

# LTE

This report presents a brief summary about Dolcera's capabilities in working with standards, with LTE as an example. The taxonomy covers most of the important aspects of LTE. Also presented are examples of mapping patents to standards going to the detail of graphical analysis. Analysis of IPR declarations made to ETSI, and documents uncovered by Dolcera search is also provided.

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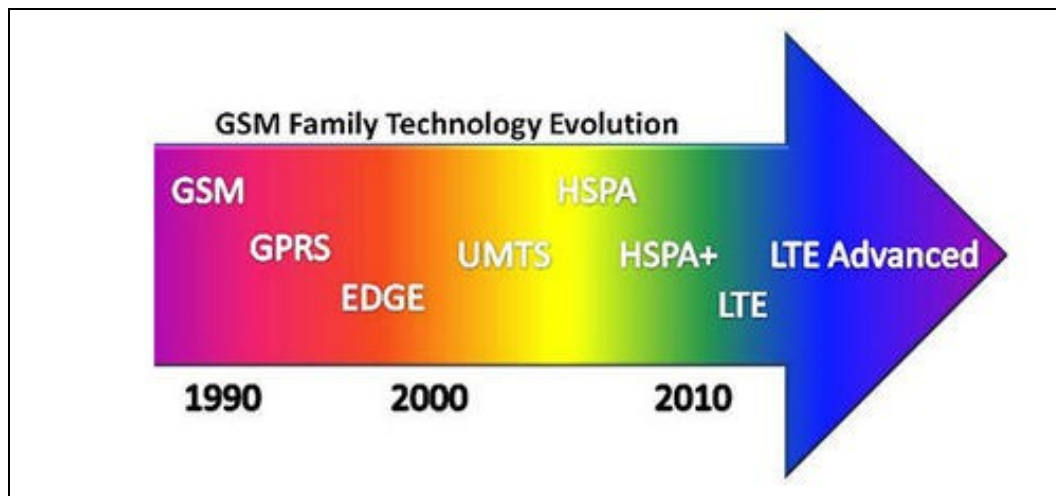
## Rationale

- LTE is the most suited mobile technology as it provides higher data rates required for the future and is an improvement over the established GSM/EDGE/HSPA systems
- LTE is promoted by major corporates as the technology enabling future communication
- The following advantages are expected to be obtained with the realization of LTE
  - ◆ Reduced cost per bit
  - ◆ Increased service provisioning - more services at lower cost with better user experience
  - ◆ Flexibility of use of existing and new frequency bands
  - ◆ Simplified architecture, Open interfaces
  - ◆ Allow for reasonable terminal power consumption

## Background description

LTE (Long Term Evolution), is the latest standard in the mobile network technology that came into existence because of the growing needs of faster data rates. It is a 3rd Generation Partnership Project (3GPP), which realized this technology. LTE is an advancement to previously realized technologies such as GSM/EDGE and UMTS/HSPA etc. Although LTE is often marketed as 4G, first-release LTE is actually a 3.9G technology since it does not fully comply with the IMT Advanced 4G requirements.

LTE-Advanced has been granted 4G compliance given the significant improvement they provide over 3G technologies [1]





### LTE Evolution

Voice traffic will be supported mainly as Voice over IP (VoIP) enabling better integration with other multimedia services. LTE is being designed to be a high data rate and low latency system. LTE is also aimed at minimizing cost and power consumption while ensuring backward-compatibility and a cost effective migration from UMTS systems. [LTE tutorial](#)

## Technical details

### Performance requirements

LTE is expected to support different types of services including web browsing, FTP, video streaming, VoIP, online gaming, real time video, push-to-talk and push-to-view. Therefore, it is being designed to be a high data rate and low latency system as indicated by the key performance criteria shown below.

|                      |   |           |
|----------------------|---|-----------|
| Access Scheme        | UL  | DFTS-OFDM |
|                      | DL  | OFDMA     |
| Bandwidth            | 1.4, 3, 5, 10, 15, 20MHz  |           |
| Minimum TTI          | 1msec   |           |
| Sub-carrier spacing  | 15kHz   |           |
| Cyclic prefix length | Short   | 4.7µsec   |
|                      | Long  | 16.7µsec  |
| Modulation           | QPSK, 16QAM, 64QAM  |           |
| Spatial multiplexing | Single layer for UL per UE<br>Up to 4 layers for DL per UE<br>MU-MIMO supported for UL and DL |           |

Fig.1

| Category                                | 1                                   | 2                  | 3  | 4   |     |
|---|-------------------------------------|--------------------|----|-----|-----|
| Peak rate Mbps                          | DL                                  | 10                 | 50 | 100 | 150 |
|   | UL                                  | 5                  | 25 | 50  | 50  |
| Capability for physical functionalities |                                     |                    |    |     |     |
| RF bandwidth                            | 20MHz                               |                    |    |     |     |
| Modulation                              | DL                                  | QPSK, 16QAM, 64QAM |    |     |     |
|   | UL                                  | QPSK, 16QAM        |    |     |     |
| Multi-antenna                           |                                     |                    |    |     |     |
| 2 Rx diversity                          | Assumed in performance requirements |                    |    |     |     |
| 2x2 MIMO                                | Not supported                       | Mandatory          |    |     |     |
| 4x4 MIMO                                | Not supported                       |                    |    |     |     |

