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.

Contents

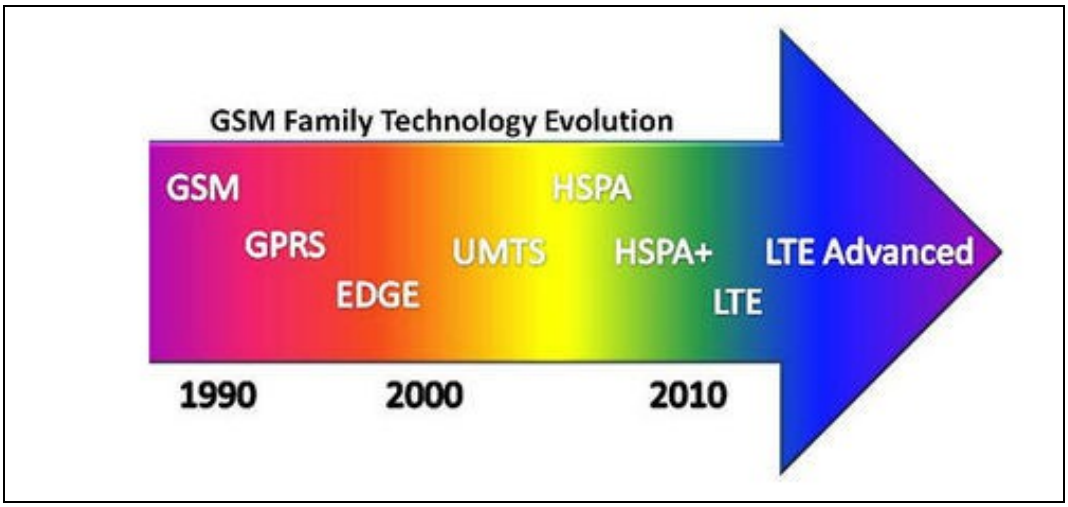
Rationale

- 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/HSxPA 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 Up to 4 layers for DL per UE MU-MIMO supported for UL and DL

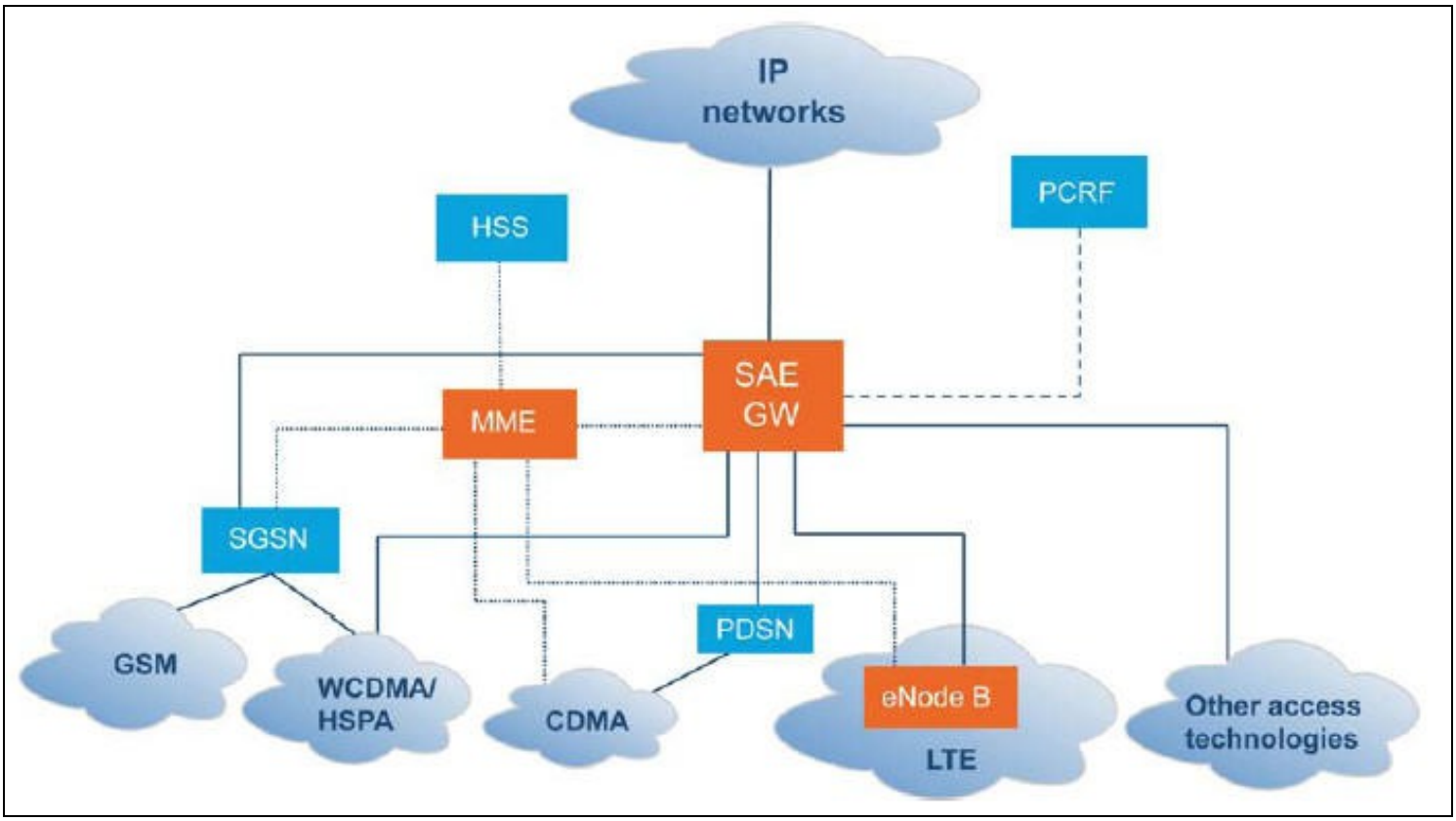
Fig.1

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 requirement			
2x2 MIMO		Not supported	Mandatory		
4x4 MIMO		Not supported			

Fig.2

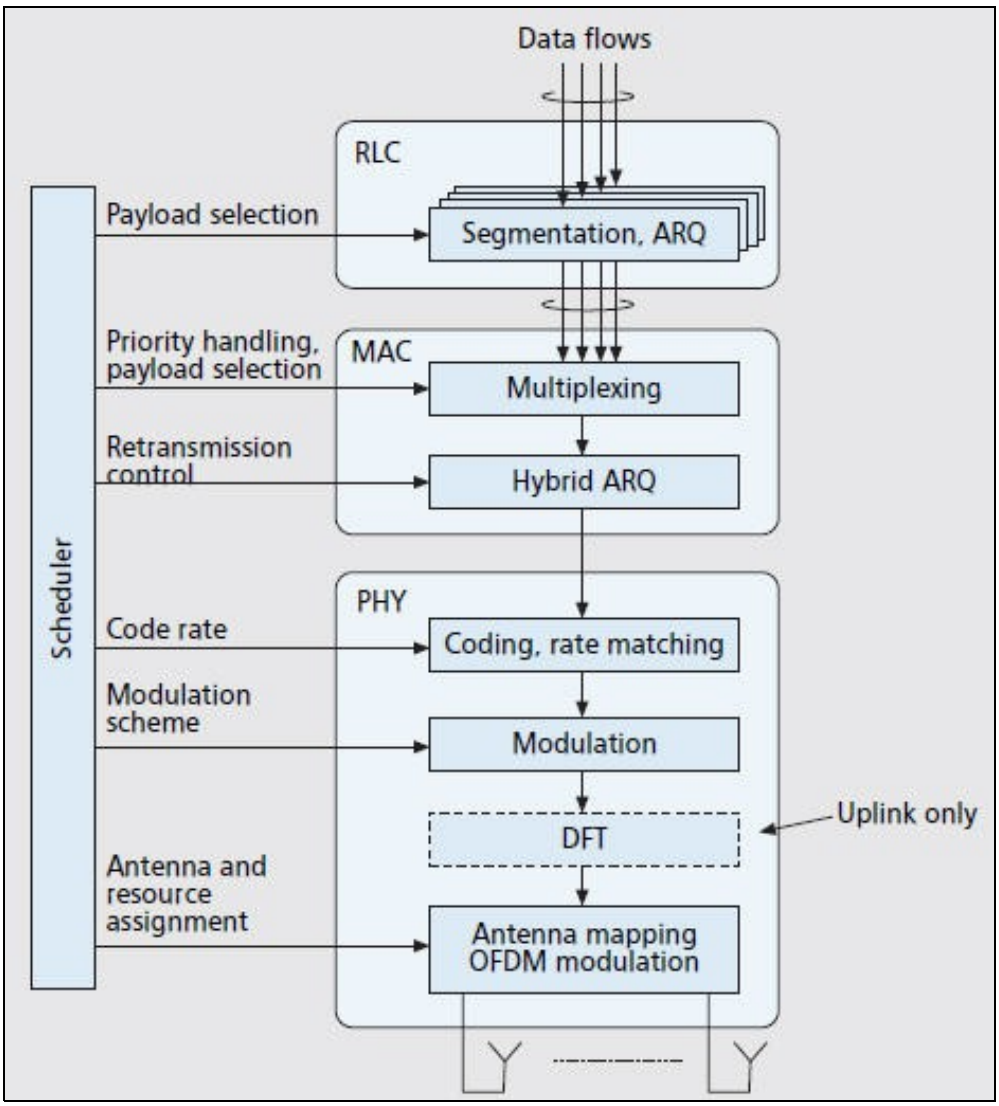
Fig.1 LTE Release 8 Major Parameters
Fig.2 LTE-Release 8 User Equipment Categories

