Patent Landscaping
As a Portfolio Strength Indicator

Felicia Vlad

Master thesis at
Department of Technology Management and Economics
CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden
2010

Master Thesis Project Number:
Department of Technology Management and Economics
Chalmers University of Economy Göteborg
ISSN:

Examiner: Professor Mats Lundqvist

Supervisor: Professor Mats Lundqvist
Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Göteborg
Sweden

Performed at Ericsson AB, Patent Strategy and Portfolio Management Department
Torshamnsgatan 21-23 SE-16483 Stockholm
Supervisor: Patent Analyst, Martin Ekenbäck

Abstract

This paper reports a study of Keywords Based Patent Landscape Assessment within the Long Term Evolution. In 2010 LTE is the technical field hoping to lead the 4G technology into the future by offering increased capacity and speed for mobile telephone networks.

The Keyword Based Patent Landscape Assessments are analyses which use keywords as mean to identify relevant patents pertaining to a technological field and patent portfolio. In a landscape one can observe evolutions of different technologies, rankings of actors, disposition of technology in geographical areas etc. These assessments are nowadays being used in order to obtain additional information in the process of patents portfolio valuations and strategic management decision making processes.
As a consequence of technological advancement and creation of good patent databases, a potential has been noticed in these types of assessments and their importance has been increasingly growing in the last couple of years. This paper presents a study meant at offering a plus of information on keyword patent landscapes and clarifying the level of trust in these types of assessments. The ambition is, for the study, to influence the degree of adoption of these assessments among the patent valuation methods, in a positive way.

In detail, the study focuses on query strategy and patent section search and suggests a search methodology for less defined technological areas, such emerging technologies.
Key findings have been identified both in the area of query search strategy and patent section search: "*sensitivity is generated not only by the nature of the keywords inserted in the query search but also by the section of the patent where the search is being performed*". Interesting findings are presented when considering what keywords should be part of the query search: "*contrary the general belief, generic keywords seem to make more sense than specific terms for the area of search*".

The present paper contains eleven chapters. The background and introductory chapters, which relate the field of study and outline the nature of the study, followed by Chapter 3 which presents reviews on related literature and current developments on the Keywords Based Patent Landscaping, together with theoretical precepts and current implementations. Prolonging, Chapter 4 presents and defends the study's selected methodology while Chapter 5 presents the results of buzz words search strategy as the first search strategy presented by the paper. Chapter 6 introduces the findings of the second search strategy of the study which is focused on sub technology levels of analyses and approaches a different method of developing search queries. Chapter 7 discusses the sensitivity given by the section of the patent as variable used in keyword based landscapes. Chapter 8 tackles the limitations encountered during the study and offers a critical view upon the methods exposed by the study. Chapters 9 and 10 conclude the study through an articulation of the research findings, a discussion of the implications of these findings and the presentation of a set of recommendations. Finally Chapter 11 opens grounds for future research work to be continued from this study.

The entire study was performed within the Patent Strategy and Portfolio Management Department of Ericsson, under the supervision of managers of the department, benefiting of the collaboration with Long Term Evolution Portfolio focus group and the expertise of some of the best inventors in the telecom industry.

Acknowledgments

Patent Landscaping subject of this Master Thesis proved one of the most challenging topics I have worked with, during the two years as a student of the Intellectual Capital Management Master Program.

At the end of four months within Ericsson, I can proudly say, I have learnt a lot about Keyword Based Patent Landscaping. However the learning process would have not been possible without the full support of my two supervisors Mats Lundqvist on behalf of Chalmers University of Technology and Martin Ekenbäck on behalf of Ericsson. I take the opportunity to thank them both for the inspiration, guidance and support throughout all this time.

The outcomes of the thesis would have not been possible without the expertise and input of some extremely experienced, professional and smart professionals within Patent Development and R&D organizations of Ericsson. I was positively surprised by the availability and support offered constantly throughout my project. Thank you very much to all of you.

I also want to thank my ICM colleagues, part of the audience and opposition teams and present at my school thesis presentation on the 31st of May 2010: your questions and feed-back were helpful in improving my paper.