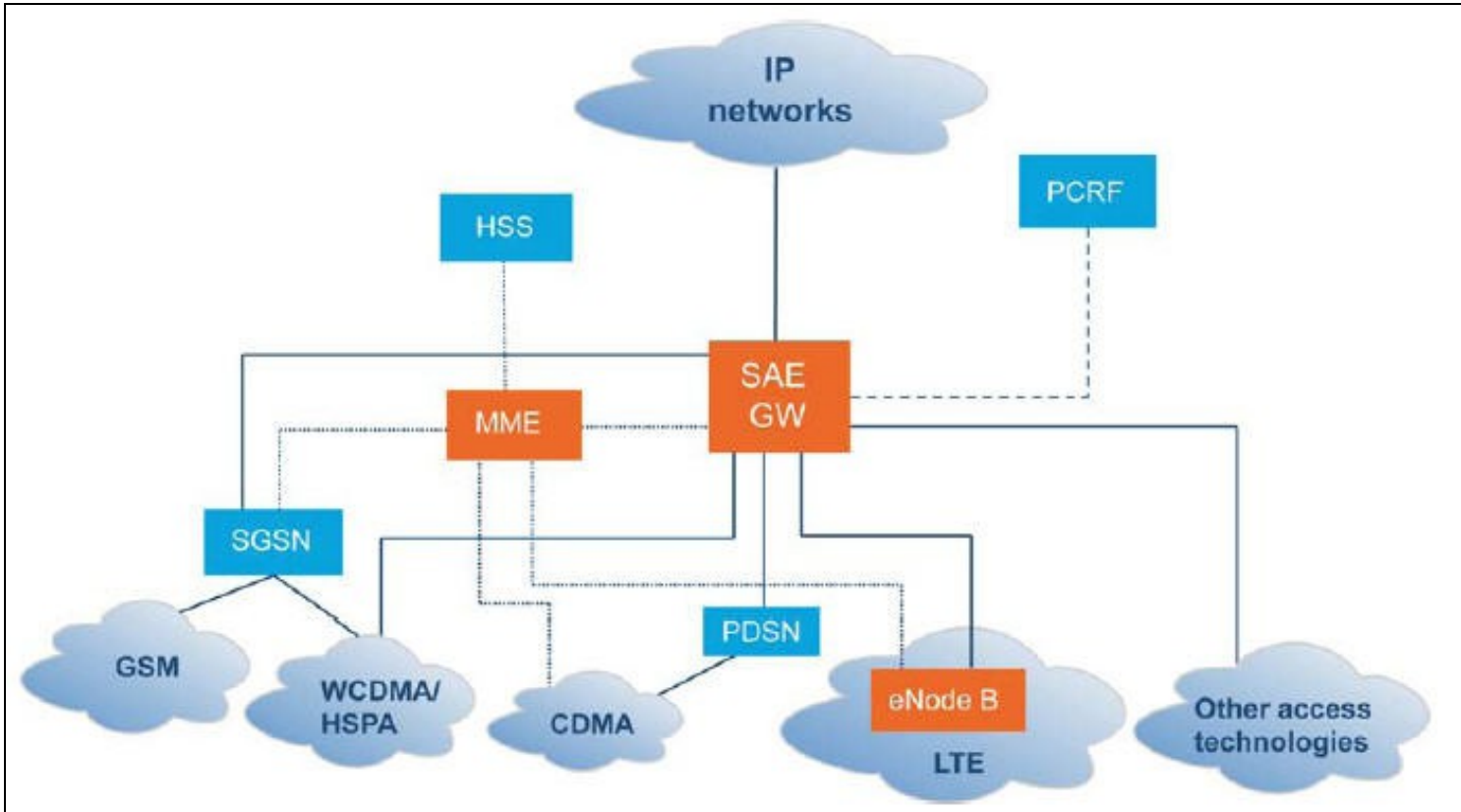
Fig.2



Fig.1 LTE Release 8 Major Parameters

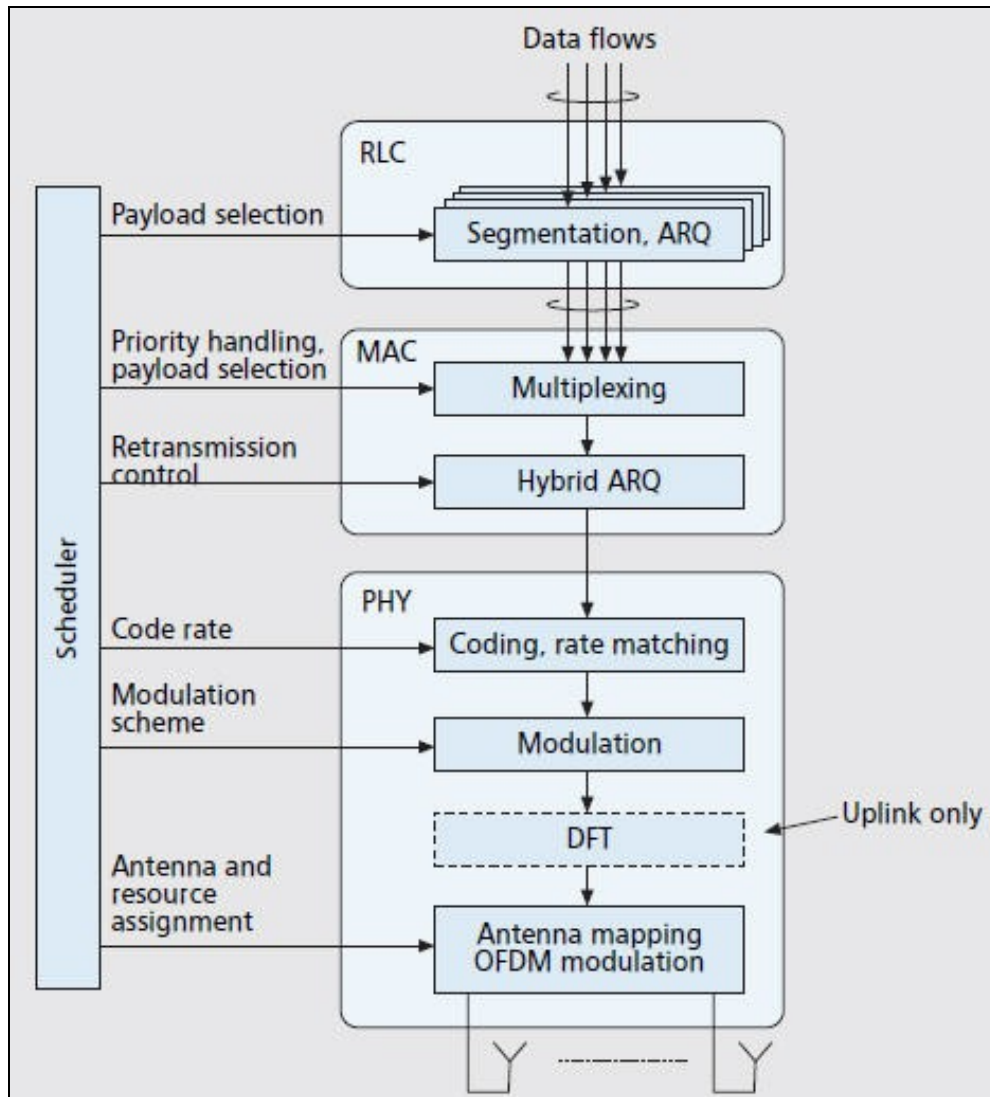
Fig.2 LTE-Release 8 User Equipment Categories

### LTE architecture



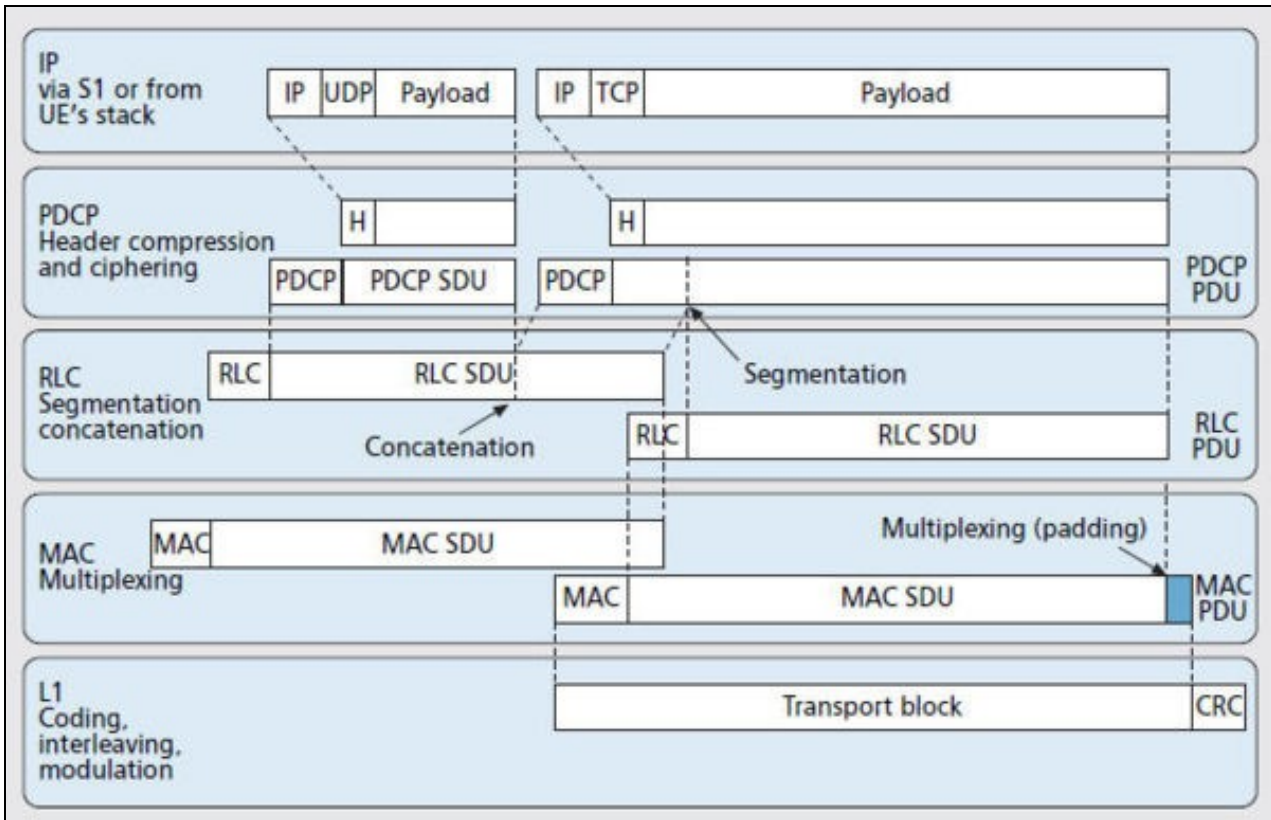
LTE architecture

## Protocol stack



### Protocol stack of LTE Data flow

The data flow through protocol stack can be shown as



Dataflow

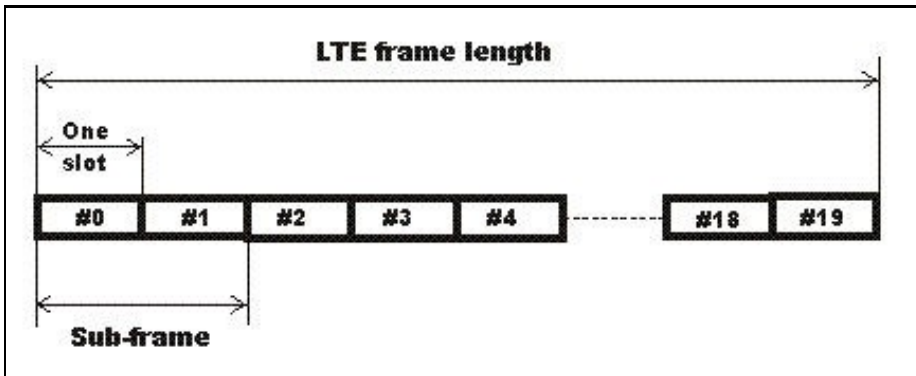
### LTE frame structure

In order to maintain synchronization and manage different types of information exchange that need to be carried between the base-station or eNodeB and the User Equipment (UE), LTE system has a defined LTE frame and sub frame structure for the E-UTRA or Evolved UMTS Terrestrial Radio Access

There are two types of LTE frame structure:

- **Type 1: FDD systems**

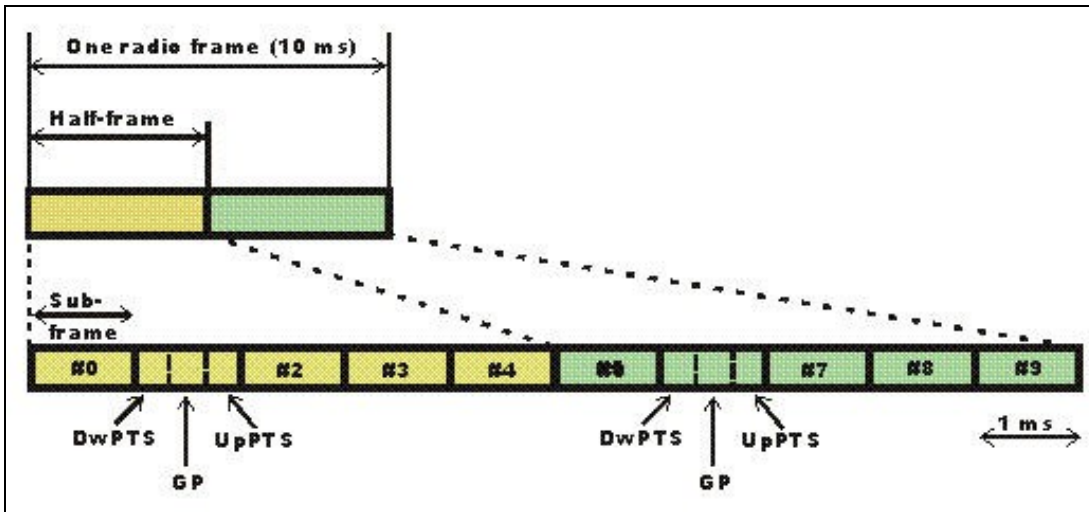
- ◆ The basic type 1 LTE frame has an overall length of 10 ms. This is then divided into a total of 20 individual slots. LTE sub frames then consist of two slots - in other words there are ten LTE sub frames within a frame.




LTE frame structure

- **Type 2: TDD systems**

- ◆ The frame structure for the type 2 frames used on LTE TDD is somewhat different. The 10 ms frame comprises two half frames, each 5 ms long. The LTE half-frames are further split into five sub frames, each 1ms long.



 LTE frame structure

- The subframes may be divided into standard sub frames of special sub frames. The special sub frames consist of three fields
  - ◆ DwPTS - Downlink Pilot Time Slot
  - ◆ GP - Guard Period
  - ◆ UpPTS - Uplink Pilot Time Slot.

