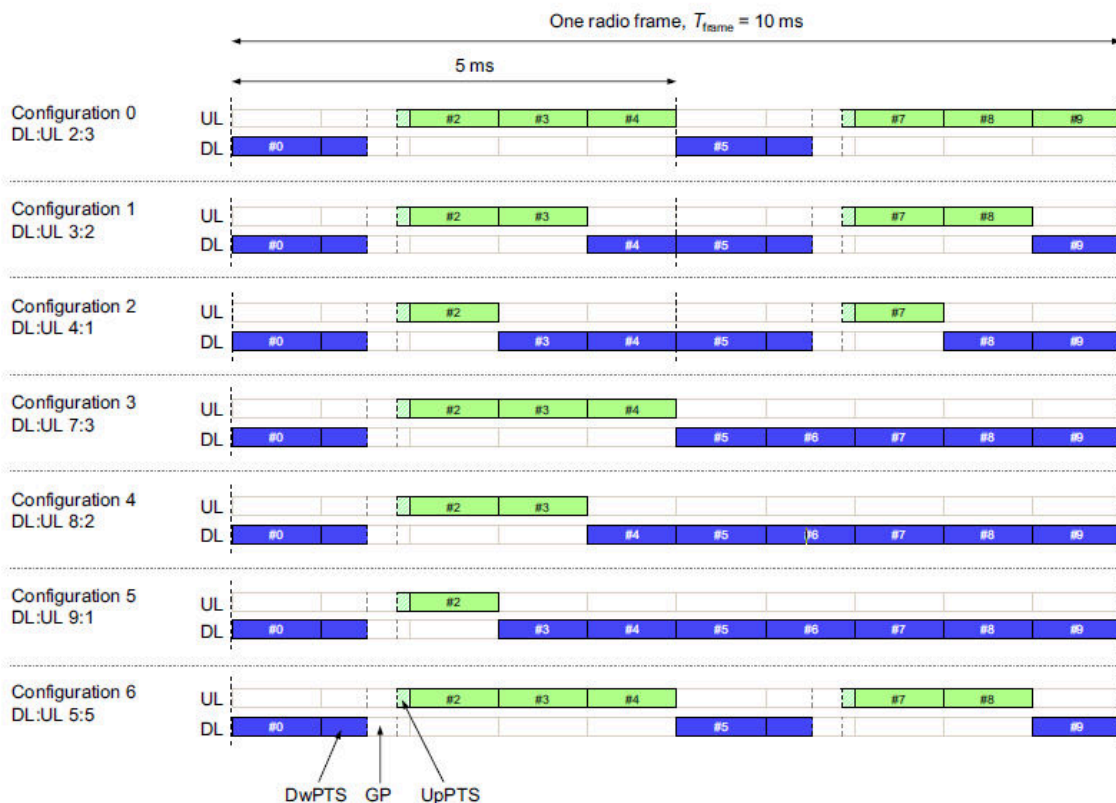


FIGURE 9.7

Different downlink/uplink configurations in case of TDD

APPLE-1007, FIG. 9.7

**6. Claim 6**

**[6.1]**

*See* [1.1] (explaining communication between a base station and UE).

APPLE-1003, 0157.

**[6.2]**

Where [1.2] references “receiving,” Kim also teaches *transmitting* from the base station *to a target receiver* (a UE) because the CSI-RS are for UEs. *See* [1.2]; APPLE-1003, 0158; APPLE-1004, 0050(“(eNB)) 300 transmits a wireless signal through scores or more transmission antennas.”), FIG. 3; APPLE-1003, 0158.