LTE architecture



LTE architecture

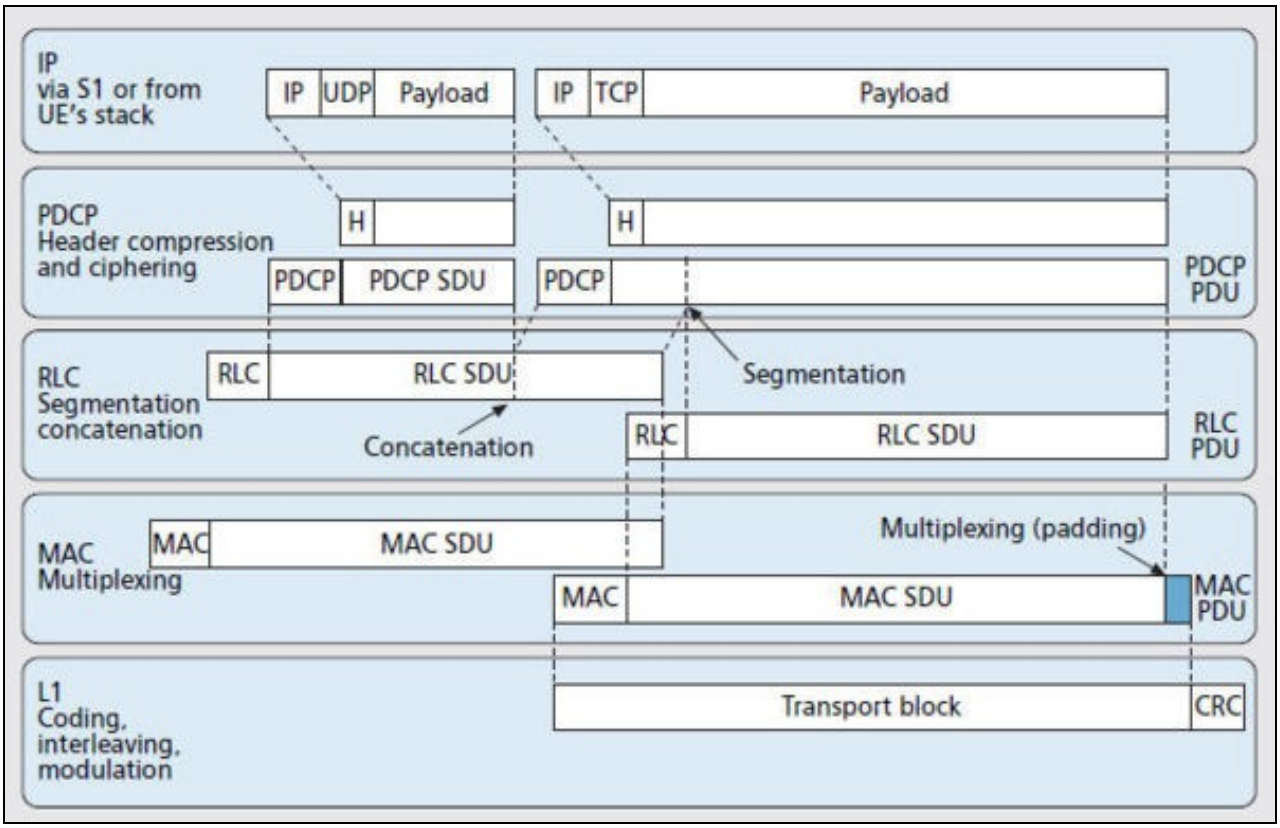
Protocol stack



Protocol stack of LTE

Data flow

The data flow through protocol stack can be shown as



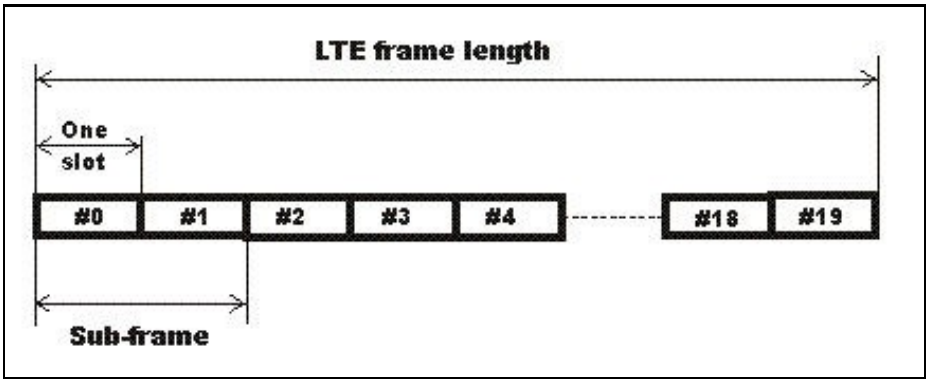
Dataflow

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

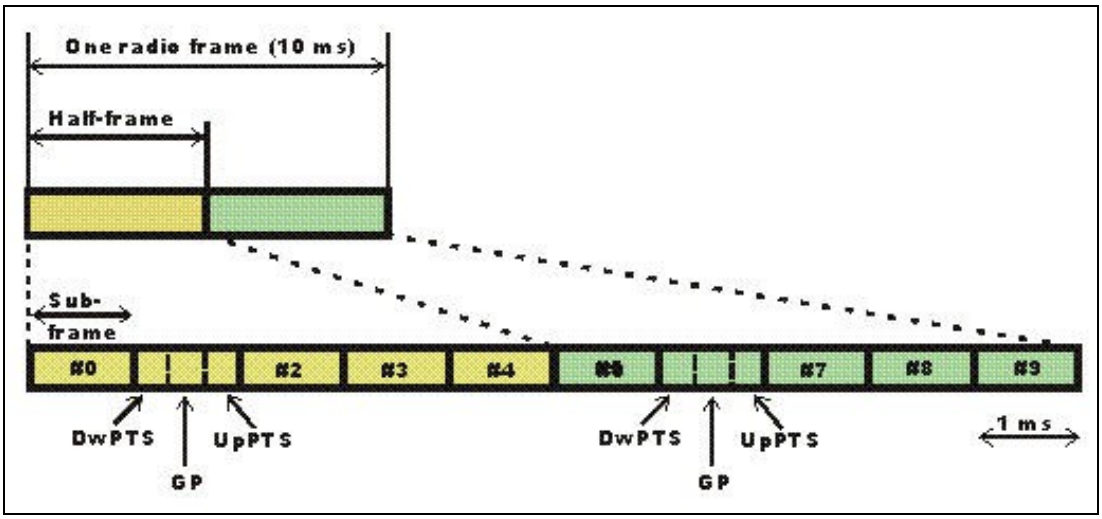
There are two types of LTE frame structure:

- **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

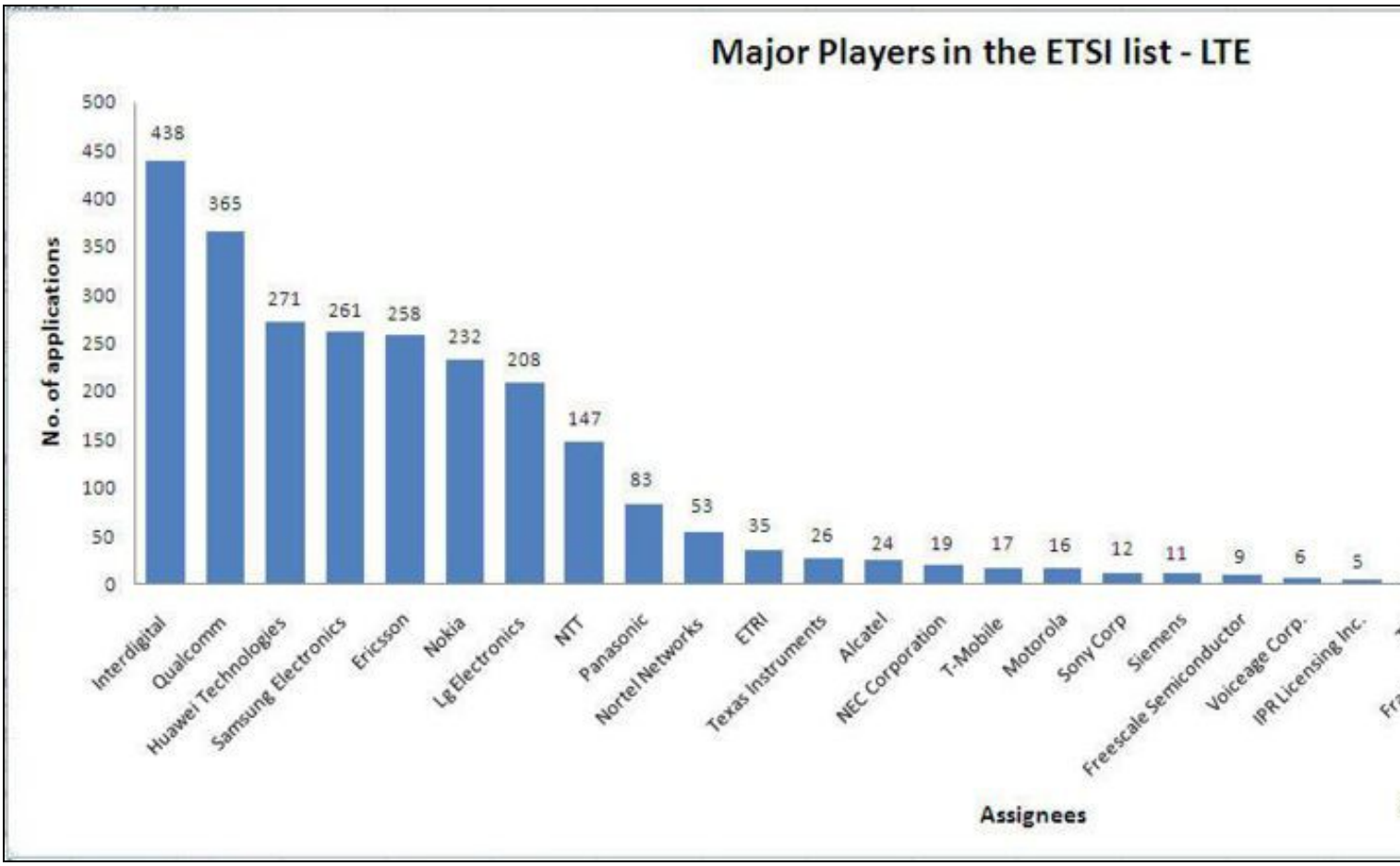
- The subframes may be divided into standard sub frames of special sub frames. The special sub frames consist of three fields
  - DwPTS - Downlink Pilot Time Slot
  - GP - Guard Period
  - UpPTS - Uplink Pilot Time Slot.

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

Major players in the ETSI list for 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	US5754976A	Algebraic codebook with signal-selected pulse amplitude/position combinations for fast coding of speech	7/28/1995	7/28/2015	1990-02-23 | 1992-09-10 | 1995-02-06 | 1995-07-28	Universite de Sherbrooke, Sherbrooke, CA	44	2
2	US6724976B2	Communication system	12/21/2000	12/21/2020	1992-03-26 | 1992-09-25 | 1993-03-25 | 1993-09-27 | 1998-04-22 | 2000-02-16 | 2000-12-21	Matsushita Electric Industrial Co. Ltd., Osaka, JP	110	3
3	US6633600B2	Traffic lights in a code division multiple access (CDMA) modem	4/24/2001	4/24/2021	1995-06-30 | 1996-06-27 | 1998-02-17 | 1999-11-22 | 2001-04-24	InterDigital Technology Corporation, Wilmington, DE, US	85	3
4	US7190966B2	Method and apparatus for performing an access procedure	6/29/2005	6/29/2025	1996-06-27 | 1998-01-06 | 2000-11-22 | 2002-03-01 | 2003-03-26 | 2004-06-14 | 2005-06-29	InterDigital Technology Corporation, Wilmington, DE, US	91	4
5	US7437177B2	Method employed by a base station for controlling initial power ramp-up using short codes	3/14/2008	3/14/2028	1996-06-27 | 1998-01-06 | 2000-11-22 | 2002-03-01 | 2003-03-26 | 2004-06-14 | 2005-06-29 | 2008-03-14	InterDigital Communications Corp., Wilmington, DE, US	190	4

- 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

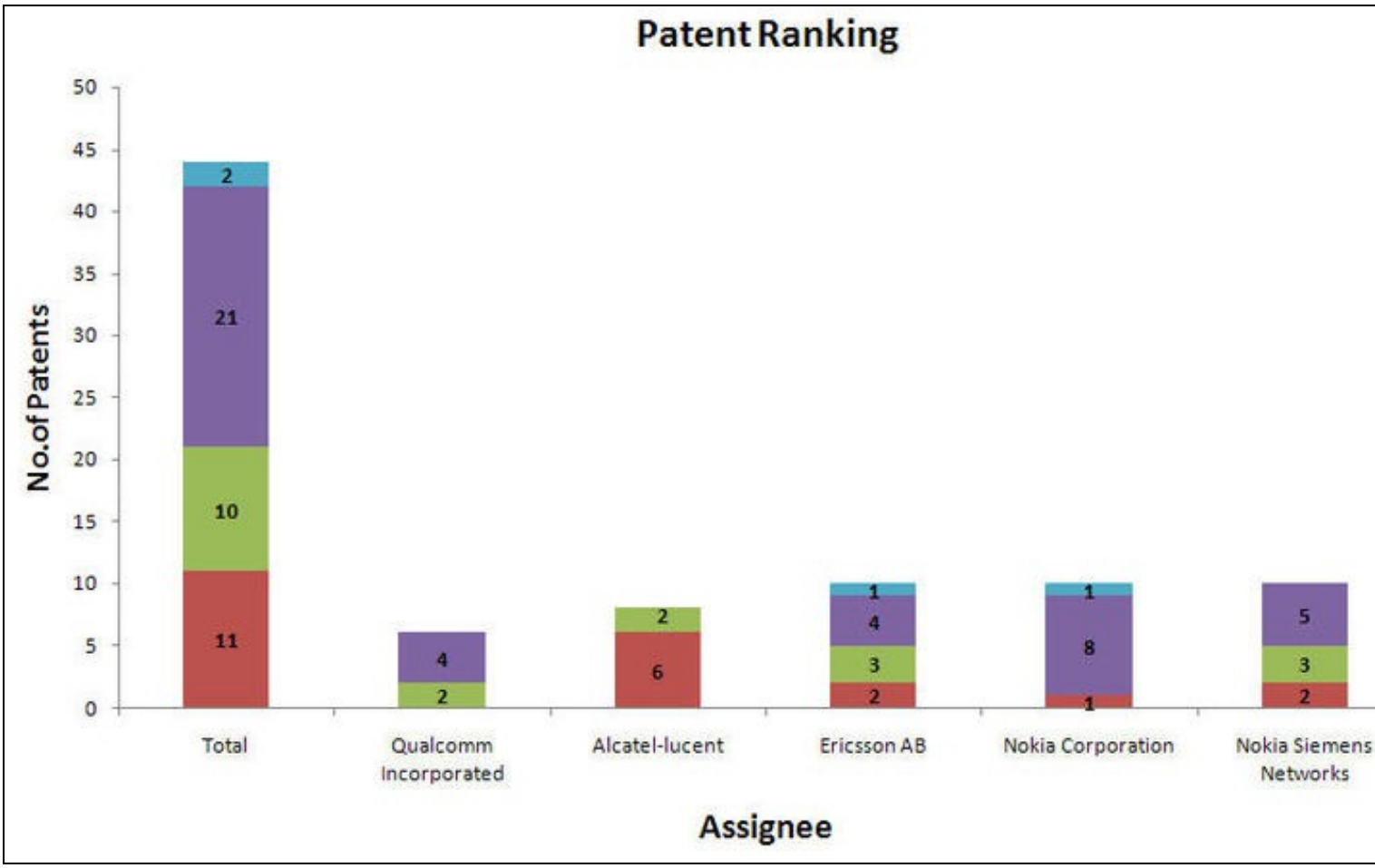
Ranking of ETSI patents

S.No	Patent/Publication No.	International Class (primary)	Assignee	Title	Publication Year	Priority Year(s)	Legal Status	Rank
1	US20100182939A1	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	EP2181559A1	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	EP1961141A2	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	US20110029834A1	H04L000118	Alcatel-Lucent	Method for operating harq buffer	2011	2008 | 2009 | 2009	Docketed New Case - Ready for Examination	**2**
5	US20090086710A1	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