## LTE enabling technologies

- **OFDMA (Orthogonal Frequency Division Multiple Access)**
  - ◆ It is used in the downlink communication of LTE as it can support high data rates
- **SC-FDMA (Single Carrier FDMA)**
  - ◆ It is used in the uplink communication of LTE as it helps in reducing terminal power consumption
- **MIMO (Multi-Input Multi-Output)**
  - ◆ Helps in obtaining increased data rates with usage of many antennas.
- **System Architecture Evolution(SAE)**
  - ◆ New core network architecture to support the high-throughput / low latency LTE access system
  - ◆ Simplified network architecture
  - ◆ All IP network
  - ◆ All services are via PS domain only, No CS domain
  - ◆ Support mobility between multiple heterogeneous access system
- **Fractional frequency reuse**
  - ◆ Helps in reusing the frequency so that spectral efficiency can be improved

## Taxonomy

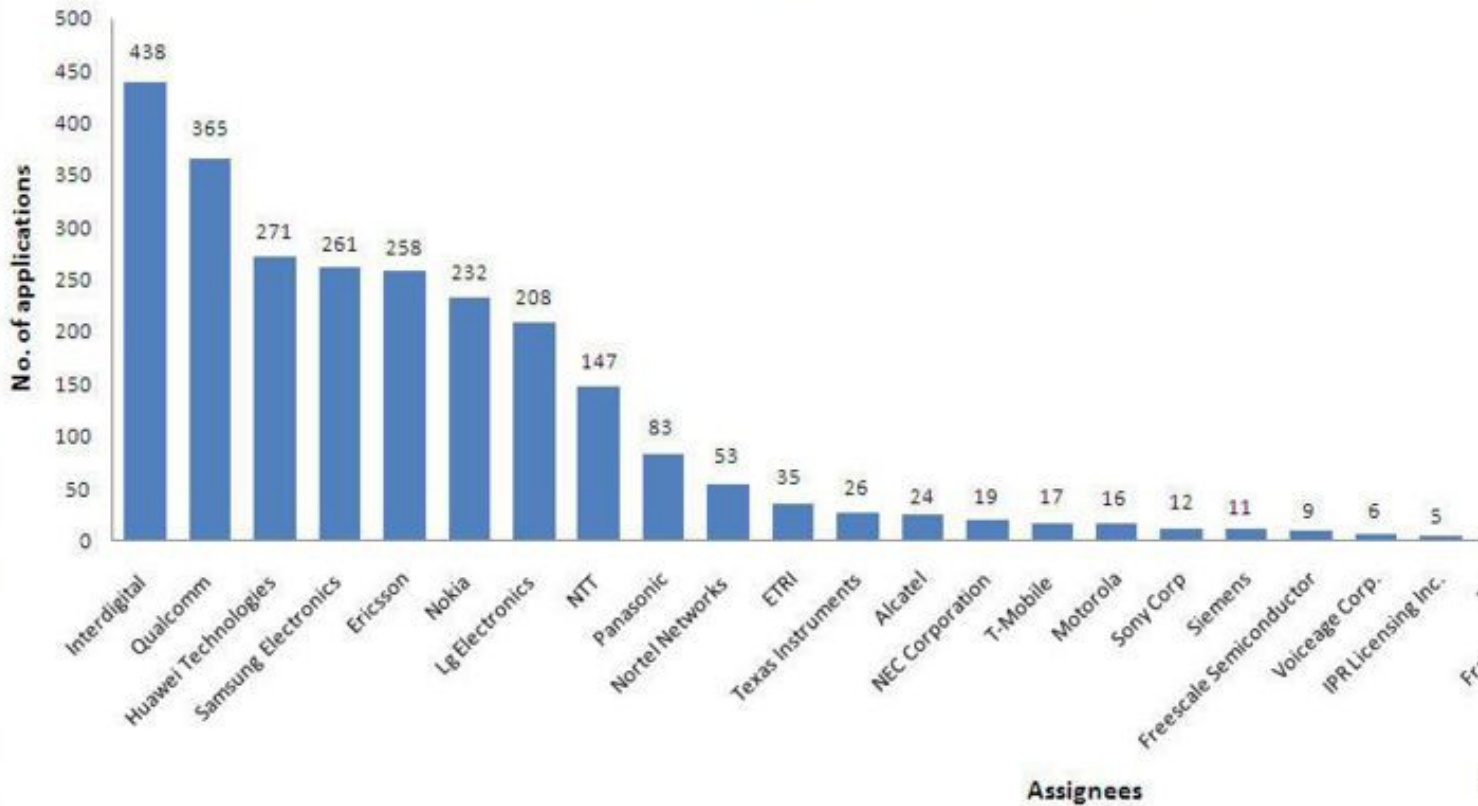
Long Term Evolution

Flash plugin or Javascript are turned off. Activate both and reload to view the mindmap

## Major players in the ETSI list for LTE



## Major Players in the ETSI list - LTE



## Relevant Documents for LTE in the ETSI list

| S.No | Publication Number          | Title   | Filing date | Expiry date | Priority Date  | Assignee/Applicant                                      | Count of Cited Refs - Patent | Rating |
|------|-----------------------------|---|-------------|-------------|--|---|------------------------------|--------|
| 1    | <a href="#">US5754976A</a>  | Algebraic codebook with signal-selected pulse amplitude/position combinations for fast coding of speech | 7/28/1995   | 7/28/2015   | 1990-02-23<br>1992-09-10<br>1995-02-06<br>1995-07-28   | Universite de Sherbrooke, Sherbrooke, CA                | 44                           | 2      |
| 2    | <a href="#">US6724976B2</a> | Communication system  | 12/21/2000  | 12/21/2020  | 1992-03-26<br>1992-09-25<br>1993-03-25<br>1993-09-27<br>1998-04-22<br>2000-02-16<br>2000-12-21               | Matsushita Electric Industrial Co. Ltd., Osaka, JP      | 110                          | 3      |
| 3    | <a href="#">US6633600B2</a> | Traffic lights in a code division multiple access (CDMA) modem  | 4/24/2001   | 4/24/2021   | 1995-06-30<br>1996-06-27<br>1998-02-17<br>1999-11-22<br>2001-04-24   | InterDigital Technology Corporation, Wilmington, DE, US | 85                           | 3      |
| 4    | <a href="#">US7190966B2</a> | Method and apparatus for performing an access procedure   | 6/29/2005   | 6/29/2025   | 1996-06-27<br>1998-01-06<br>2000-11-22<br>2002-03-01<br>2003-03-26<br>2004-06-14<br>2005-06-29               | InterDigital Technology Corporation, Wilmington, DE, US | 91                           | 4      |
| 5    | <a href="#">US7437177B2</a> | Method employed by a base station for controlling initial power ramp-up using short codes               | 3/14/2008   | 3/14/2028   | 1996-06-27<br>1998-01-06<br>2000-11-22<br>2002-03-01<br>2003-03-26<br>2004-06-14<br>2005-06-29<br>2008-03-14 | InterDigital Communications Corp., Wilmington, DE, US   | 190                          | 4      |

Disclaimer:

- Rating is given based on claims, no.of cited patents, expiry date and priority date
- Rating is done on a scale from 1 to 5

## Ranking of ETSI patents

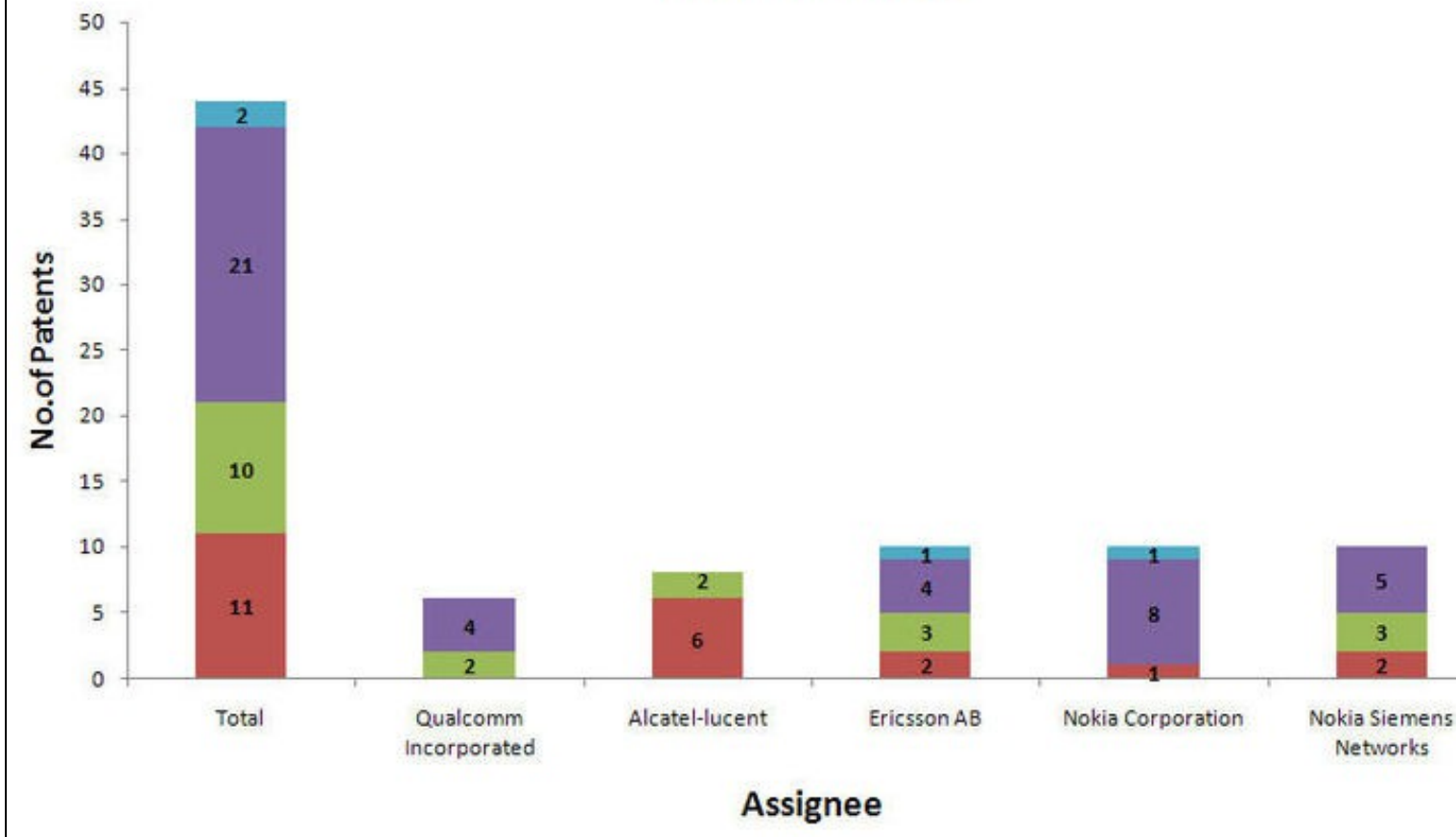
| S.No | Patent/Publication No.          | International Class (primary) | Assignee               | Title  | Publication Year | Priority Year(s)   | Legal Status                              | Rank |
|------|---------------------------------|-------------------------------|------------------------|--|------------------|--------------------|---|------|
| 1    | <a href="#">US20100182939A1</a> | H04J000300                    | Nokia Corporation      | Configuration of multi-periodicity semi-persistent scheduling for time division duplex operation in a packet-based wireless communication system | 2010             | 2008   2009        | Docketed New Case - Ready for Examination | 2    |
| 2    | <a href="#">EP2181559A1</a>     | H04W003608                    | Nokia Siemens Networks | Handover of a user equipment with forwarding and reusing a user equipment configuration  | 2010             | 2007   2008   2008 | Request for Examination Filed             | 2    |
| 3    | <a href="#">EP1961141A2</a>     | H04L000100                    | Ericsson AB            | Efficient channel quality reporting and link adaptation for multi-carrier broadband wireless communication                                       | 2008             | 2005   2006   2006 | Request for Examination Filed             | 2    |
| 4    | <a href="#">US20110029834A1</a> | H04L000118                    | Alcatel-Lucent         | Method for operating harq buffer   | 2011             | 2008   2009   2009 | Docketed New Case - Ready for Examination | 2    |
| 5    | <a href="#">US20090086710A1</a> | H04J000324                    | Qualcomm Incorporated  | Method and apparatus for implementing lte rlc header formats   | 2009             | 2007   2008        | Docketed New Case - Ready for Examination | 3    |