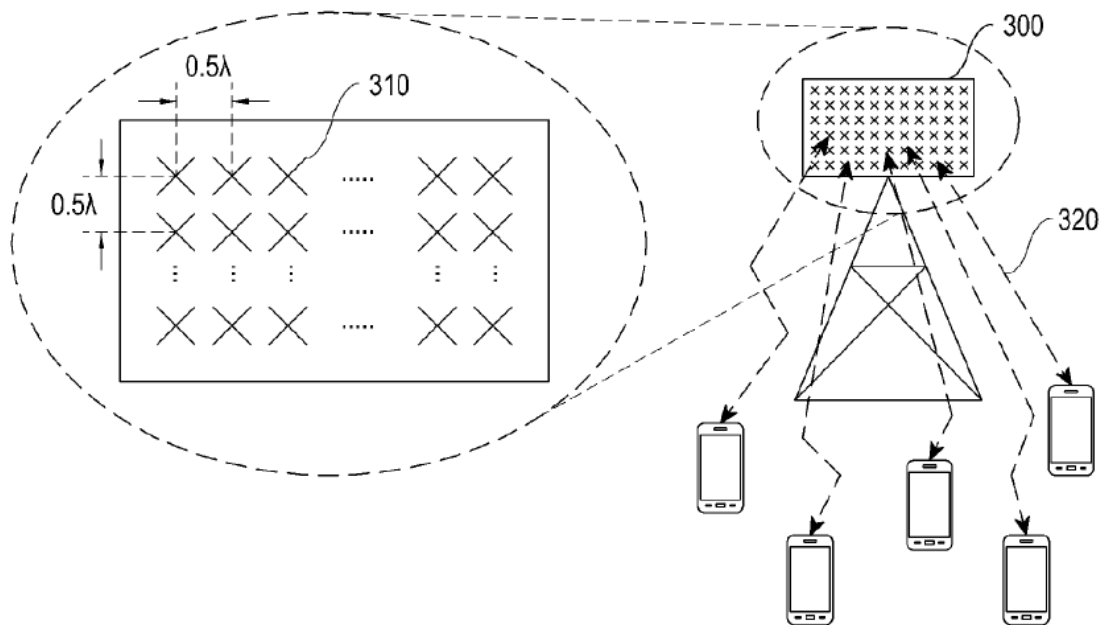


**FIG.3**

APPLE-1004, FIG. 3.

**[6.3]**

*See* [6.2], [1.3]; APPLE-1003, 0159.

**[6.4]**

*See* [1.4]; APPLE-1003, 0160.

**[6.5]**

*See* [1.5]; APPLE-1003, 0161.

**[6.6]**

*See* [1.6]; APPLE-1003, 0162.

**[6.7]**

*See* [1.7]; APPLE-1003, 0163.

**[6.8]**

*See* [1.8]; APPLE-1003, 0164.

**[6.9]**

*See* [1.9]; APPLE-1003, 0165.

**7. Claim 7**

**[7.1]**

Where [2.1] references “receiving,” Kim also teaches *transmitting* from the base station. *See* [2.1]; APPLE-1003, 0166.

**[7.2]**

Where [2.2] references “operating” and [2.3] requires the “operating” to be “receiving” and a POSITA would have understood and found obvious that

*performing* and “operating” a transmission from the base station are synonymous.

*See* [2.2], [7.3](where performing is transmitting). A POSITA would have understood and found obvious that the MIMO system of the Combination renders obvious *performing* because the UE and base station both transmit and receive.

APPLE-1003, 0167.

**[7.3]**

*See* [2.3]; APPLE-1003, 0168.

**[7.4]**

*See* [2.4]; APPLE-1003, 0169.

**[7.5]**

*See* [2.5]; APPLE-1003, 0170.

**8. Claim 8**

**[8.1]**

*See* [3.1]; APPLE-1003, 0171.

**[8.2]**

Where [3.2] references “receiving,” Kim also teaches *transmitting* from the base station. *See* [3.2]; APPLE-1003, 0172.

**9. Claim 9**

**[9.1]**

Where [4.1] references “receiving,” Kim also teaches *transmitting* from the base station. *See* [4.1]; APPLE-1003, 0173.

**[9.2]**

*See* [4.2]; APPLE-1003, 0174.

**10. Claim 10**

**[10]**

*See* [5]; APPLE-1003, 0175.