Chalmers, Göteborg June 2010

Felicia Vlad

List of Abbreviations

3GPP	Third Generation Partnership Project
CDMA	Code Division Multiple Access
DWPI	Derwent World Patent Index
E-UTRA	Evolved UTRA
E-UTRAN	Evolved UTRAN
GSM	Global System for Mobile Communications
HARQ	Hybrid ARQ
LTE	Long Term Evolution
NPE	Non Practicing Entity
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
Qos	Quality of Service
SC-FDMA	Single Carrier Frequency Division Multiple Access
SDMA	Spatial Division Multiple Access
UMB	Ultra Mobile Broadband
UMTS	Universal Mobile Telecommunications System
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial Radio Access Network
VoIP	Voice over Internet Protocol
WCDMA	Wideband Code Division Multiple Access
WiMAX	Worldwide Interoperability for Microwave Access
HSxPA	High Speed Xlink Packet Access

List of Figures

List of Tables

Scope

The present study focuses on **Keyword Based Patent Landscaping** as a business intelligence tool for the **Licensing and Patent Development Department in Ericsson.**

The technological scope addresses the Long Term Evolution technical field due to its importance in leading the 4G technology into the future. LTE is a project of 3GPP (3^{rd} Generation Partnership Project) and represents the 4^{th} of generation of radio technologies.
LTE offers increased capacity and speed for mobile telephone networks.

Objectives

The study aims at providing a better understanding on key words based patent landscape analyses. The study assesses the *sensitivity* offered by *keyword searches* (through the nature and combination of different types of keywords) and by *patent sections* (the section of the patent in which the search is performed).

The first objective of the study is to understand the sensitivity level offered by the keywords. Findings and observations are presented around two search strategies.

A second objective of the study is to observe how the choice of the patent section is influencing the results of an analysis. With other words the second objective aims at observing the sensitivity level created by patent sections.

A third objective of the thesis is to suggest different methodologies, of performing keyword based patent landscaping, meant to cover different needs. In this sense two search strategies are being presented in the study: 1) the *"buzz words"* approach and 2) the *"technology breakdown analysis"*.

A fourth objective of the thesis is to define the relevance, advantages and limitations of keyword based patent landscape assessment, as business intelligence tool.

Chapter 1 Introduction and Overview

1.1 Introduction

Many industry reports are presenting their results based on different methods of analyzing patent portfolios. One of the most frequently used types of analysis is keywords based patent landscaping. However most of these reports omit to reveal the methodology behind their analyses and how they reached their conclusions. In this sense the present study tries to bring some clarity and to present aspects that could be considered when performing keyword based patent landscaping.

The study discusses two approaches to initiate a keywords based patent landscape assessment, the particularities of each approach, advantages and setbacks. The study also touches upon the patent sections search. The main conclusion is that, there are different ways to approach keywords based patent landscape assessments, each approach to be decided according to the context and the resources available at the moment. Understanding the underlying aspects of a keywords based patent landscaping would ease the process of grasping into different analyses where the methods used are not being revealed.

The study targets a diverse audience: 1) the analyst interested in improving its assessments, 2) the manager trying to decode what lies behind public statements, press and information offered by different industry reports; 3) The Patent Organization interested in evaluating its own and others’ patent portfolios; 4) The R&D organization interested in spotting the latest development trends.
Nevertheless the study is meant to offer interesting and accessible information to the public interested in the topic.

1.2 Importance of Topic

In recent period, keywords based patent landscape assessments, together with other more qualitative methods of patent landscaping, tend to play a more important role for actors interested in IP Transactions, Licensing, R&D Development, Standardization, Investments or simply in positioning on the market. Intellectual Property valuation methods have become a hot topic since there is more and more pressure to put a value on an IP and there is no adopted common practice to valuation. Any type of landscape assessment, quantitative and qualitative, is meant to offer a plus of information in the IP valuation methods. Any plus of information is more than beneficial in the attempt to estimate a value of any Intellectual Property.

1.3 State of Field

The greater majority of comparative researches and studies, focuses more on qualitative methods of analyze and not so much on quantitative methods such the keywords based patent landscape assessments. No academic literature has been identified to precisely tackle the topic of the study; however there are a number of articles, industry reports and studies identified on the topic.

This thesis aims at contributing to the existing literature by creating a case for applicability and designing a model for implementation of these assessments.

1.4 Field Research Problems

The main challenge with the study of keyword based patent landscape assessment was the lack of previous studies on the topic. Therefore no specific framework of reference could be used in drawing the final conclusions. Previously, some degree of attention has been offered to the patent landscaping assessments but mostly to qualitative methods. One assumption is that quantitative methods have not received much attention until presently due to the lack of tools to manage this type of analyses. However this aspect is changing rapidly since the offer of databases to be used in quantitative assessments has grown rapidly, and so as the offer on data mining tools helpful in keywords selections.

The particularities of each area of assessment and inability to come with a common set of conclusions, has also proved a challenge for the study of patent landscaping. An example in this sense could be a field of study for an emerging technology versus an already established one. The emerging technology would prove more difficult to capture thorough a keywords based query search while the established technology already uses an established sets of keywords used to identified areas. But lack of previous research can be seen as opportunity for the current study of thesis since it offers a lot of opportunities to take the research in the desired direction.