[Click here to see full list of Ranking of ETSI patents](#)

**Disclaimer: Patent ranking has been done according to the following logic:**

- **Rank-1:** Granted + LTE related (claims)
- **Rank-2:** Published + LTE related (claims)
- **Rank-3:** LTE related (Full spec )
- **Rank-4:** May be relevant and requires further analysis
- **Rank-5:** Abandoned or Expired

## Patent Ranking

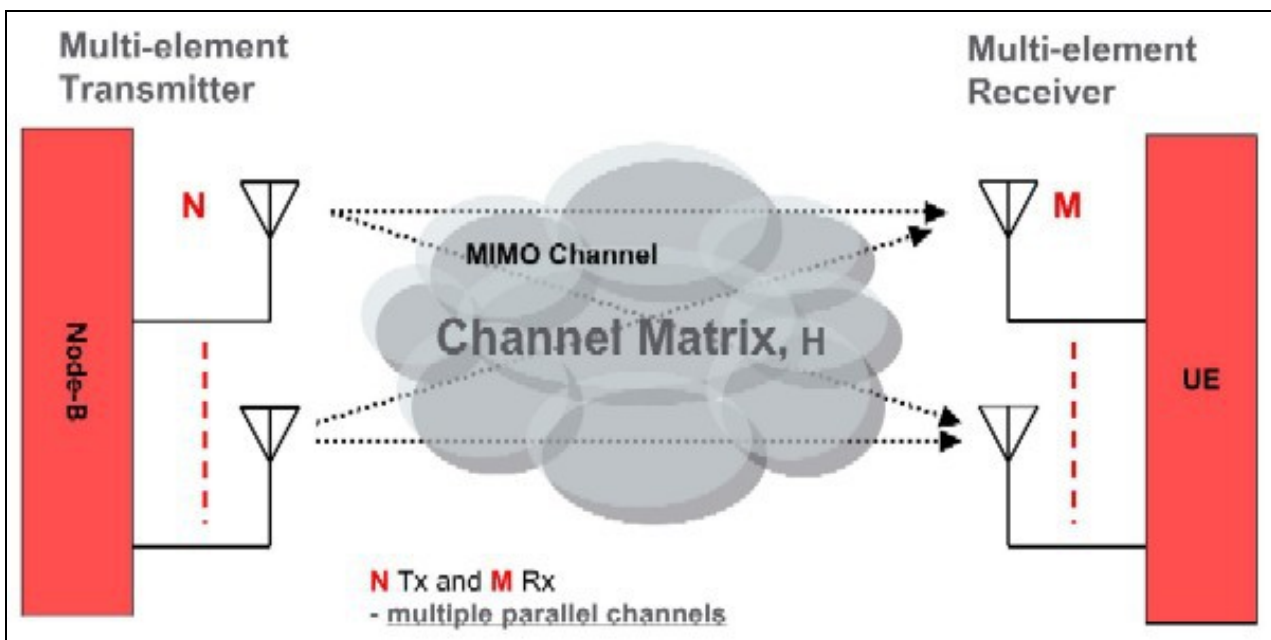


**Note:** Here a total of 44 patents from ETSI have been taken, out of which **Qualcomm Incorporated** has 6 patents, **Alcatel-lucent** has 8 patents, **Ericsson AB**, **Nokia corporation**, **Nokia Siemens Networks** have 10 each

## MIMO(Multiple Input Multiple Output)

Multiple input multiple output (MIMO) technologies introduced in LTE such as spatial multiplexing, transmit diversity, and beamforming are key components for providing higher peak rate at a better system efficiency, which are essential for supporting future broadband data service over wireless links. In Long Term Evolution (LTE), MIMO technologies have been widely used to improve downlink peak rate, cell coverage, as well as average cell throughput.

To achieve this diverse set of objectives, LTE adopted various MIMO technologies including transmit diversity, single user (SU)-MIMO, multiuser (MU)-MIMO, closed-loop rank-1 precoding, and dedicated beamforming. [MIMO in LTE](#)







|    |  |
|----|--|
| 16 | beam adj2<br>steer*                        |
| 17 | smart adj<br>antenna*1                     |
| 18 | spatial adj<br>multiplex*3                 |
| 19 | multiple adj<br>transmit* adj<br>antenna*1 |
| 20 | multiple adj<br>receive* adj<br>antenna*1  |
| 21 | Adaptive adj2<br>antenna adj2<br>steer*    |
| 22 | beam adj2<br>forming                       |
| 23 | eigenmode<br>adj2<br>multiplex*            |

## Control patents

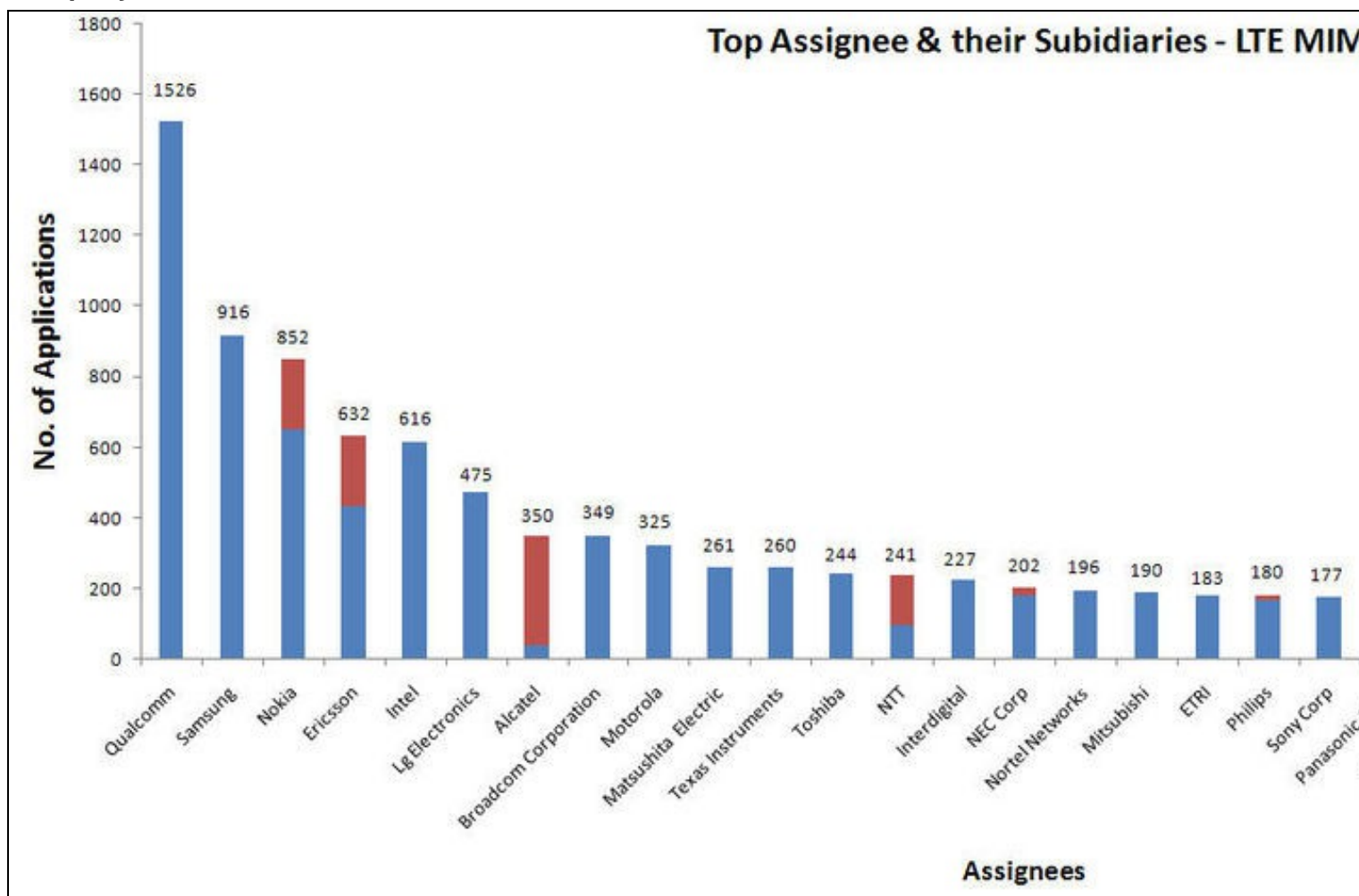
- Control patents are mostly used
  - ◆ to prepare concepts
  - ◆ to search classes, and
  - ◆ to verify the search strategy
- Control patents are found by running a query with narrow keywords, and in this process litigation's and file wrappers are also looked at.