**11. Claim 11**

**[11.1]**

*See* [1.1]; APPLE-1003, 0176.

**[11.2]**

The Combination renders obvious and a POSITA would have understood and found obvious that a UE (e.g., a mobile device communication with a transmission tower base station) would utilize a transceiver operably connected to the antennas of the MIMO device. APPLE-1004, 0007 (“receiver and transmitter”), 0020, 0050, FIG. 14-15, cl. 20; *See* [1.2]; APPLE-1003, 0177.

**[11.3]**

The Combination renders obvious the use of multiple receivers. APPLE-1004, 0132, FIG. 15; APPLE-1003, 0178; *See* [11.2], [1.3].

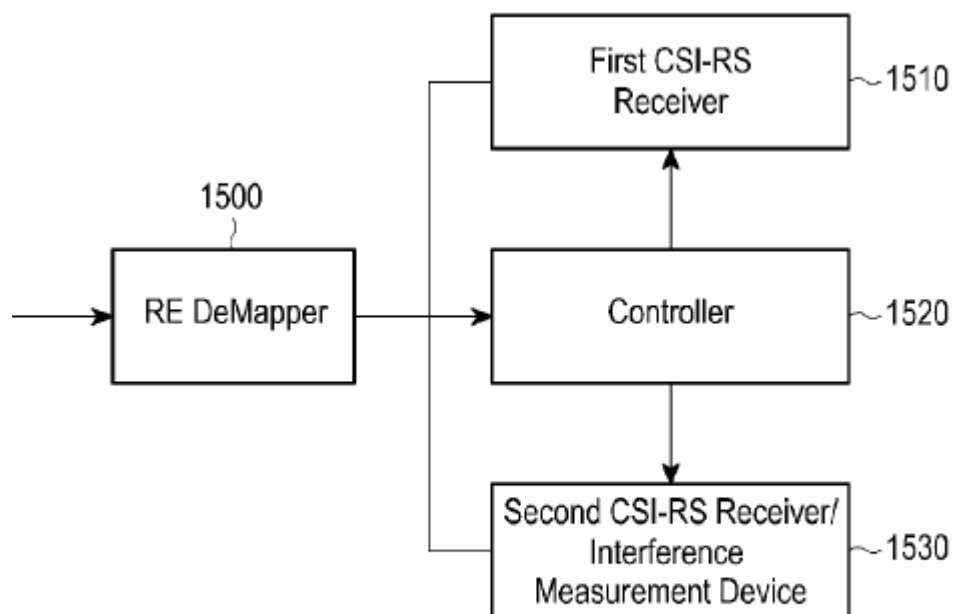


FIG.15

APPLE-1004, FIG. 15.

[11.4]

*See* [1.4]; APPLE-1003, 0179.

[11.5]

*See* [1.5]; APPLE-1003, 0180.

[11.6]

*See* [1.6]; APPLE-1003, 0181.

[11.7]

*See* [1.7]; APPLE-1003, 0182.

[11.8]

*See* [1.8]; APPLE-1003, 0183.

**[11.9]**

*See* [1.9]; APPLE-1003, 0184.

**12. Claim 12**

**[12.1]**

The Combination renders obvious and a POSITA would have understood and found obvious that in a MIMO system, some devices would contain multiple transceivers. APPLE-1004, 0132, FIG. 15; APPLE-1003, 0185; *see* [11.3], [2.1].

**[12.2]**

APPLE-1004, 0132, FIG. 15; APPLE-1003, 0186; *see* [11.3], [12.2], [2.2].

**[12.3]**

*See* [2.3]; APPLE-1003, 0187.

**[12.4]**

*See* [2.4]; APPLE-1003, 0188.

**[12.5]**

*See* [2.5]; APPLE-1003, 0189.

**13. Claim 13**

**[13.1]**

*See* [3.1], [12.1]; APPLE-1003, 0190.

**[13.2]**

*See* [3.2], [12.1]; APPLE-1003, 0191.