1.5 Summary

As mentioned throughout the chapter the study will focus on Keywords Based Patent Landscape assessment using as a field of applicability the Long Term Evolution Technology field. The study will gradually touch upon different strategies of creating search queries but will focus also on other variables used to isolate the area of search. A separate analysis will be revealed within the Patent Section Search area. The study is meant to bring a plus of information to a diverse audience and is meant to be easily understood by any reader. Since not so many previous academic studies have focused on the topic of the study, a lot of free hand has been offered in the research of the topic.

Chapter 2 Background

The Background chapter will offer the reader some business and technological perspective on the field of study. A plus of information on the technology scope, the IPR policies within wireless networks industry, the interactions between actors, their strategies and interests, would not only put the reader into a context but also raise its interest on the field.

The use of patent information is gaining increasing attention in the fields of innovation, technological and strategic management. Patents represent valuable sources of information that can be used in plotting the technological information as well as valuable sources of revenues by their commercialization. Patent portfolios can be evaluated from a qualitative and quantitative perspective. Qualitative indicators can be citations, granted patents, technological and international scope of the patent, and they usually offer the weight of a portfolio. A quantitative perspective would focus on the numerical factors such the counting of patents or patent families. Such numerical indicator would offer information on how much a portfolio has increased in terms of numbers of patents but would not offer information related to the quality of patents.

Keywords Based patent landscape assessments enter the study of quantitative methods of analysis and it can be seen as a first step taken in completing competitive analyses studies. This study agrees with the point of view expressed by Maravedis which suggests to use the keywords based patent landscaping linked with more qualitative methods of analyses such citations analyses, claim analyses, product and market trends analyses, forecasting etc.

2.1 Long Term Evolution Technological Scope

Long Term Evolution (LTE) technology was selected as the field of application for this study. Any results highlighted by the study offer information linked to the size of LTE patent portfolios. LTE was the preferred area due to its important role into the 4G telecom solutions. LTE together with WiMAX and UMB will define the Intellectual Property landscape in the 4G context.

LTE offers a new radio platform technology which proposes higher end user peak throughputs, higher spectrum bandwidth and improvement on end user experience through full mobility. With the emerge of Internet Protocol, LTE is expected to provide support for IP based traffic with end to end Quality of Service (Qos) and a better integration with other multimedia services through Voice over IP (VoIP).

LTE is the latest standard in the mobile networks technology tree (that previously realized the GSM/EDGE and UMTS/HSxPA network technologies) and which now account for over 85%

of all mobile subscribers. LTE is supported by almost all 3GPP[1] and 3GPP2 service providers and offers a competitive edge over other cellular technologies.

2.2 IPR policies in wireless network industry

One common goal, of each company involved in standardization, is to have its innovations implemented in the standards. A larger portfolio of standard essential patents in a certain industry is valuated better and will offer an upper hand in the bilateral negotiations. This will allow not only driving technology progress in the desired direction, but also imposing higher licensing rates and ensuring better negotiating in cross licensing deals. The decisions, on what technical solutions are adopted in a standard, are made by the Standard Setting Organization (for example 3GPP).

Standards Setting Organizations are the industry groups which set common standards for the particular industry in order to ensure compatibility and interoperability of devices manufactured by different entities[2]. Companies participating in standardization are typically obliged to offer a license to standard essential patents on RAND (Reasonable and Non Discriminatory) and/or FRAND (Fair, Reasonable and Non Discriminatory) terms. The main purpose of this obligation is to facilitate licensing, prevent monopolies practices or licensing abuse.

2.3 Patent strategy

Different business strategies characterize today's wireless industry are enumerated as following:

- The **Non Practicing Entities,** such Interdigital, investment funds, who are patent owners but do not manufacture any product. Their revenue streams are based on licensing. They are also called patent trolls due to their habit of suing for infringement and pursuit for any possible patent enforcement. *They are manifestation of evolution of patents as source of monetization*. On the positive side they create a valuable secondary market by recycling unused patents and make them part of productive economy.
- The **vendors/manufacturers** such Nokia, Motorola, Ericsson, focused on both *protecting their R&D expenditure and reducing royalty payments*.
- **Licensors** such Qualcomm *focused on one sector and building a powerful portfolio in that area.*

.