| S.No | Patent/Publication No.    | Title  | Abstract  |
|------|---------------------------|--|---|
| 1    | <a href="#">US6873606</a> | Rate adaptive transmission scheme for MIMO systems   | A rate adaptive transmission scheme for MIMO systems, which can transmit a variable number of data symbol streams, provide transmit diversity for each data symbol stream, and fully utilize the total transmit power of the system and the full power of each antenna. In one method, at least one data symbol stream is received for transmission from a plurality of antennas. Each data symbol stream is scaled with a respective weight corresponding to the amount of transmit power allocated to that stream. The scaled data symbol stream(s) are multiplied with a transmit basis matrix to provide a plurality of transmit symbol streams for the plurality of antennas. The transmit basis matrix (e.g., a Walsh-Hadamard matrix or a DFT matrix) is defined such that each data symbol stream is transmitted from all antennas and each transmit symbol stream is transmitted at (or near) the full power for the associated antenna. |
| 2    | <a href="#">US7233625</a> | Preamble design for multiple input--multiple output (MIMO), orthogonal frequency division multiplexing (OFDM) system         | One or more preambles are inserted into frames of Orthogonal Frequency Multiplexing (OFDM)-Multiple Input, Multiple Output (MIMO) signals. The preamble is received by the antennas of a receiver, decoded and compared to known values to provide synchronization, framing, channels estimation, offsets and other corrections to the transmitted signal.  |
| 3    | <a href="#">US7248559</a> | Scattered pilot pattern and channel estimation method for MIMO-OFDM systems  | A method and apparatus are provided for reducing the number of pilot symbols within a MIMO-OFDM communication system, and for improving channel estimation within such a system. For each transmitting antenna in an OFDM transmitter, pilot symbols are encoded so as to be unique to the transmitting antenna. The encoded pilot symbols are then inserted into an OFDM frame to form a diamond lattice, the diamond lattices for the different transmitting antennae using the same frequencies but being offset from each other by a single symbol in the time domain. At the OFDM receiver, a channel response is estimated for a symbol central to each diamond of the diamond lattice using a two-dimensional interpolation. The estimated channel responses are smoothed in the frequency domain. The channel responses of remaining symbols are then estimated by interpolation in the frequency domain.                                 |
| 4    | <a href="#">US7548506</a> | System access and synchronization methods for MIMO OFDM communications systems and physical layer packet and preamble design | A method and apparatus are provided for performing acquisition, synchronization and cell selection within an MIMO-OFDM communication system. A coarse synchronization is performed to determine a searching window. A fine synchronization is then performed by measuring correlations between subsets of signal samples, whose first signal sample lies within the searching window, and known values. The correlations are performed in the frequency domain of the received signal. In a multiple-output OFDM system, each antenna of the OFDM transmitter has a unique known value. The known value is transmitted as pairs of consecutive pilot symbols, each pair of pilot symbols being transmitted at the same subset of sub-carrier frequencies within the OFDM frame.   |
| 5    | <a href="#">US7120395</a> | MIMO communications  | The present invention allows a wireless communication system, such as a base station, to select N antennas from an associated group of M antennas for transmitting multiple streams of data to a given user. Based on the channel conditions between the M antennas of the wireless communication system and the multiple antennas at the receiver, the N antennas to use for transmission are selected to enhance channel capacity, signal-to-noise ratios, or a combination thereof. The channel conditions are measured at the receiver, and may be sent back to the wireless communication system for processing or may be processed at the receiver, wherein instructions are transmitted back to the wireless communication system to control antenna selection.  |

[Click here to see full list of LTE control patents](#)

## Search Strategy - MIMO

### Company wise distribution of IP



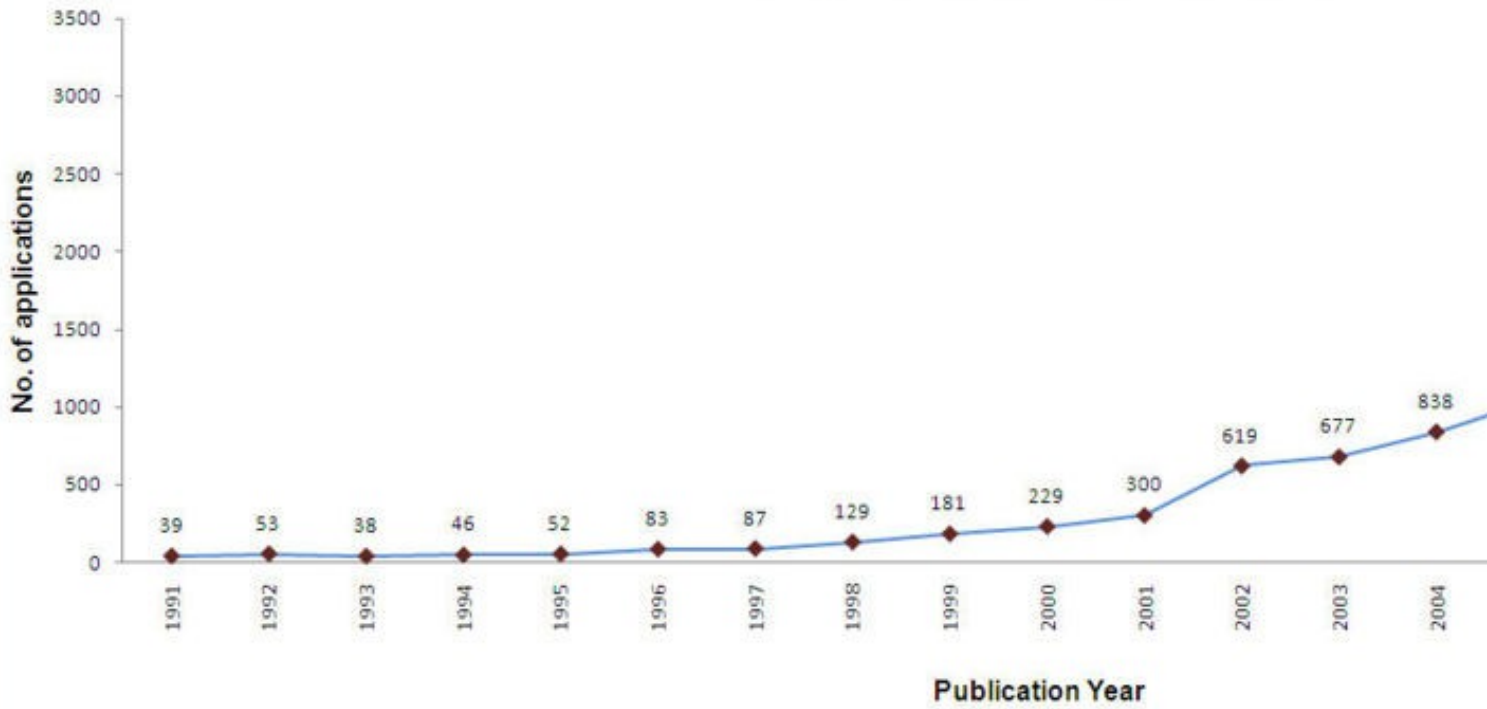
Company wise distribution of IP

**Note:**

- The subsidiaries of Nokia includes : Nokia Telecommunication Oy and Nokia Siemens.
- The subsidiaries of Ericsson/LM Ericsson includes : Ericsson GE Mobile Communications Inc, ST-Ericsson, Sony Ericsson.
- The Subsidiaries of Alcatel includes : Alcatel-Lucent, Alcatel Shangai bell company, Alcatel Transmission, Lucent Technologies, CIT Alcatel.
- The Subsidiaries of NTT includes : Nippondenso Co, NTT Docomo.
- The subsidiaries of NEC Corp includes : NEC Access technica Ltd., NEC Laboratories.
- The subsidiaries of Philips includes : Philips Electronics, Philips Intellectual property & standards.
- The subsidiaries of Fujitsu includes : Fujistu ten Limited, Fujitsu Microelectronics Limited.
- The subsidiaries of AT&T includes : AT&T Mobility, AT & T BLS Intellectual Property, AT&T Bell Laboratories, AT&T Wireless Services Inc., BellSouth Intellectual Property Corporation.