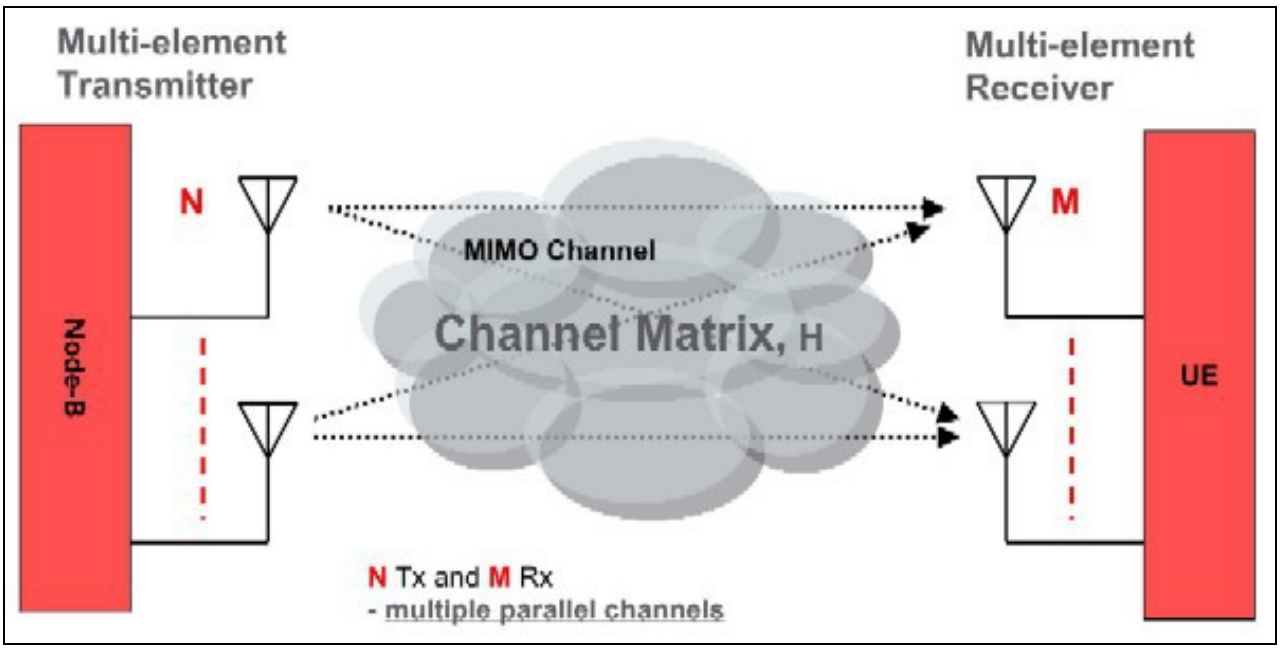


Note: Here a total of **44** patents from ETSI have been taken, out of which **Qualcomm Incorporated** has **6** patents, **Alcatel-lucent** has **8** patents, **Ericsson AB**, **Nokia corporation**, **Nokia Siemens Networks** have **10 each**

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



MIMO working

Concept table for MIMO

S.no	MIMO	OFDMA	SCFDMA	Interference	SDMA	HARQ	Multipath	LTE	Others
1	Multiple adj input* adj multiple adj output*	OFDM	scfdma	interference near3 mitigate*	Space adj2 time adj2 transmit adj2 diversity	HARQ	Multipath near2 effect*	LTE	channel adj2 quality adj2 indication adj2 channel*
2	Distributed adj transmission adj directional adj reception	(orthogonal adj frequency adj division) near2 multiplex*	SINGLE adj CARRIER adj FREQUENCY adj DIVISION adj MULTIPLE adj ACCESS*	interference near3 cancel*	antenna adj2 multiplex*	Hybrid adj automatic adj repeat adj request	Multipath near2 propagat*	Long term evolution	CQICH
3	DTDR	ofdma	scfdm	interference near3 reduc*	SDMA	feedback adj2 mechani*	Multipath near2 phenomenon	Evolved packet system	Downlink adj2 Channel adj2 Descriptor adj2 message*
4	transmission adj2 diversit*	(orthogonal adj frequency adj division) near2 (multiple adj access)	single adj carrier adj frequency adj division adj multiplex*	interference near3 null*	Space adj2 division adj2 multiple adj2 access	Hybrid ARQ		System architecture evolution	adaptive adj2 modulation adj2 coding
5	SFBC	discrete adj multi adj tone	SC-FDMA		Space adj2 domain adj2 multiple adj2 access	ARQ		E-UTRA*	pre adj coding*3
6	Space adj2 frequency adj2 block adj coding	DMT	DFT-spread adj OFDM		plural* near2 (spatial adj streams	automatic adj repeat adj request		Evolved UMTS terrestrial radio access	per adj2 antenna adj2 rate adj2 control
7	SU adj2 MIMO	(adaptive ADJ modulation*)	DFT-S-OFDMA		spatial adj2 adaptation	Automatic Repeat Query			permutation adj2 mode adj2 selection
8	MU adj2 MIMO	sofdm	Interleaved adj FDMA		adaptive adj2 transmi*				
9	space adj2 time adj2 cod*		Interleaved adj Frequency adj Division adj Multiple adj Access		Bell adj2 Labs adj2 Layer adj2 Space adj2 Time				
10	multiple adj antenna*		IFDMA		spatial adj2 multiplex*				
11	multi adj antenna*		Discrete adj Fourier adj Transform adj Spread adj Orthogonal adj Frequency adj Multiple adj Access						
12	multiple adj transmit* adj2 receive*		DFT- SOFDM						
13	plural* adj2 antenna*								
14	atleast adj2 two adj2 antenna*								
15	layer adj map*4								

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

Control patents

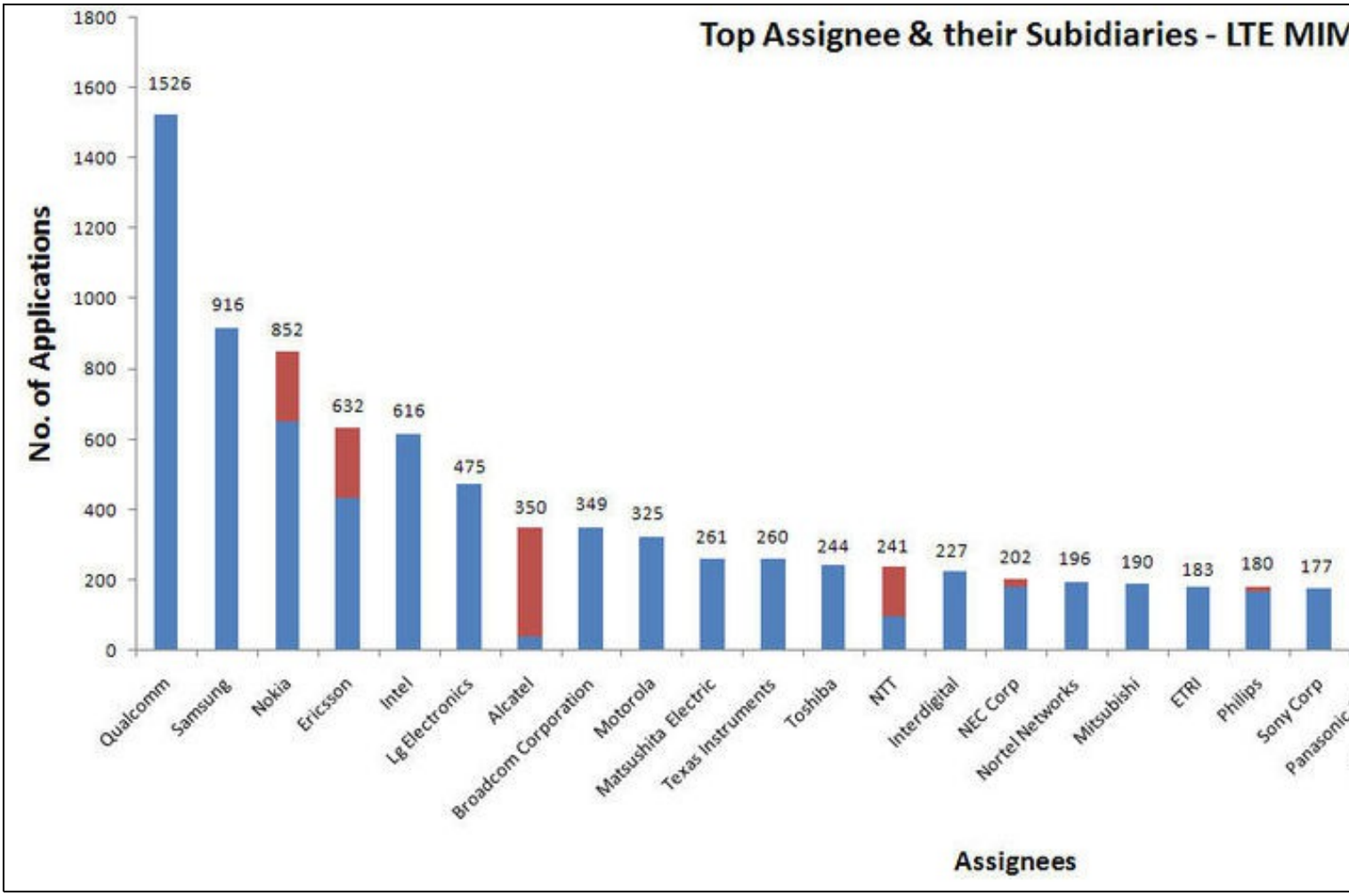
- Control patents are mostly used
  - ♦ to prepare concepts
  - ♦ to search classes, and
  - ♦ to verify the search strategy
- Control patents are found by running a query with narrow keywords, and in this process litigation's and file wrappers are also looked at.