[1] 3rd Generation Partnership Project is a collaboration between the following groups of telecommunication associations and its

[2] 74 Antitrust L.J. 671 (2007) , Pricing Patents for Licensing in Standard-Setting Organizations: Making Sense of Fraud Commitments; Layne-Farrar, Anne; Padilla, A. Jorge; Schmalensee, Richard

2.4 Business Context

However, the common practice among the actors, part of standard setting organizations and/or submitted to agreements such FRAND and RAND, is to hold only bilateral licensing negotiations, with closed doors.

Same actors have realized that the key to better negotiate royalty payments in the licensing process is to gain a precise knowledge of the strengths and setbacks of each other's patent portfolios. In the past, patents were perceived more as a legal tool meant to protect the innovation and they were mainly used in defensive purposes against infringement and plagiarism. Nowadays patents are being used as objects of transactions not only in the standardization sphere but also as sources of information used in spotting new business opportunities such licensing in new markets, commercialization or joining patent pools.
Today more effort is being put in sharing and cooperation practices through for example: creating structures as patent pools meant to monetize patents, reduce the costs of licensing and include also smaller actors (usually intimidated by the larger competitors). However, a lot of disputes on infringement matters continue to take place, especially in cases where patents are being used strictly in a defensive way.
The following two sections will illustrate the actual context which combines the new business practices with the old ones.

2.4.1 Patent Pools

Patent pools are mutual beneficial agreements, between multiple patent holders, agreeing to cross-license patents relating to a particular technology[3]. The creation of a patent pool can save the patentees and licensees time and money, and, in case of blocking patents, it may also be the only reasonable method for making the invention available to the public.. The primary goal of patent pools is to reduce royalty rates. They achieve this by proposing a business model through which an interested party is enabled to license the entire portfolio of patents in the pool through a single transaction, at a single price.
Patent pools have raised popularity in some areas of technology for example MPEG video compression or IC memory technology and started to have a limited impact in wireless technology as well[4]. An example of patent pool initiatives in wireless industry is "3G Patent Platforms" proposed by 3GPP. Such initiative would benefit both in seeking licensing and protecting against litigations. Patent pools are more likely to be accepted at first by smaller companies, easily intimidated by the threat of lawsuits, which is not the case with large companies who dispose of dedicated departments for handling IPR and budgets for enforcement and defense issues.
The initiative to form an industry specific patent pool, over the private patent pools such Via Licensing, came from the rationale that, a public, nonprofit patent licensing pool, would create a joint defense against aggressive licensing actions. Non profit establishment of patent pool for LTE technology would reduce costs and control better the risks[5].

[3] http://en.wikipedia.org/wiki/Patent_pool
[4] Maravedus WiMAX/LTE 4g Intellectual Property Rights Policy and Market Report, February 2007, page 42
[5] Maravedus WiMAX/LTE 4g Intellectual Property Rights Policy and Market Report, February 2007, page 44

However efforts in establishing patent pools continue to be made by private companies such Via Licensing, Sisvel and MPEG who have already initiated meetings with LTE patent owners to discuss the structure and terms of a future patent pool. *But not all the major actors prefer patent pools.*
According to ABI Research Report "Mobile Device Royalties, Intellectual Property Rates for GSM, WCDMA and LTE" , 2008, *Nokia, Nokia Siemens Networks, Alcatel Lucent, Ericsson, Sony Ericsson and NextWave Wireless already formed another type of initiative* to provide a "*predictable and more transparent maximum aggregate costs for licensing IP rights"*. However this initiative excludes a large group with solid portfolio in LTE such Qualcomm, Nortel, Interdigital.

2.4.2 Patent Disputes

In the last two years the wireless industry has been also animated by patent disputes, except the ones initiated or caused by NPEs (Non Practicing Entities). The most important disputes involve IPCom, Nokia, Apple and Qualcomm. Among the mentioned Nokia has been involved in disputes both with IPCom and Apple.
In the last three years, IPCom[6] has fought against Nokia over patents and their validity. In January 2010 UK High Court has ruled in favor of Nokia[7]. According with the UK High Court decision Nokia has not infringed two of IPCom patents related to mobile network technology since the patents were invalid. The dispute between Nokia and IPcom continue though, in trials related to the validity of other patents and countersuits.

Another major dispute, this time involving Apple, was launched by Nokia at the end of 2009. Nokia has sued Apple over patents related to GSM, UMTS and WiFi where Nokia is demanding royalties plus grand backs which could sum to hundreds of millions in annual royalties. Apple denies the patents are actually essential to GSM /UMTS, it denies infringing them and considers them invalid and unenforceable[8]. In return Apple countersuits Nokia for infringing on their user interface patents.