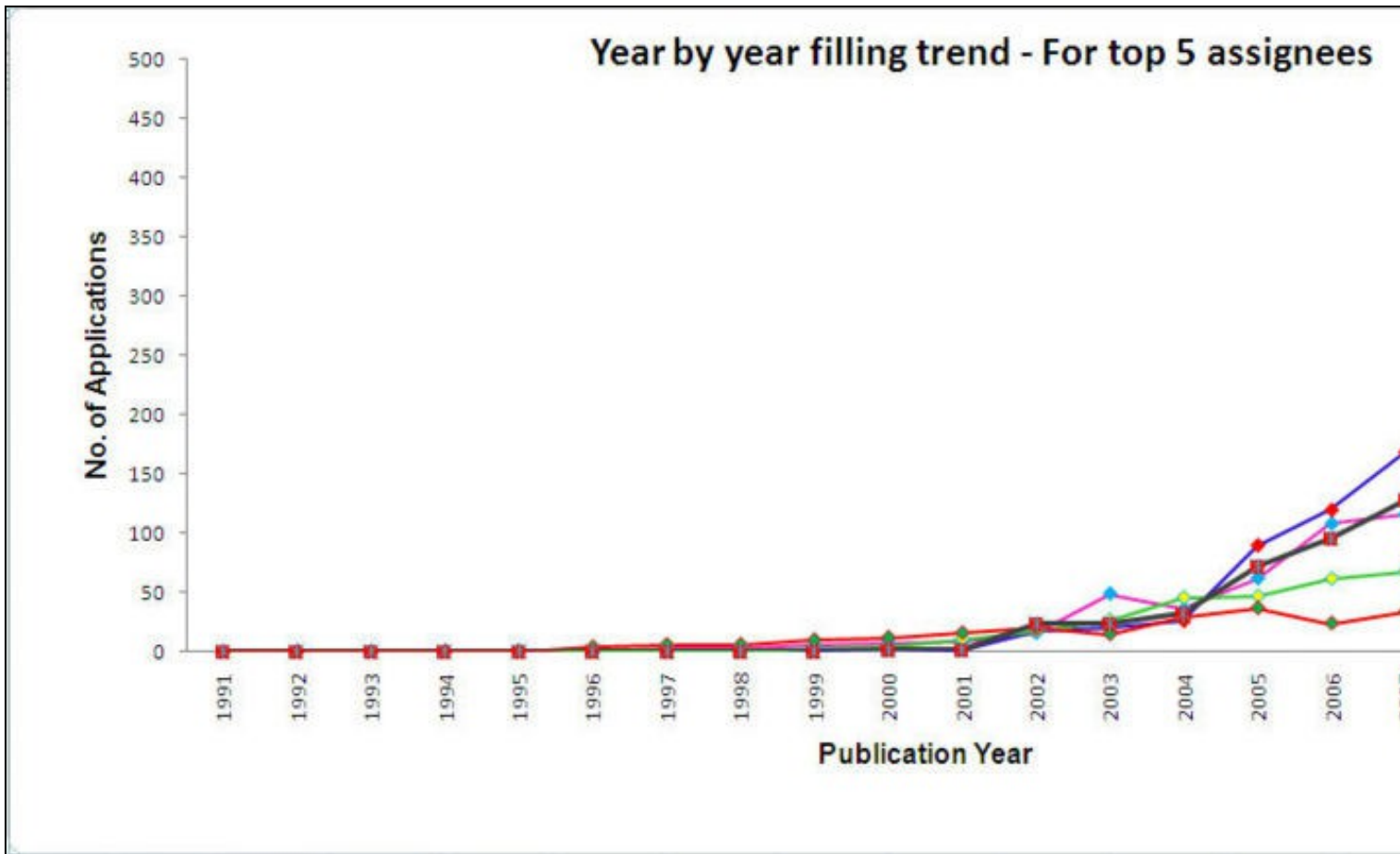
### Filing trends over the years

### Filling trends over time - LTE MIMO

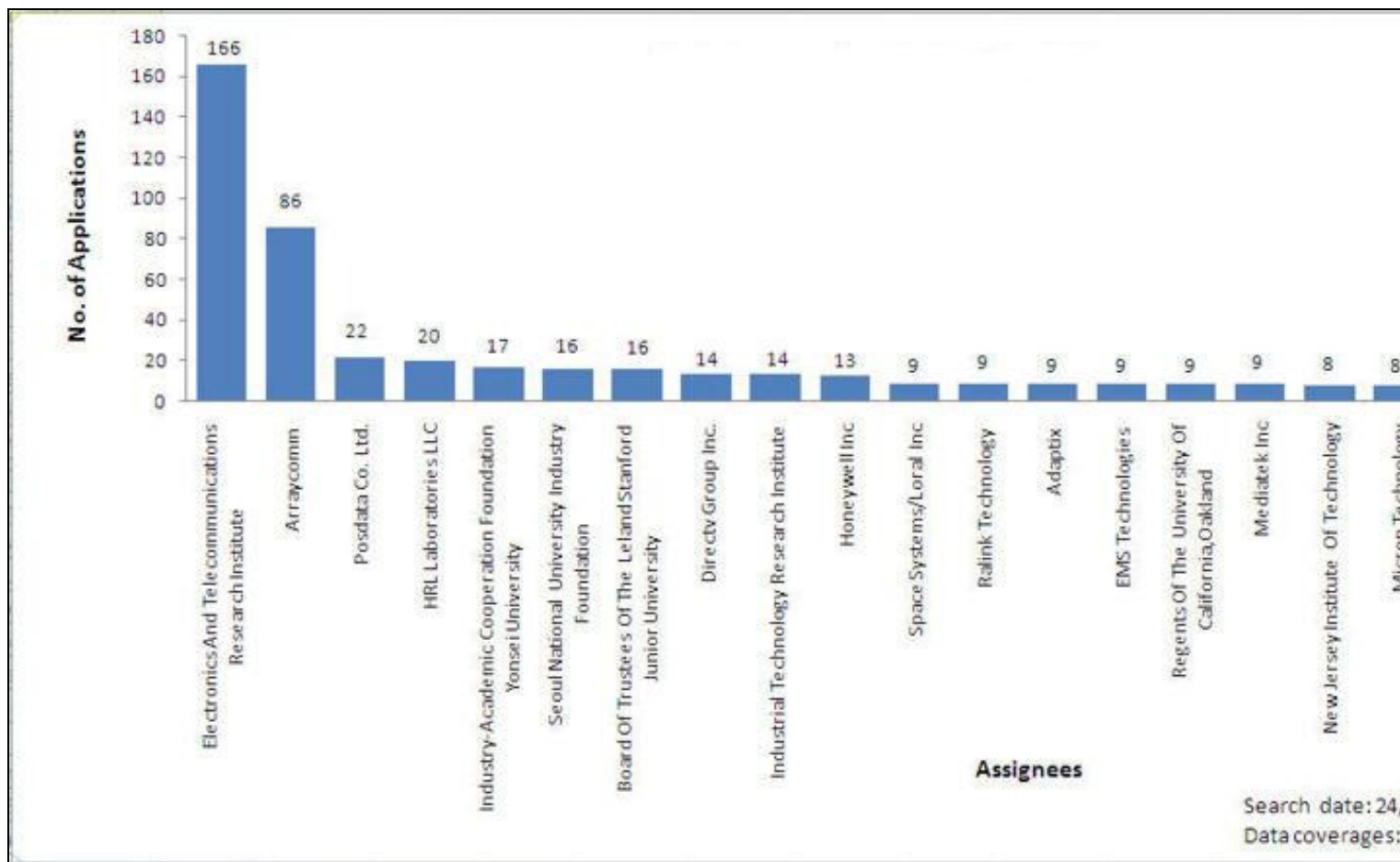


Filing trends over the years

### Year by year trends of top 5 companies



## Companies with relevant IP for further analysis



**Disclaimer 1:** Here primarily, companies with an average annual revenue less than 400 million USD are considered. In addition to these, some big companies whose primary interest is not LTE and those which provide IP licensing are also considered.

**Disclaimer 2:** The above graph is based on raw data available with us. Some of the patents may not be relevant

## Most cited documents in non-ETSI list for MIMO

| S.No | Patent/Publication No.      | Title  | Priority Date                        | Assignee/Applicant   | Count of Citing Patents |
|------|-----------------------------|--|--------------------------------------|--|-------------------------|
| 1    | <a href="#">US5541955A</a>  | Adaptive data rate modem   | 1992-11-06   1995-04-28              | Pericle Communications Company                                 | 272                     |
| 2    | <a href="#">US5999561A</a>  | Direct sequence spread spectrum method, computer-based product, apparatus and system tolerant to frequency | 1997-05-20   1997-07-08   1997-09-15 | Sanconix Inc   | 161                     |
| 3    | <a href="#">US752164A</a>   | Autonomous remote measurement unit for a personal communications service system                            | 1992-04-27   1995-04-25              | American PCS L   | 146                     |
| 4    | <a href="#">US4441180A</a>  | Service integrated communication transmission and interchange system                                       | 1979-06-01   1980-05-30              | Licentia Patent Verwaltungs GmbH                               | 134                     |
| 5    | <a href="#">US6072994A</a>  | Digitally programmable multifunction radio system architecture   | 1995-8-31                            | Northrop Grumman Corporation                                   | 133                     |
| 6    | <a href="#">US6314147B1</a> | Two-stage CCI/ISI reduction with space-time processing in TDMA cellular networks                           | 1997-11-04   1998-11-04              | The Board of Trustees of the Leland Stanford Junior University | 132                     |
| 7    | <a href="#">US5859878A</a>  | Common receive module for a programmable digital radio   | 1995-8-31                            | Northrop Grumman Corporation                                   | 131                     |
| 8    | <a href="#">US5345471A</a>  | Ultra-wideband receiver  | 1993-12-4                            | The Regents of the University of California                    | 130                     |
| 9    | <a href="#">US5694134A</a>  | Phased array antenna system including a coplanar waveguide feed arrangement                                | 1992-12-01   1993-10-21              | Superconducting Core Technologies, Inc.                        | 128                     |

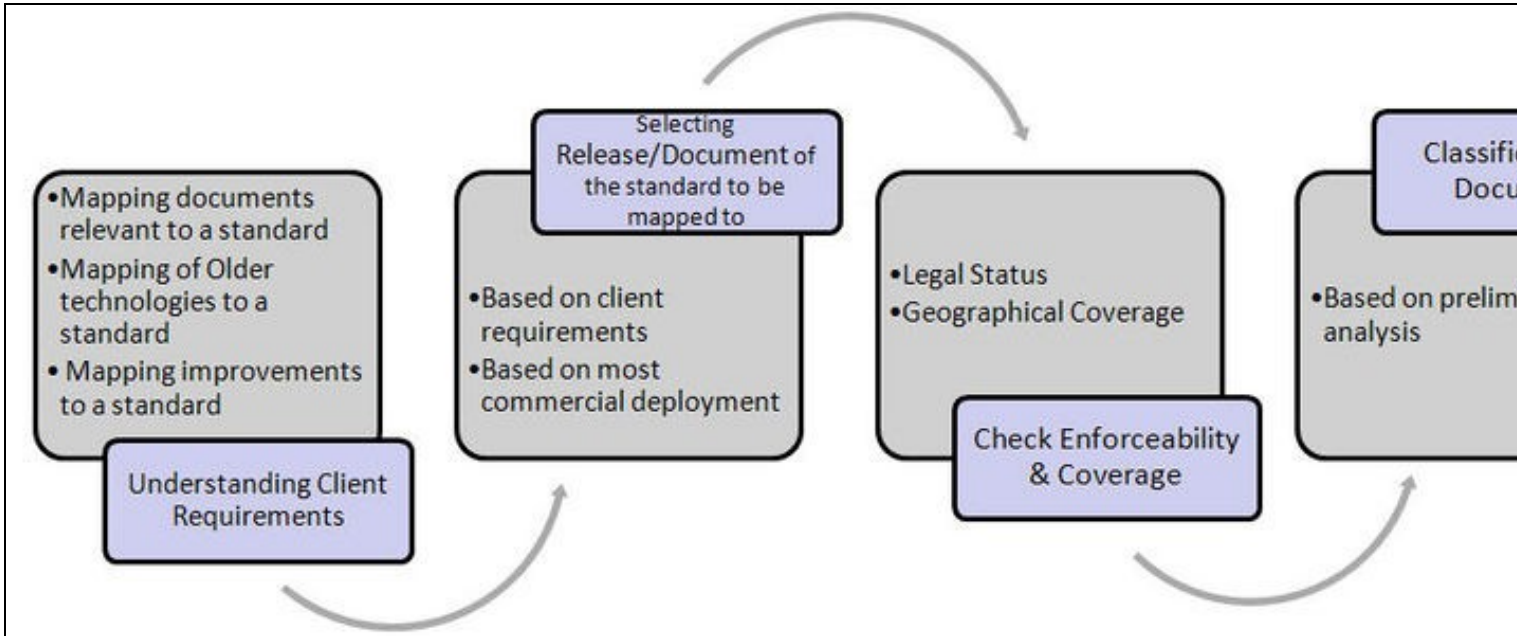
|    |                            |   |                         |                            |     |
|----|----------------------------|---|-------------------------|----------------------------|-----|
|    |                            |   | 1994-01-14              |                            |     |
| 10 | <a href="#">US5347286A</a> | Automatic antenna pointing system based on global positioning system (GPS) attitude information | 1992-02-13   1993-03-19 | Trimble Navigation Limited | 115 |