**14. Claim 14**

**[14.1]**

*See* [4.1], [12.1]; APPLE-1003, 0192.

**[14.2]**

*See* [4.2], [12.1]; APPLE-1003, 0193.

**15. Claim 15**

**[15]**

*See* [5]; APPLE-1003, 0194.

**16. Claim 16**

**[16.1]**

*See* [1.1], [6.1]; APPLE-1003, 0195.

**[16.2]**

*See* [1.2], [12.1]; APPLE-1003, 0196.

**[16.3]**

*See* [1.3], [12.1]; APPLE-1003, 0197.

**[16.4]**

*See* [1.4]; APPLE-1003, 0198.

**[16.5]**

*See* [1.5]; APPLE-1003, 0199.

**[16.6]**

*See* [1.6]; APPLE-1003, 0200.

**[16.7]**

*See* [1.7]; APPLE-1003, 0201.

**[16.8]**

*See* [1.8]; APPLE-1003, 0202.

**[16.9]**

*See* [1.9]; APPLE-1003, 0203.

**17. Claim 17**

**[17.1]**

*See* [2.1], [11.2]-[11.3], [12.1]; APPLE-1003, 0204.

**[17.2]**

*See* [2.2], [11.2]-[11.3], [12.1]; APPLE-1003, 0205.

**[17.3]**

*See* [2.3], [12.1]; APPLE-1003, 0206.

**[17.4]**

*See* [2.4], [12.1]; APPLE-1003, 0207.

**[17.5]**

*See* [2.5], [12.1]; APPLE-1003, 0208.

**18. Claim 18**

**[18.1]**

*See* [3.1], [12.1]; APPLE-1003, 0209.

**[18.2]**

*See* [3.2], [12.1]; APPLE-1003, 0210.

**19. Claim 19**

**[19.1]**

*See* [4.1], [12.1]; APPLE-1003, 0211.

**[19.2]**

*See* [4.2], [12.1]; APPLE-1003, 0212.

**20. Claim 20**

**[20]**

*See* [5]; APPLE-1003, 0213.

**V. PTAB DISCRETION SHOULD NOT PRECLUDE INSTITUTION**

Petitioner believes that discretionary denial is unwarranted, and yet, Petitioner intends to utilize the bifurcated briefing process contemplated by the March 26, 2025, Stewart Memorandum to rebut contentions if offered by Patent Owner to the contrary. *See, e.g. Learn about the new interim processes relating to institution in AIA proceedings* (available at <https://www.uspto.gov/about-us/events/learn-about-new-interim-processes-relating-institution-aia-proceedings>, April 24, 2025); <https://uspto.cosocloud.com/p9xpz6s4jn75/> (Video).

**VI. PAYMENT OF FEES – 37 C.F.R. §42.103**

Petitioner authorizes the Patent and Trademark Office to charge any fees to Deposit Account No. 06-1050.

## **VII. CONCLUSION**

The cited prior art references identified in this Petition contain pertinent technological teachings (both cited and uncited), either explicitly or inherently disclosed, which were not previously considered in the manner presented herein, or relied upon on the record during original examination of the '527 Patent. In sum, these references provide new, non-cumulative technological teachings which indicate a reasonable likelihood of success as to Petitioner's assertion that the Challenged Claims of the '527 Patent are not patentable pursuant to the grounds presented in this Petition. Accordingly, Petitioner respectfully requests institution of an IPR for those claims of the '527 Patent for each of the grounds presented herein.

**VIII. MANDATORY NOTICES UNDER 37 C.F.R §42.8(a)(1)**

**A. Real Party-In-Interest Under 37 C.F.R. §42.8(b)(1)**

Apple Inc. is the petitioner and the real party-in-interest.