S.No	Patent/Publication No.	Title	Abstract
1	US6873606	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	US7233625	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	US7248559	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	US7548506	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	US7120395	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

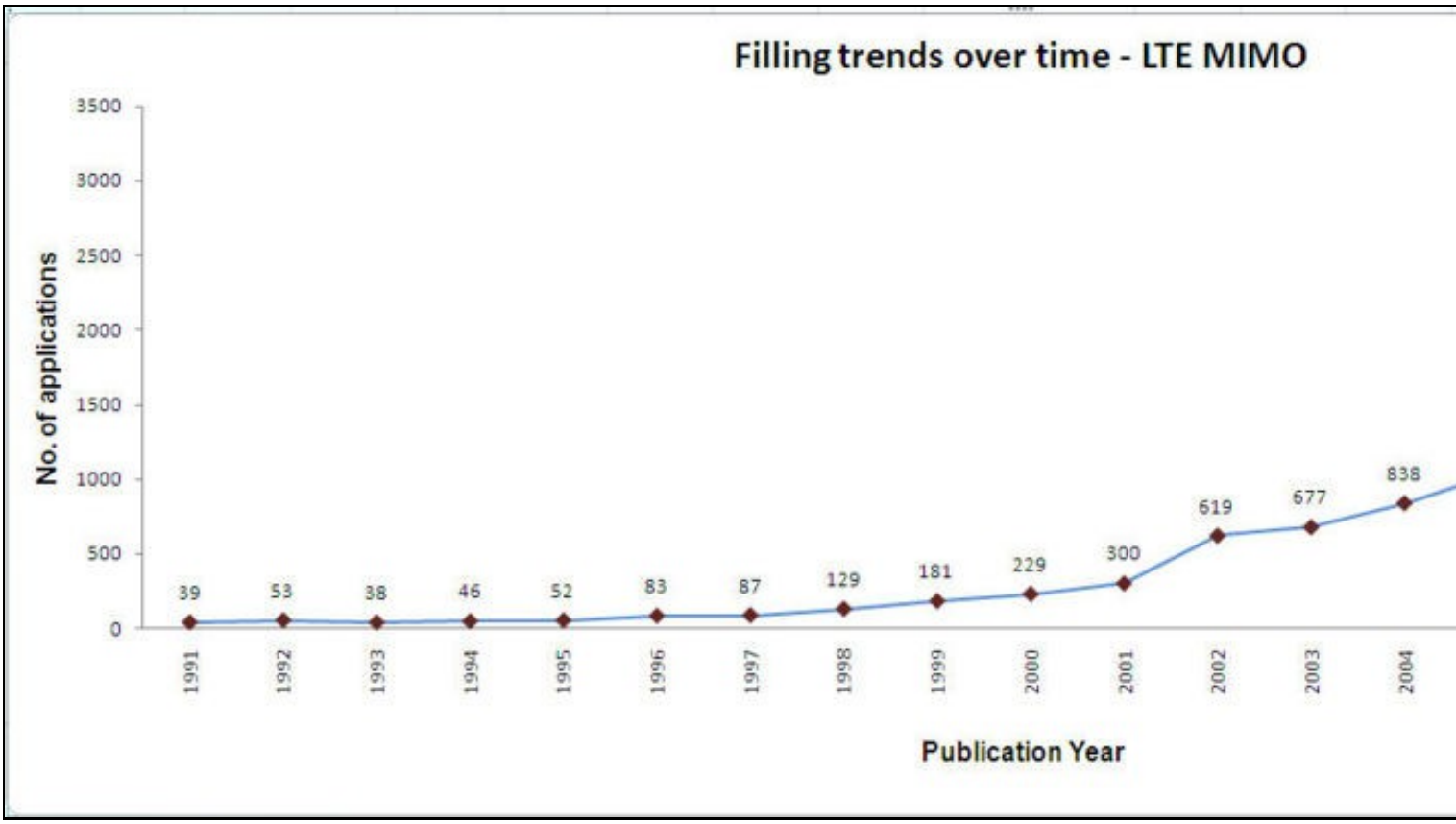


Company wise distribution of IP

Note:

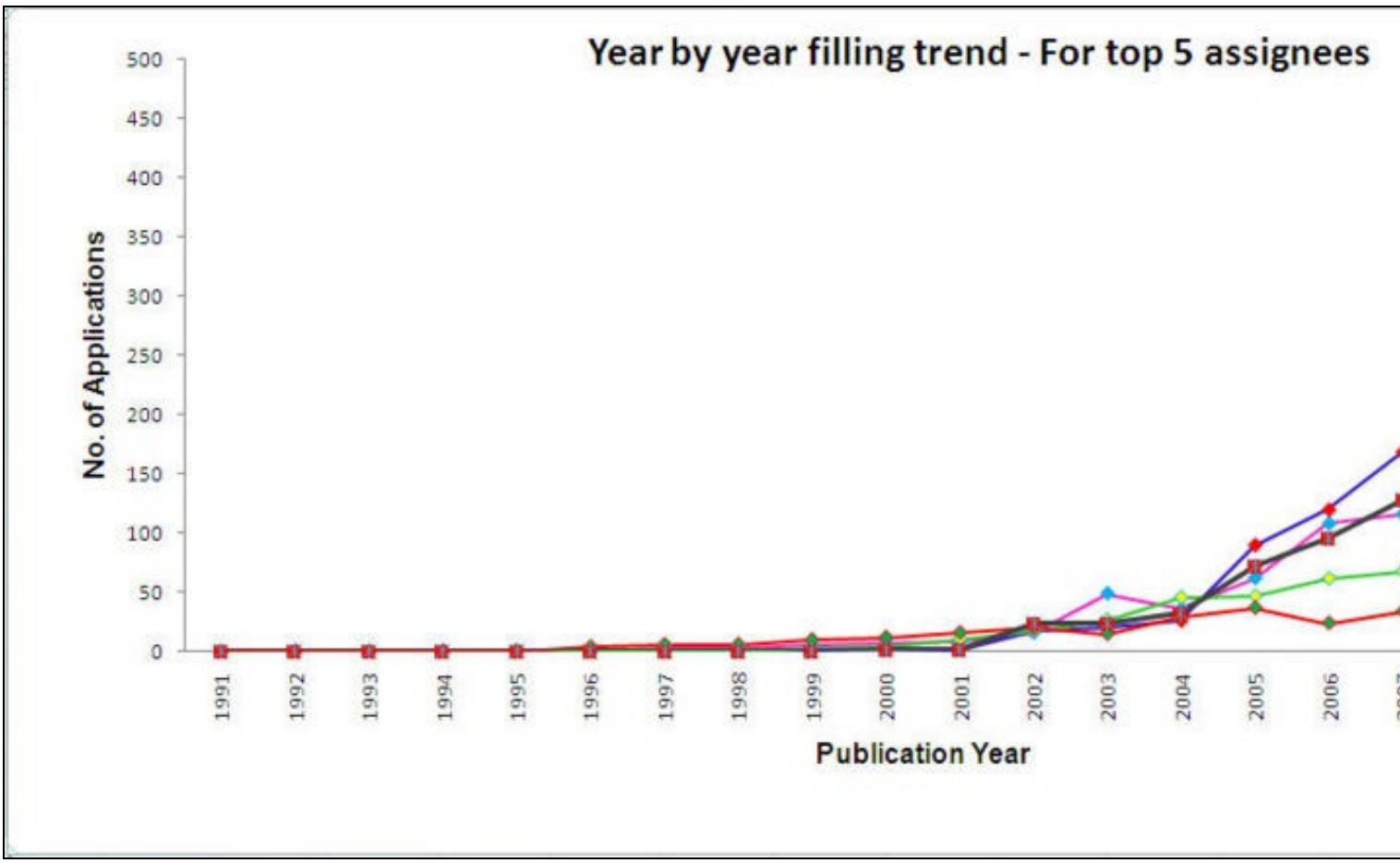
- The subsidiaries of Nokia includes : Nokia Telecommunication Oy and Nokia Siemens.
- The subsidiaries of Ericsson/LM Ericsson includes : Ericsson GE Mobile Communications Inc, ST-Ericsson, Sony Ericcson.
- The Subsidiaries of Alcatel includes : Alcatel-Lucent, Alcatel Shangai bell company, Alcatel 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 Phlilps includes : Philips Electronics, Philips Intellectual property & standards.
- The subsidiaries of Fujistu 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