In August 2009 Qualcomm was accused by Japan Fair Trade Commission (JFTC) of forcing Japanese licensees to give Qualcomm access to their patents on a royalty free basis. Qualcomm was ordered by FFTC to eliminate cross licensing and not to assert provisions in its patent-licensing agreements with Japanese companies that impede fair business practices[9]. Qualcomm is put in a delicate position and is set to dispute the claim.

As a follow up of the business context in which the paper is being written, the following chapter presents a review of the relevant contemporary literature on the selected topic, with particular focus on quantitative landscape assessments.

Chapter 3 Literature Study

[6] IPcom Technologies is a company specialized in designing, developing and implementing Core Platforms and Value Added Solutions (VAS) for the mobile and fixed telephony market.
[7] http://www.reuters.com/article/idUSTRE60H37620100118. Retrieved 2010-05-23
[8] http://www.engadget.com/2009/12/11/apple-countersues-nokia-for-infringing-13-patents/. Retrieved 2010-05-23
[9] http://www.law360.com/registrations/user_registration?article_id=125359&concurrency_check=false

The background literature is based mostly on **industry reports** and **articles** on the topic of patent landscaping. Unfortunately no academic studies have been identified to tackle the topic of keyword based patent landscaping.

The current chapter is meant to emphasize what are the theories behind the frameworks and methods used to draw the analyses and conclusions of this study. The chapter is also meat to offer the reader a plus of information on current methodologies and directions of research on the topic, even though they could not explicitly be used in the current paper.

While the industry reports offered the background information and suggestions on the applications areas, the different articles on the topic of patent landscaping methodologies offered the frame for the analysis and conclusions of the study.

By reading different industry reports, was created an understanding about the methodologies currently used by analyst companies, on how the portfolio of patents are being evaluated, and how these reports are being used in communication purposes. A common characteristic, among all the studied reports, was the brief descriptions of their methodologies. On top of that almost all the reports presented very different methodologies in their analyses, different databases, period of observations and approaches.

The main conclusion taken from the different industry reports is that, at the moment, there is no common accepted methodology of analyzing patent portfolios: quantitative or qualitative. Every analysis presented in the reports proved contextual and unique.

3.1 Articles

A series of articles have been consulted as a background literature. The purpose was to use them as theoretical frameworks, and to reapply their suggested methodologies on the current study. However the articles, very few related directly to the scope of the current study, proved insufficient. In this case the methodologies used by the current study have been inspired partly from different frameworks suggested in some articles, industry reports (such ABI) and recommendations from the experts within Ericsson.

To exemplify, the article of *Evert Nujhof* ***"****Subject analysis and search strategy-Has the searcher become the bottleneck in the search process?"* written in March 2006, offered the theoretical framework on how define searches and identify keywords to capture the desired area. The article proved insightful in the area of search strategies.

Other literature suggestions were *Miles and Huberman, 1994 edition of Qualitative Data Analysis,* which provided techniques and ideas on qualitative analysis methods used in the interviews performed with the inventors. More exactly the current study used Miles and Huberman suggestion of using semi structured interviews in order to give the opportunity to free discussions in the desired direction.

Other borrowed concept was the Technology tree visual representation of the LTE field, a concept widely used nowadays across different areas of applications, with the purpose to map the existing technological developments at different levels. This concept was initially used in software design.

In consequence the current paper presents **two different methodologies** which gave the two directions of the study: a) one methodology related to the buzz words search strategy, very simple and inspired from industry reports such ABI reports; b) one methodology used for the study of Technological Breakdown Analysis which includes existing theoretical frameworks mentioned in the next paragraph.

The following section of the chapter will offer short overview of all the articles studied as background literature. The purpose behind is to offer the reader a plus of information on the current patent landscaping methods theories published in scientific articles, even though they were not explicitly used in the current paper.

Reading different articles one could notice a wide usage of patent information in areas such competitor monitoring, technology assessments, R&D portfolio management, identifying sources of external knowledge, human resources management etc. Some articles support the retrieval and evaluation of patent data in-house due to their strategic value and to ensure a permanent, systematic and continuous use of patent information in decision making process. Other articles target to the external stakeholders of the firm such analyst who is interested in assessing a firm’s technological competences from an outsider perspective.

Many articles tackle the topic of patent analysis from a strategic planning and knowledge management perspective; others go more into explaining methods of analysis. The first category discusses the application of patent information analyses; the second category discuses methods of analyses as such. The most used methods of analyses are citation analyses, patent mapping and visualizations. In this sense there are proposed different methods to retrieve and use patent information such social network analyses meant to facilitate visualization or analysis and cooperation between technology fields, patent applicants, inventors or patent documents.