**B. Related Matters Under 37 C.F.R. §42.8(b)(2)**

Petitioner is not aware of any disclaimers, reexamination certificates or petitions for inter partes review for the '527 Patent. The '527 Patent is the subject of a number of civil actions including: *Apex Beam Technologies LLC v. Apple Inc*, 6-24-cv-00223 (WDTX), filed April 29, 2024; *Samsung Electronics Co., Ltd. et al. v. Apex Beam Technologies LLC*, IPR2023-00603(PTAB), filed February 28, 2023; *Apex Beam Technologies LLC v. Samsung Electronics Co., Ltd. et al*, 2-24-cv-00188 (EDTX), filed June 1, 2022; *Apex Beam Technologies LLC v. ZTE Corporation*, 2-22-cv-00031 (EDTX), filed February 1, 2022; *Apex Beam Technologies LLC v. OnePlus Technology (Shenzhen) Co., Ltd.*, 2-22-cv-00032 (EDTX), filed February 1, 2022; *Apex Beam Technologies LLC v. TCT Mobile International Limited et al*, 2-21-cv-00438 (EDTX), filed November 30, 2021.

**C. Lead And Back-Up Counsel Under 37 C.F.R. §42.8(b)(3)**

Petitioner provides the following designation of counsel.

| Lead Counsel                                                                                                                                                                                                                                     | Backup counsel                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| W. Karl Renner, Reg. No. 41,265<br>Fish & Richardson P.C.<br>60 South Sixth Street, Suite 3200<br>Minneapolis, MN 55402<br>Tel: 202-783-5070<br>Fax: 877-769-7945<br>Email: <a href="mailto:IPR50095-0228IP1@fr.com">IPR50095-0228IP1@fr.com</a> | Jonathan Driesslein, Reg. No. 82,202<br>Thomas Rozylowicz, Reg. No. 50,620<br>Fish & Richardson P.C.<br>60 South Sixth Street, Suite 3200<br>Minneapolis, MN 55402<br>Tel: 202-783-5070<br>Fax: 877-769-7945<br>Email: <a href="mailto:IPR50095-0228IP1@fr.com">IPR50095-0228IP1@fr.com</a> |

**D. Service Information**

Please address all correspondence and service to the address listed above.

Petitioner consents to electronic service by email at [IPR50095-0228IP1@fr.com](mailto:IPR50095-0228IP1@fr.com).

Respectfully submitted,

Dated: May 5, 2025

/W. Karl Renner/  
W. Karl Renner, Reg. No. 41,265  
Jonathan Driesslein, Reg. No. 82,202  
Thomas Rozylowicz, Reg. No. 50,620  
Fish & Richardson P.C.  
60 South Sixth Street, Suite 3200  
Minneapolis, MN 55402  
T: 202-783-5070  
F: 877-769-7945

(Control No. IPR2025-00897)

*Attorneys for Petitioner*

**CERTIFICATION UNDER 37 CFR §42.24**

Under the provisions of 37 CFR §42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter Partes* Review totals 12,256 words, which is less than the 14,000 allowed under 37 CFR §42.24.

Dated: May 5, 2025

/W. Karl Renner/

W. Karl Renner, Reg. No. 41,265  
Jonathan Driesslein, Reg. No. 82,202  
Thomas Rozylowicz, Reg. No. 50,620  
Fish & Richardson P.C.  
60 South Sixth Street, Suite 3200  
Minneapolis, MN 55402  
T: 202-783-5070  
F: 877-769-7945

(Control No. IPR2025-00897)

*Attorneys for Petitioner*

**CERTIFICATE OF SERVICE**

Pursuant to 37 CFR §§42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on May 5, 2025, a complete and entire copy of this Petition for *Inter partes* Review, Power of Attorney, and all supporting exhibits were provided via Federal Express, to the Patent Owner by serving the correspondence address of record as follows:

Zhong Law, LLC  
51 JFK Parkway  
1<sup>st</sup> Floor West  
Short Hills, NJ 07078  
(908) 376-3104

/Crena Pacheco/

Crena Pacheco  
Fish & Richardson P.C.  
60 South Sixth Street, Suite 3200  
Minneapolis, MN 55402  
[pacheco@fr.com](mailto:pacheco@fr.com)