### Patent mapping by graphical analysis

| Sno. | Patent/Publication No.          | Title  | Figure analyzed | Analyzed result                                       | Standard mapped into      |
|------|---------------------------------|--|-----------------|---|---------------------------|
| 1    | <a href="#">US20070217538A1</a> | Systems and methods for improving performance of multiple spatial communication channels | Figure 4        | DL data rate: 220 M bps for 3x3 advanced MIMO-SVD     | LTE release 8, category 4 |
| 2    | <a href="#">US20090232229A1</a> | Device, system and method of resource allocation in a wireless network                   | Figure 2A       | DL data rate: 210 M bps for a 2x2 MIMO at cell centre | LTE release 8, category 5 |

### Claim Mapping

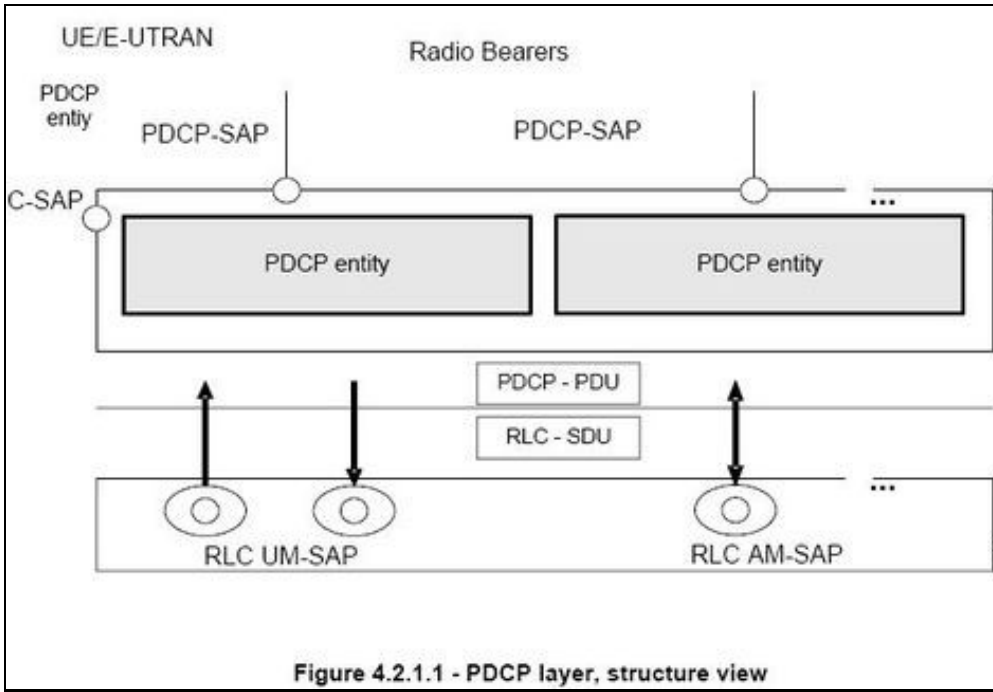
#### Process Flow



### Sample claim charting

| S.No. | Patent/Publication No. | Claim Language  | Relevant Section in LTE release 8  |
|-------|------------------------|---|--|
|       |                        | Claim1  | 4.2.1 PDCP structure 3GPP TS 36.323 V8.6.0 (2009-06) Packet Data Convergence Protocol (PDCP) specification (Release 8) |
|       |                        | A data communication method in a wireless communication system, the method comprising: receiving, from a lower layer, |  |





a data unit having a sequence number; storing the received data unit in a buffer;

4.3.2 Services expected from lower layers 3GPP TS 36.323 V8.6.0 (2009-06) Packet Data Convergence Protocol (PDCP) specification (Release 8)

in-sequence delivery, except at re-establishment of lower layers;

determining whether the sequence number of the received data unit is equal to a sequence number +1 from a sequence number of a last delivered data unit;

5.1.2 DL Data Transfer Procedures 3GPP TS 36.323 V8.6.0 (2009-06) Packet Data Convergence Protocol (PDCP) specification (Release 8)

set Next\_PDCP\_RX\_SN to the received PDCP SN + 1;

and delivering, in ascending order, all stored data units with consecutively associated sequence numbers greater than or equal to the sequence number of the received data unit based on the determining step.

5.1.2 DL Data Transfer Procedures 3GPP TS 36.323 V8.6.0 (2009-06) Packet Data Convergence Protocol (PDCP) specification (Release 8)

deliver to upper layers in ascending order of the associated COUNT value

Claim2

4.2.1 PDCP structure 3GPP TS 36.323 V8.6.0 (2009-06) Packet Data Convergence Protocol (PDCP) specification (Release 8)

The method of claim 1, wherein the lower layer is a Radio Link Control (RLC) layer.

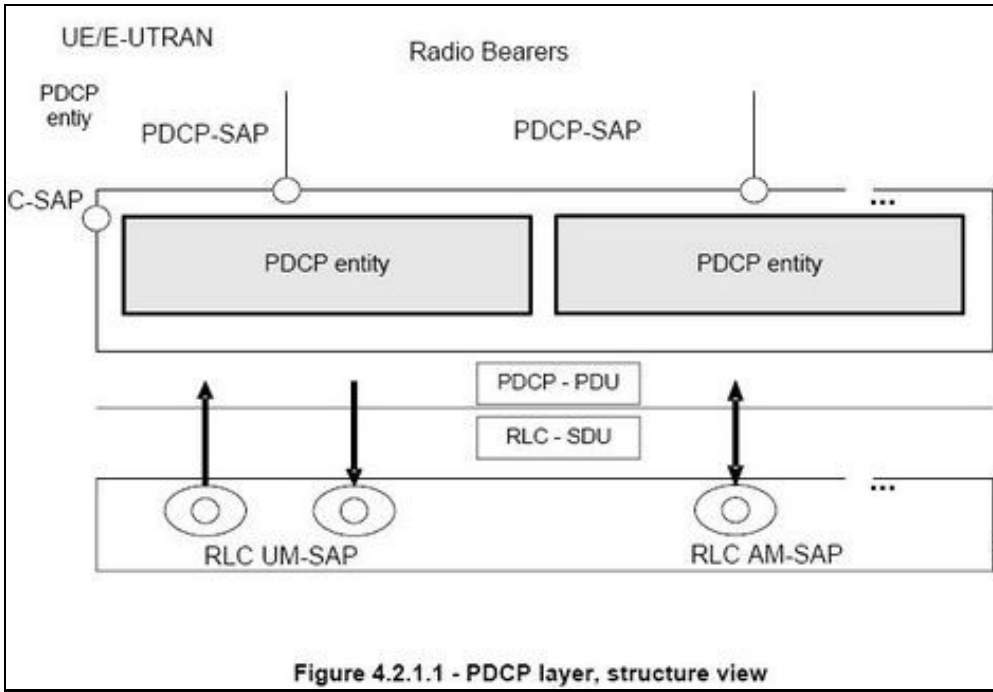


Figure 4.2.1.1 - PDCP layer, structure view

Claim3

4.2.2 PDCP entities 3GPP TS 36.323 V8.6.0 (2009-06) Packet Data Convergence Protocol (PDCP) specification (Release 8)

The method of claim 1, wherein the steps of determining and delivering are performed in a Packet Data Convergence Protocol (PDCP) entity.