3.2 Industry Reports

The **industries reports** used as a background literature constitute the starting point of the hypotheses presented in the current paper. Except ABI reports, to some extent, none of the studied reports offered a clear framework or methodology possible to reapply. This is because all the reports exposed only brief guidelines of the methodology used in reaching their results. Also no common approach could be extracted from all the reports since they all used different methods and perspectives.

The methodology used by ABI is the closest to the one used in the current paper for the Buzz words/indicators search strategy. An ambition to replicate their analysis has been shortly left behind due to the lack of clarity on their searches and databases used. Basically only the suggested keywords used in the ABI reports were used in the Buzz words Search Strategy presented in Chapter 5.

The following section of the chapter will offer a short description of all the reports studied as background literature. The purpose is to offer the reader a plus of information on the different patent landscaping methods currently applied across mobile industry. The following section is also meant to exemplify what quantitative and qualitative methods are being used by the industry analysts especially since they present different methodologies of the ones presented in more scientific papers.

ABI Research Report "*4G Intellectual Property and Royalties" an Analysis of LTE, WiMAX and UMB written in 2007*, offers a 4G IP landscape assessment around the LTE, WiMAX and UMB at different technology levels common to the 3 areas such: beam forming, fast power control, hybrid ARQ, MIMO, OFDM, OFDMA, SC-FDMA and SDMA. They offer conclusions at company level per each technology analyzed from a patent perspective. They mention to a certain extent the criteria behind each search, however it is not mentioned what tools or methods have been used to process the data and reach the conclusions. For example when analyzing the area of Beamforming, ABI has mentioned that records which included beamforming in their description were identified. On top of that they offered details on the timeline of patent filings used for narrowing down the search, jurisdictions and the section of the patent in which the searches have been performed. Though it might seem sufficient, the tools and databases used to perform analyses could also change the results of the conclusions. More details on the specific queries used in the searches would also help at understanding if all the necessary keywords have been included in the search. *ABI reports were the only ones approaching the keywords based landscape assessment.*

Fairfield Resources International Inc is a good example of Analyst Company which reports conclusions based on qualitative measures such as declared essential patents to the standards. They propose a unique method to analyze the patents which are declared essential by industry members to ETSI[10]. Therefore their database for analyze is created by the declared essential patents at ETSI. Their methodology is highly contested mainly due to the particularity of their method.

Contesting is a generalized reaction for almost any report coming on the market since, that report most likely presents a new and unique methodology, doesn't offer clear understanding

[10] European Telecommunications Standards Institute

of the data and methodology used, or the results presented do not match any other report's outcomes.

Quantitative methods of analyze were used in unique ways and mostly to narrow down the area of search to a certain level where qualitative assessment could be applied. For example **Maravedis** in their WIMAX/LTE 4G Intellectual Property Rights Policy & Market Report , published 1st of February 2007 has used an unique method to create a database of patents and applications judged to become part of the standards relevant for the technology. After a database of 6000 records related to the WIMAX/LTE field of study has been created, each record has been individually judged if it corresponded in the database or not and in consequence the database was reduced to only 3500 records. Only at this stage each record was evaluated taking into consideration criteria such essentiality and other valuation methods. However the study mentions very briefly the criteria on which the initial 6000 records have been selected for further study or the criteria to narrow down the group to only 3500. This lack of details makes it hard to understand on what basis the conclusions are being taken, in return raising more question signs.

3.3 Summary

The first section of the chapter focuses on all the articles used as background literature for the current study. The section emphasizes which theoretical models and frameworks were used in drawing the framework and conclusions of this study. On top of that it discusses also the current direction of research in the field of patent landscaping as such. This comes as a consequence of the fact that keyword based patent landscaping is almost never a method used or analyzed by itself. The scientific articles and industry studies proved that almost in every case the keyword based patent landscaping is complemented with more qualitative methods as well.

The second section of the chapter focuses on all the industry reports used as background literature for the current study. The section emphasizes which reports offered frameworks that could be used in drawing the methodologies and conclusions of this study.
The second section discusses, also the uniqueness of each report in terms of methodology, criteria, and tools, trying to bring a perspective on current methods of analyses preffered and applied by industry analysts.
The initial desired outcome of the reports was to use them as a learning tool. However the uniqueness of their methodologies and lack of details in their methods made it difficult to obtain more than a high level perspective. Their contextual approach makes it hard to be trusted as well, since their results can be considered as one time situation.