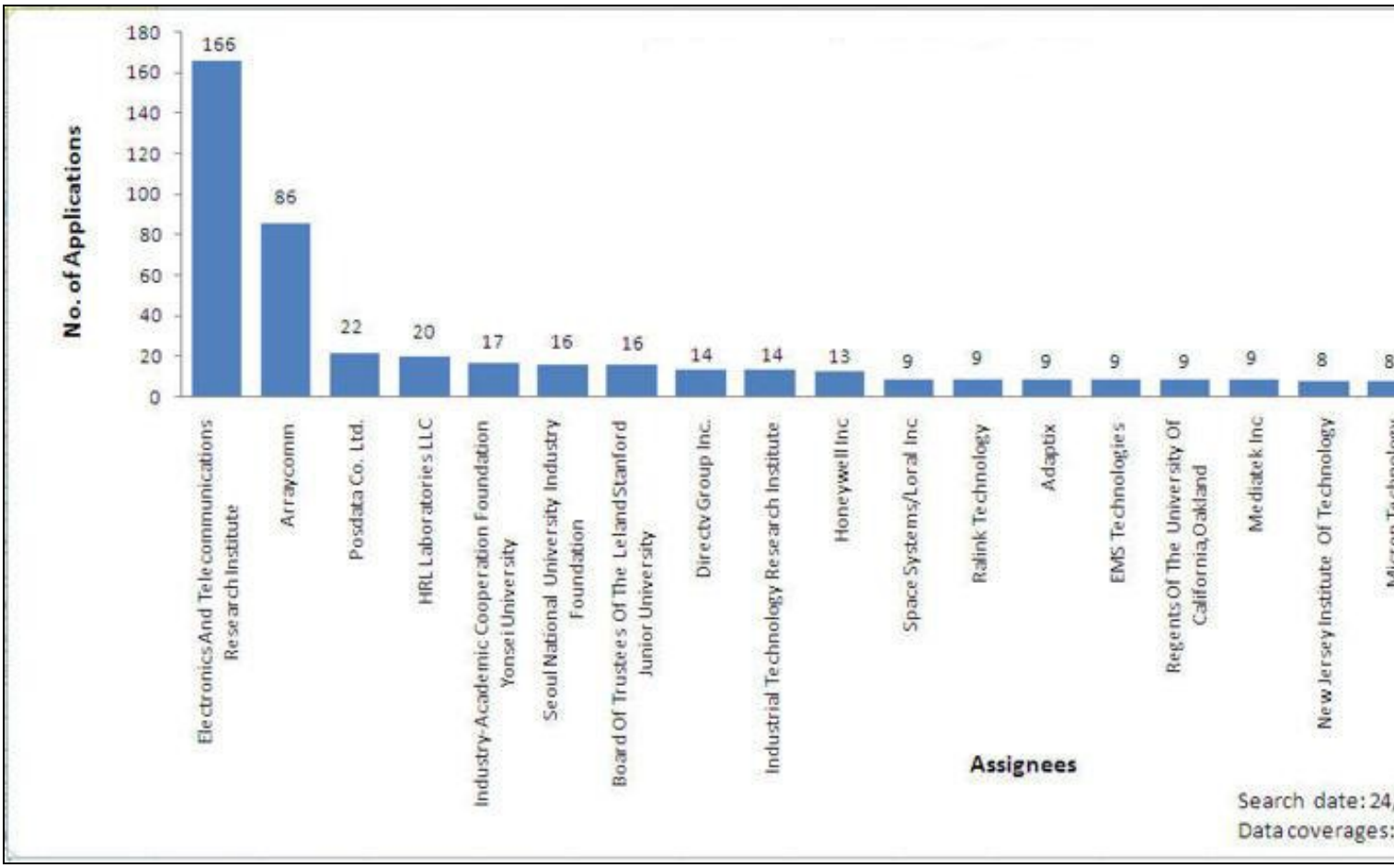
Filing trends over the years

Year by year trends of top 5 companies



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	US5541955A	Adaptive data rate modem	1992-11-06 | 1995-04-28	Pericle Communications Company	272
2	US5999561A	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	US5752164A	Autonomous remote measurement unit for a personal communications service system	1992-04-27 | 1995-04-25	American PCS L	146
4	US4441180A	Service integrated communication transmission and interchange system	1979-06-01 | 1980-05-30	Licentia Patent Verwaltungs GmbH	134
5	US6072994A	Digitally programmable multifunction radio system architecture	1995-8-31	Northrop Grumman Corporation	133
6	US6314147B1	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	US5859878A	Common receive module for a programmable digital radio	1995-8-31	Northrop Grumman Corporation	131
8	US5345471A	Ultra-wideband receiver	1993-12-4	The Regents of the University of California	130
9	US5694134A	Phased array antenna system including a coplanar waveguide feed arrangement	1992-12-01 | 1993-10-21 |	Superconducting Core Technologies, Inc.	128

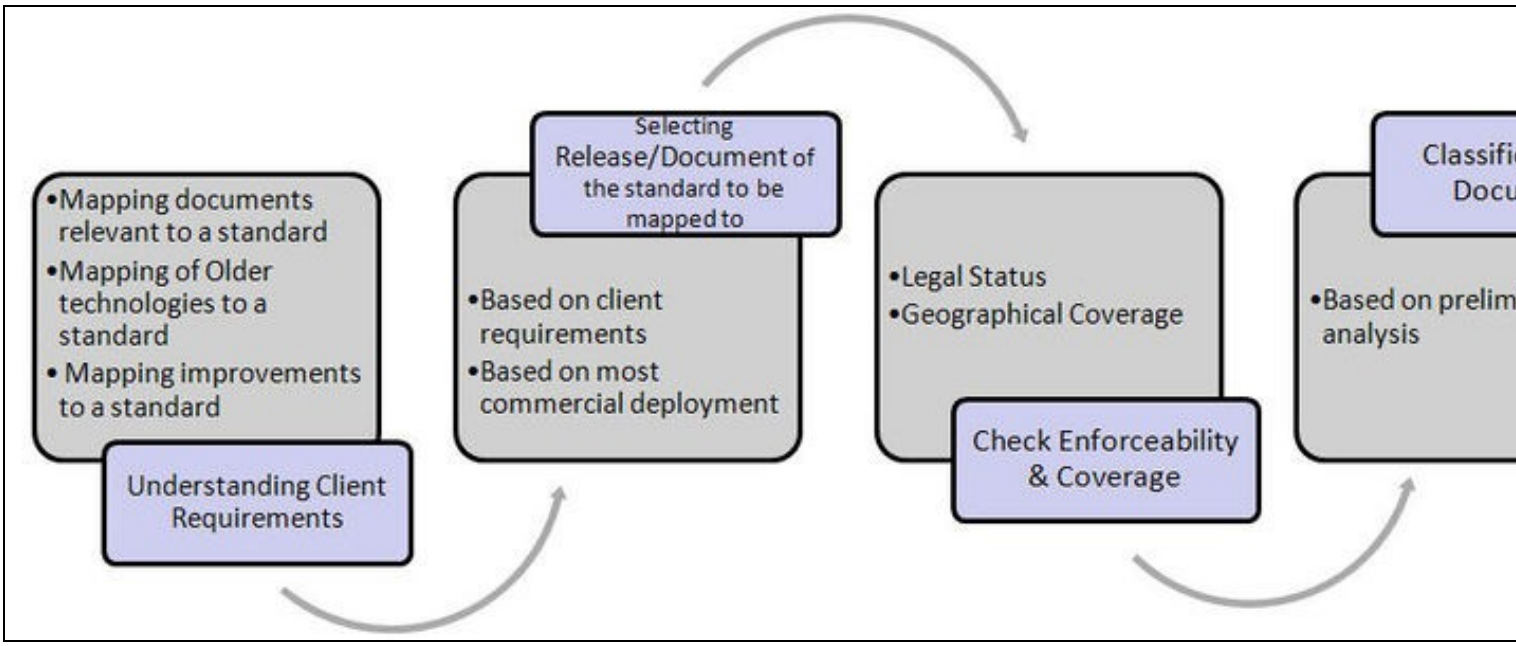
			1994-01-14		
10	US5347286A	Automatic antenna pointing system based on global positioning system (GPS) attitude information	1992-02-13 | 1993-03-19	Trimble Navigation Limited	115