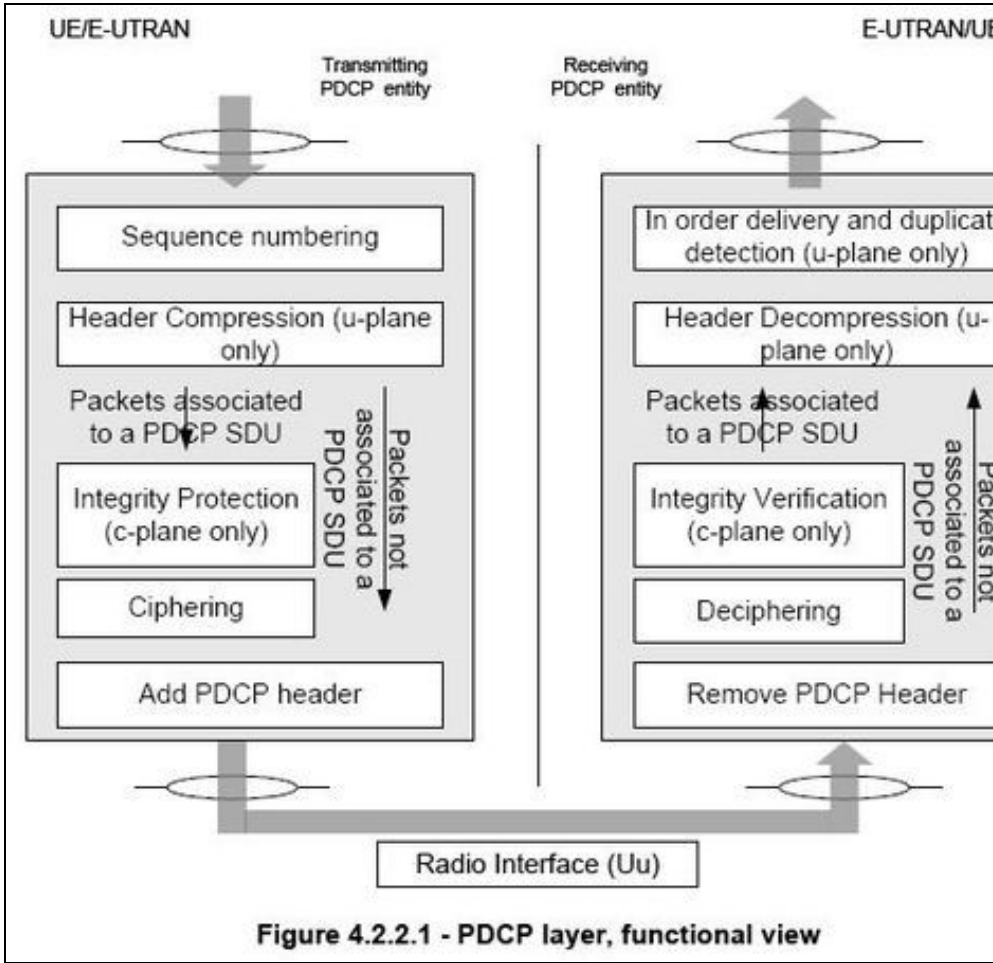
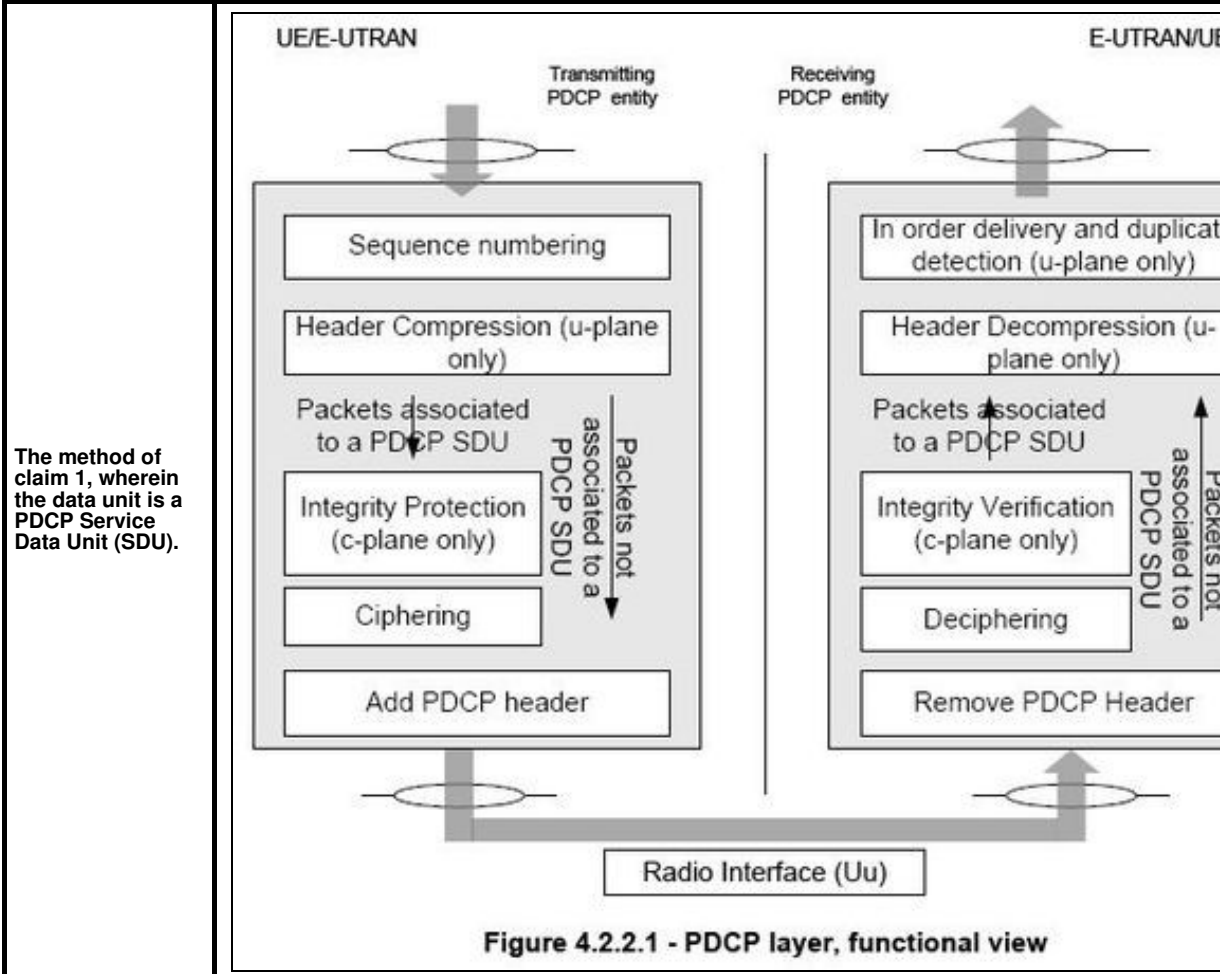


Figure 4.2.2.1 - PDCP layer, functional view

Claim4

4.2.2 PDCP entities 3GPP TS 36.323 V8.6.0 (2009-06) Packet Data Convergence Protocol (PDCP) specification (Release 8)



|  |  |
|--|--|
| Claim5   | <b>4.4 Functions 3GPP TS 36.323 V8.6.0 (2009-06) Packet Data Convergence Protocol (PDCP) specification (Release 8)</b>   |
| The method of claim 1, wherein the data unit is received through a RLC re-establishment.   | duplicate elimination of lower layer SDUs at re-establishment of lower layers for radio bearers mapped on AM   |
| Claim6   | <b>5.1.2 DL Data Transfer Procedures 3GPP TS 36.323 V8.6.0 (2009-06) Packet Data Convergence Protocol (PDCP) specification (Release 8)</b>   |
| The method of claim 1, wherein a header decompression or a deciphering is performed between the receiving step and the storing step.                                     | <p>if received PDCP SN &gt; Next_PDCP_RX_SN: - decipher the PDCP PDU as specified in the subclause 5.6, using COUNT based on RX_HFN - 1 and the received PDCP SN;</p> <p>---</p> <p>if the PDCP PDU has not been discarded in the above:</p> <ul style="list-style-type: none"> <li>- perform deciphering and header decompression (if configured) for the PDCP PDU as specified in the subclauses 5.6 and 5.5.5, respectively;</li> <li>- if a PDCP SDU with the same PDCP SN is stored:</li> <li>- discard this PDCP SDU;</li> <li>- else: - store the PDCP SDU;</li> </ul> <p>---</p> |
| Claim7   | <b>5.1.2 DL Data Transfer Procedures 3GPP TS 36.323 V8.6.0 (2009-06) Packet Data Convergence Protocol (PDCP) specification (Release 8)</b>   |
| The method of claim 1, wherein the sequence number +1 indicates a sequence number that is immediately subsequent to the sequence number of the last delivered data unit. | set Next_PDCP_RX_SN to the received PDCP SN + 1;   |

|  |  |   |
|--|--|---|
|  | <b>Claim8</b>  |   |
|  | The method of claim 1, wherein the sequence number +1 indicates a next sequence number from the sequence number of the last delivered data unit. |   |
|  | <b>Claim9</b>  | 5.1.2 DL Data Transfer Procedures 3GPP TS 36.323 V8.6.0 (2009-06) Packet Data Convergence Protocol (PDCP) specification (Release 8) |
|  | The method of claim 1, further comprising: setting a sequence number of a last data unit delivered to an upper layer as a 'LAST'.                | set Last_Submitted_PDCP_RX_SN to the PDCP SN of the last PDCP SDU delivered to upper layers   |

- Click [here](#) to download the excel sheet.
- Click [here](#) to download the release for 3GPP TS 36.323 V8.6.0 (2009-06) Packet Data Convergence Protocol (PDCP) specification (Release 8)

## Ranking of Non ETSI patents

| Sno. | Patent/Publication No.          | US Class (primary) | Title  | Publication Year | Priority Year(s) | Legal status                              | Rank |
|------|---------------------------------|--------------------|--|------------------|------------------|---|------|
| 1    | <a href="#">US7548730B2</a>     | 375267             | Systems and methods for improving performance of multiple spatial communication channels | 2007             | 2006             | Patented Case                             | 1    |
| 2    | <a href="#">US20090232229A1</a> | 375260             | Device, system and method of resource allocation in a wireless network                   | 2009             | 2008             | Docketed New Case - Ready for Examination | 2    |
| 3    | <a href="#">US20080187066A1</a> | 375267             | Detection method and apparatus for a multi-stream MIMO                                   | 2008             | 2007             | Non Final Action Mailed                   | 2    |
| 4    | <a href="#">US7796546B2</a>     | 370315             | Apparatus and method for supporting multiple links in a network using frequency bands    | 2007             | 2006             | Patented Case                             | 4    |

**Disclaimer: Patent ranking has been done according to the following logic:**

- **Rank-1:** Granted + LTE related (claims)
- **Rank-2:** Published + LTE related (claims)
- **Rank-3:** LTE related (Full spec)
- **Rank-4:** May be relevant and requires further analysis
- **Rank-5:** Abandoned or Expired

## Interactive Taxonomy

LTE

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 Note: This interactive taxonomy consists of 131 sample documents.

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- Data Filters:** A tree view on the left showing categories like 'Parts (83)', 'Rotor (73)', and 'Stator (69)'.
- Information:** A table of patent entries with columns for 'Publication', 'Title', and 'Assignee'. The selected entry is US6448735B1, titled 'Controller for a wound rotor slip ring induction machine'.
- Different Views:** Buttons for 'Patent Charts', 'Patents', and 'Articles'.
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- Document PDF:** A callout pointing to a 'Document PDF' button next to the selected patent entry.
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## LTE Release 8

LTE Release 8

## Meeting minutes

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