The diversity of methods is a consequence of no consensus which characterized the entire IP valuation field of study. Lack of common accepted methodology makes it a challenge for all the promoters of patent landscapes, since until a common accepted method is being recognized, these reports will not be used more than extra information in decision making process. Until a consensus and best practices examples are being set one has only to favor a certain approach and follow the evolution from that perspective.

Chapter 4 Research Methodologies

This chapter provides an overview of the methodologies and research approaches for the study of Patent Landscape Assessment. In its exploration on the ways to perform a quantitative assessment the thesis investigates different search strategies and their outcomes. This chapter supports the entire study by offering detailed information on the methods and methodologies preferred.

The current chapter includes four important sections:

- The first section of the chapter (4.1) focuses on the objectives of the study, the underlying questions and hypotheses.
- The second section of the chapter (4.2) motivates and discusses the two search strategies selected for the study and their methodologies.
- The third section of the chapter (4.3.1) discusses the approaches taken in reaching the objectives of the chapter: the *deductive approach* taken for the buzz words/indicators search strategy, the *inductive approach* taken for the Technology Breakdown search strategy, the *qualitative* and *quantitative approaches* used for all the analyses performed.
- The forth section of the chapter (4.3.2) focuses on the actions taken to reach the objectives of the study: the keywords generation, the interviews, the queries construction, the results generations.

4.1 Research Background

The following section will focus on the hypotheses, questions and objectives of the study. The hypotheses represent the starting point of the study, the "issues" raised by the specialists of the area which needed to be answered in order to clarify to which extent these types of searches can be trusted.

4.1.1 Research Hypotheses

- *A first hypothesis* of the study is that search results can be misled by infiltrating specific keywords in the body of the patent with the purpose to generate high hit rates. These keywords would be represented by already established terms, easy to introduce in the body of the patent, even though not related to the content. A set of keywords was "suspected" to be noise generator and a closer look was taken into this direction: Long Term Evolution (LTE), Super 3G, evolved UMTS Terrestrial Radio Access Network, and Evolved UTRAN.
- *A second hypothesis* is the fact that keyword based patent landscapes are highly dependent on the nature of the keyword used in the search: *there is sensitivity offered by the keywords.*

- *A third hypothesis* is that certain searches results differ among each other not only as a result of the used keywords but also as a result of the section of the patent in which they are applied. As an exemplification a search query including the same term “Long Term Evolution” could return different results if executed in the Full text of the patent, than in the Claims section of the patent.
- *A forth hypothesis* is the fact that there are several ways to perform keyword based patent landscape assessments. While a search pointing directly to the technology/area analyzed could prove more efficient and effective it might not offer an overview of the underlying sub technologies which would ask a different approach. To cover this need at looking at sub technology level the study is proposing the “Technology Breakdown Analysis”.

Having the hypotheses clarified it was easy to summarize the most important questions of the study.

4.1.2 Research Questions

The study aimed at answering the following questions:

1. How different are among each other the searches performed in different sections of the patent such Title or Full Text or Claims?
2. How is the set of keywords changing the results of an assessment? Is it a big different among the landscapes? Are keywords creating sensitivity?
3. What is the best way to create a query search that would encircle the technical area and minimize the noise?
4. What are the limitations of keyword based landscape assessments?

Following, the Objectives resulted from thinking how to answer the main questions of the study, and they represent the pillars of the study.

4.1.3 Research Objectives

1. To study the existent literature in the field, identify previous academic studies and developed models that would be of help in performing keywords based patent landscape assessments.
2. To analyze different search strategies of a keyword based patent landscape assessment.
3. To determine the best approaches of keyword based patent landscape assessment
4. To demonstrate the sensitivity given by the keywords and section of the patent.

The second section of the chapter motivates and discusses the two search strategies selected for the study and the methodologies behind.

4.2 Research strategy

4.2.1 Keywords classification

The purpose of this section is to offer some understanding on the nature of the keywords which lead to the two search strategies presented. The following paragraphs will focus on classifying the keywords used and thus motivate the search strategies proposed.

One classification of types of keywords used in searches is single keywords (one term only) and multiple keywords (multiple terms grouped).

The single keywords can be grouped in two major categories: generic keywords and indicators/buzz words. *Generic keywords* are general terms common to more different areas of search or technologies such for example terms “delay”, “channel”, “transmission” etc. Searches which include generic terms very likely to identify more than the searched area; they will return a lot of undesired information (noise), which makes it very difficult to separate the relevant records of the less interesting ones. *Indicators/buzz words* are words related to the topic of search. They are used in a certain context area or to define a certain technology. An example of such a keyword is “LTE”. The “indicators” or “buzz words” are referred in the study as “specific” as well.