Patent mapping by graphical analysis

Sno.	Patent/Publication No.	Title	Figure analyzed	Analyzed result	Standard mapped into
1	US20070217538A1	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	US20090232229A1	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,	

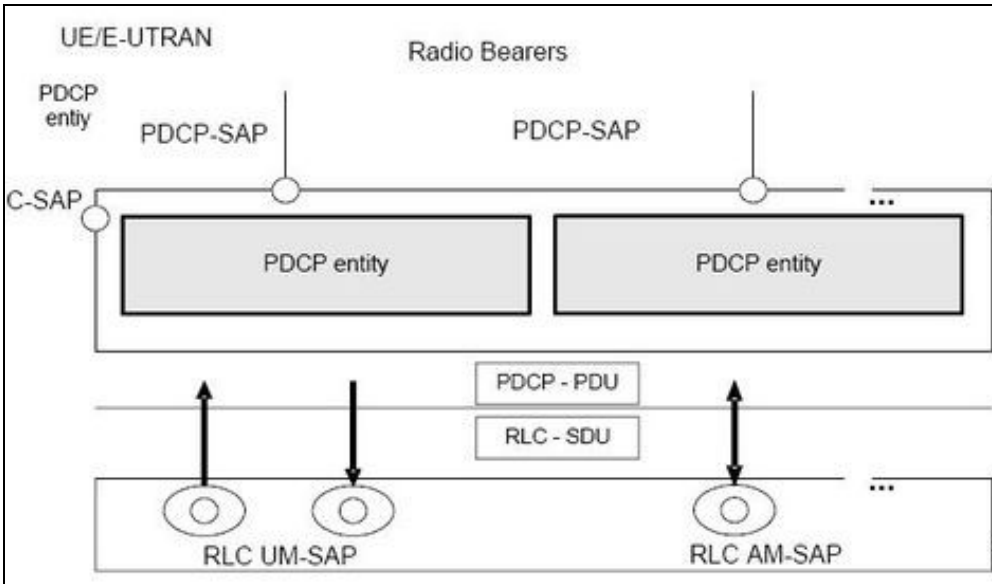


Figure 4.2.1.1 - PDCP layer, structure view

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 Converger 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 Prot (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 Prot (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.	

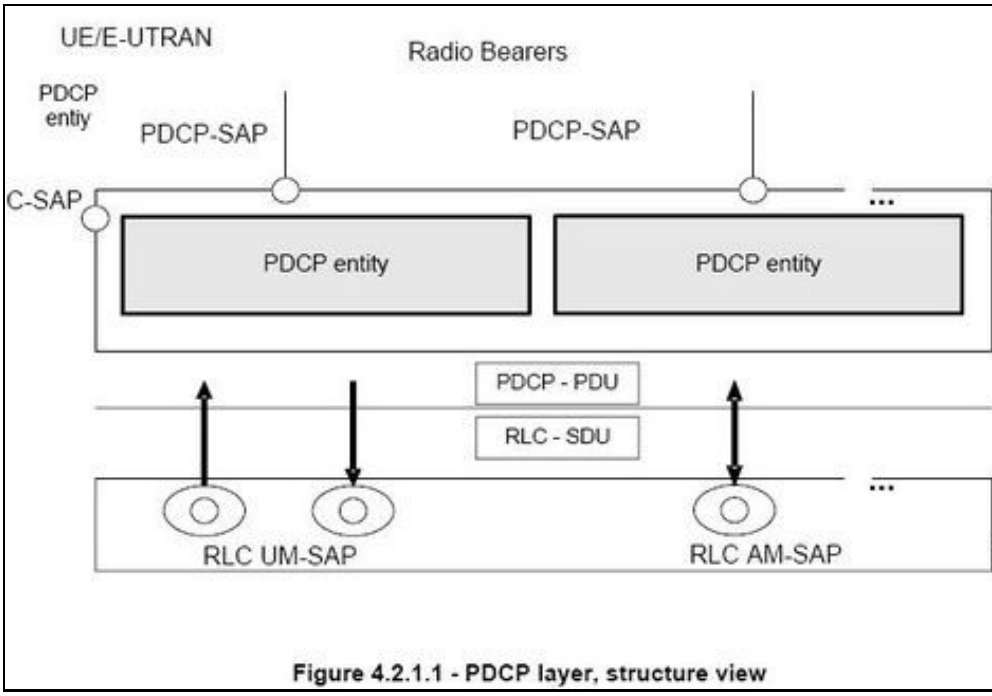


Figure 4.2.1.1 - PDCP layer, structure view

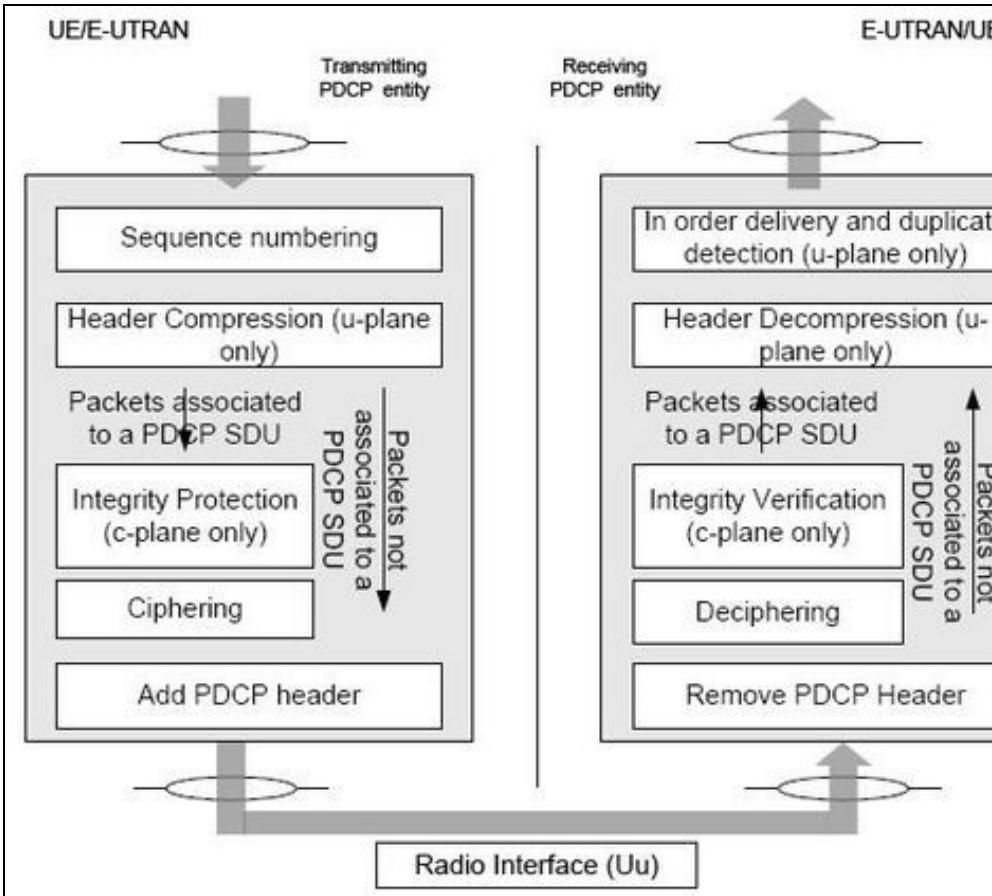
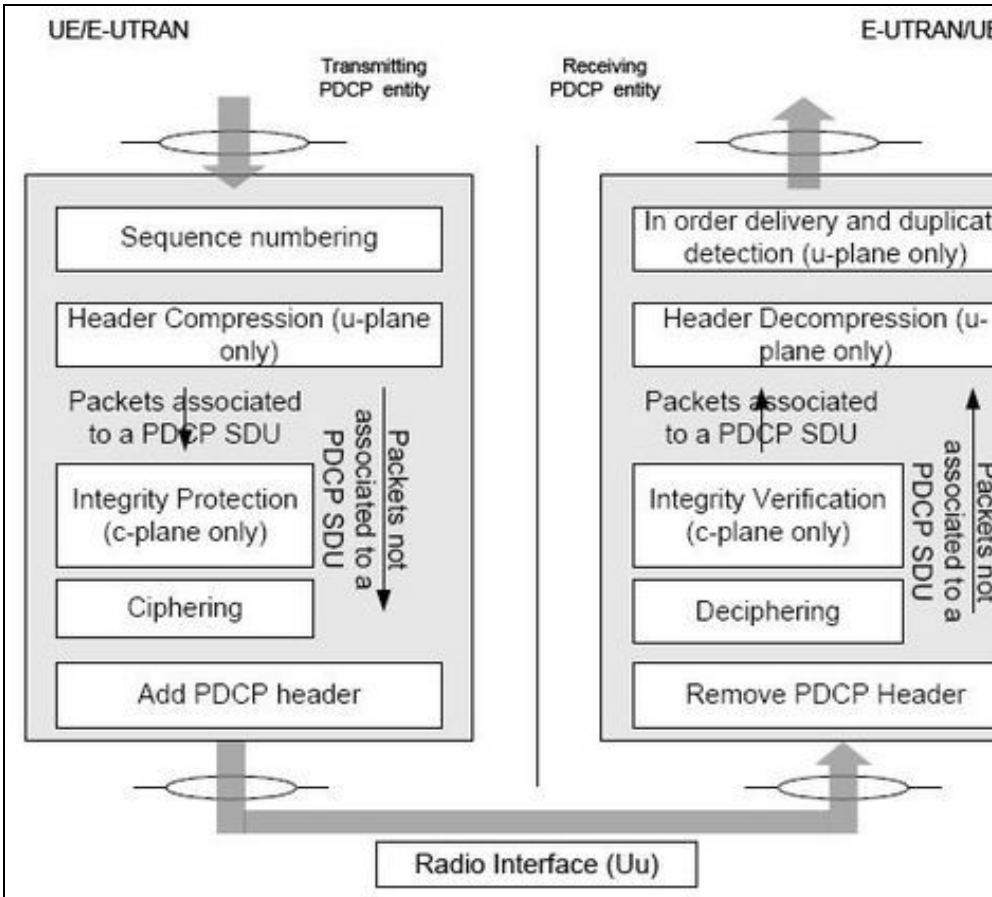
Claim3	**4.2.2 PDCP entities** 3GPP TS 36.323 V8.6.0 (2009-06) **Packet Data Convergence Protocol (PDCP) specification (Release 8)**
The method of claim 1, wherein the steps of determining and delivering are performed in a Packet Data Convergence Protocol (PDCP) entity.	

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)**

The method of claim 1, wherein the data unit is a PDCP Service Data Unit (SDU).	 **Figure 4.2.2.1 - PDCP layer, functional view**
Claim5	**4.4 Functions** 3GPP TS 36.323 V8.6.0 (2009-06) **Packet Data Convergence Protocol (PDCP) specific (Release 8)**
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	**5.1.2 DL Data Transfer Procedures** 3GPP TS 36.323 V8.6.0 (2009-06) **Packet Data Convergence Prot (PDCP) specification (Release 8)**
The method of claim 1, wherein a header decompression or a deciphering is performed between the receiving step and the storing step.	**if received PDCP SN > 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; -- -- if the PDCP PDU has not been discarded in the above: - perform deciphering and header decompression (if configured) for the PDCP PDU as specified in the subclauses 5.6 and 5.5.5, respectively; - if a PDCP SDU with the same PDCP SN is stored: - discard this PDCP SDU; - else: - **store the PDCP SDU**; --- ---
Claim7	**5.1.2 DL Data Transfer Procedures** 3GPP TS 36.323 V8.6.0 (2009-06) **Packet Data Convergence Prot (PDCP) specification (Release 8)**
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;

		Claim8	
		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.	
		Claim9	**5.1.2 DL Data Transfer Procedures** 3GPP TS 36.323 V8.6.0 (2009-06) **Packet Data Convergence Prot (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	US7548730B2	375267	Systems and methods for improving performance of multiple spatial communication channels	2007	2006	Patented Case	**1**
2	US20090232229A1	375260	Device, system and method of resource allocation in a wireless network	2009	2008	Docketed New Case - Ready for Examination	**2**
3	US20080187066A1	375267	Detection method and apparatus for a multi-stream MIMO	2008	2007	Non Final Action Mailed	**2**
4	US7796546B2	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

```
        .markmap-node {
            cursor: pointer;
        }

        .markmap-node-circle {
            fill: #fff;
            stroke-width: 1.5px;
        }

        .markmap-node-text {
            fill:  #000;
            font: 10px sans-serif;
        }

        .markmap-link {
            fill: none;
        }

        pre, .mw-code{
          background-color: transparent;
        }
    d3.xml("https://www.dolcera.com/wiki/images/Mmap977%281.1%29.mm", function(error, data) {
            if (error) throw error;

            markmap("svg#mindmap_61e7ef12a81516ae488d1b1cbdeb9641", data, {
                preset: "colorful",
                linkShape: "diagonal"
            }, "xml");
          });
```

Note:This interactive taxonomy consists of 131 sample documents.

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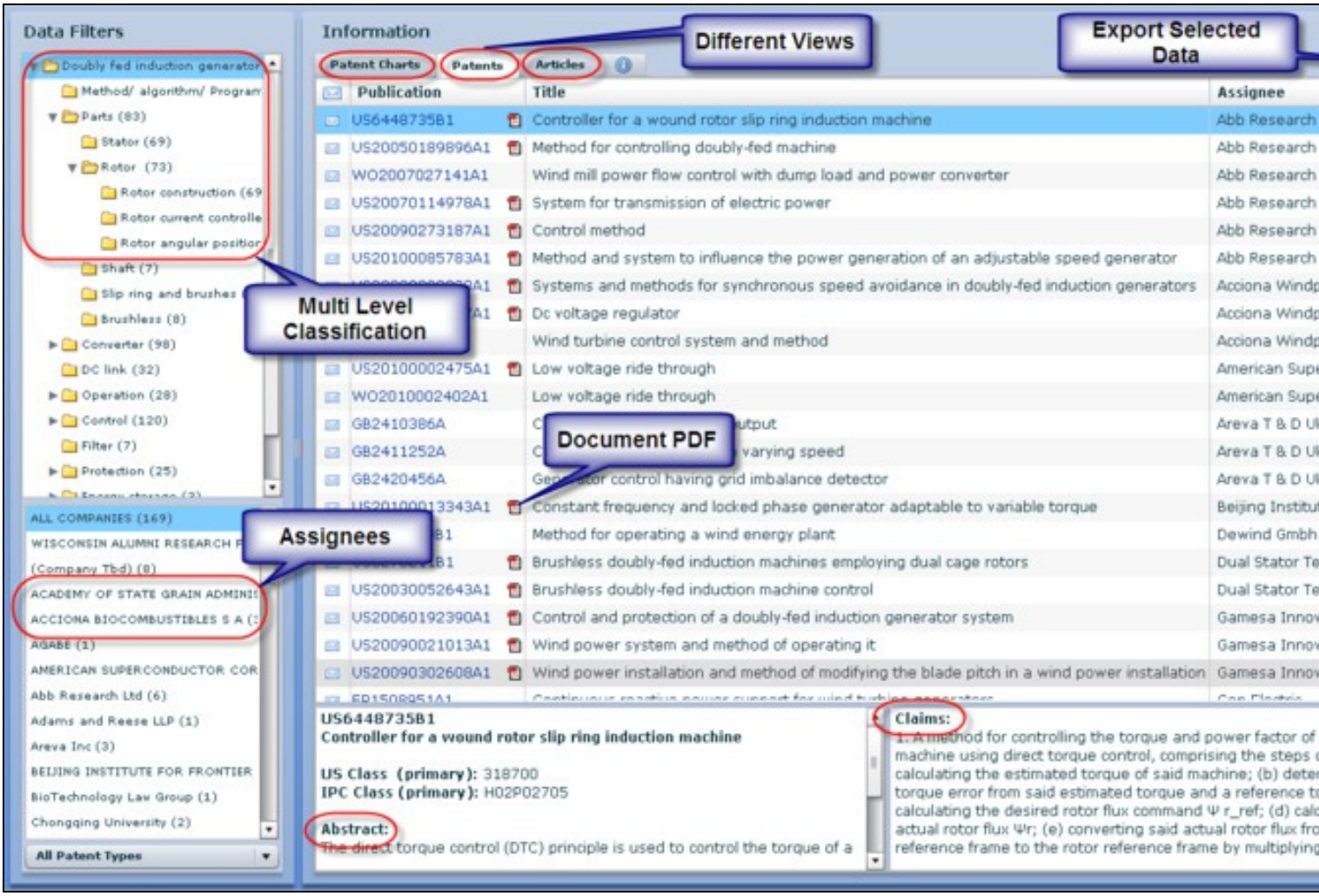

Dashboard Link

The Dashboard is Dolcera's visualization platform to present the organized patent landscape

- Best viewed in Internet explorer 6 and higher versions
- To view dashboard you would require a flash player. Kindly install a flash player if its not installed in your system

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- Note1: Use the following credentials to view the dashboard 1.1
  - Username: demo@dolcera.com
  - Password: demo123
- Note2: A total of 131 patents were considered for the creation of the sample dashboard

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