The multiple keywords are a combination of two, three, four or more terms. An example in this sense is “Single Carrier Frequency Division Multiple Access” (SC-FDMA). SC-FDMA is frequency-division multiple access scheme characteristic to LTE.

The multiple keywords can also be similarly classified. This can be done according to the nature of the single words forming the multiple keywords; therefore multiple keywords can be grouped as well in *generic* and *indicators*. It is safe to say that by combining two generic keywords one obtains a generic combination of multiple keywords such for example the terms: access selection, admission control etc. But there are exceptions too. Some combinations of generic terms could prove specific for a certain area and therefore the resulted multiple keywords can act as “indicators”. An example in this sense is “Long Term Evolution” multiple word which includes three generic words but creates a unique combination and therefore is classified as an indicator. Other examples could be: Fast Power Control, Multiple in Multiple out, Super 3G etc.

Using this classification one could say that the first search strategy presented in Chapter 5, - **Buzz words/Indicator Search**- includes **single and multiple indicator** type of **keywords** while the second search strategy presented in Chapter 6- **Technology Breakdown Analysis**- includes **single, multiple indicators and generic** type of **keywords.**

4.2.2 Patent Landscaping Parameters& Processes

This section gives an overview of all the variables/entry data used in the analyses of this study and the steps of the analyses. Overall the study has focused its attention towards two variables only: **keywords** and **section of the patent**. All the other parameters have been kept constant for all the analyses in order to keep the focus on the dynamic of the two variables under observation.

The following figure will visualize the preferred process of analysis applied for the current study. Each analysis is unique in the sense that it focuses differently on any of the above mentioned steps. While some analyses require more focus on the preparation of the data as it happened for the Technology Breakdown Analysis, other analyses require more focus on the analysis step or on presenting and offering recommendations as in the case of Buzz words/indicators analysis and Patent Section Analysis.

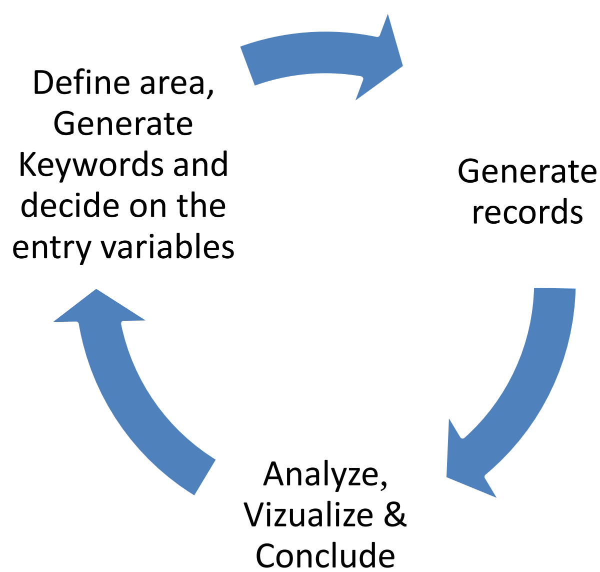

Figure 1 Analysis process

A) Define area, Generate Keywords & other parameters

The first step of the all the analysis includes decisions and actions such as to:

a) Define the area of interest and the questions to be answered by the analysis
b) Decide and/or identify a set of keywords to encircle the desired area and strategy
c) Decide the entering parameters of the analysis such :
   - Section of the Patent in which the search can be made

- Time frame
- Publication Number
- Date of publication
- Priority numbers
- Class Codes (IPC, Derwent, ECLA etc.)
- Patents and Patent Families

A lot of time and effort was put for this step in the case of the Technology Breakdown Analysis. This is due to the process of defining the LTE sub areas using the Technology Tree model, identifying keywords to encircle every sub area and creating the search queries.

B) Generate records

This step includes the part in which the queries are being run in Thomson Innovation, reports generated and exported in Thomson Data Analyzer.

C) Analyze, Visualize and Conclude step includes the stage in which the report results are being analyzed and communicated to the audience.

This is the step where most effort has been put in the case of the Patent Search Analysis, related in Chapter 7, by analyzing the results through statistics and different visualizations, before concluding the results.

4.2.3 Search strategies

The study proposes two search strategies. The reasoning behind the two search strategies is based on the nature of keywords used in the searches and the objectives to be reached. The first strategy uses indicators or buzz words while looking at the search area for an overall perspective. The other strategy uses a larger diversity of terms meant to encircle sub technologies of LTE and capture background records as well.

The keywords (single or multiple) could be combined using different operators. In this study only two operators have been used “AND” and “OR”. “AND” operator identifies the documents which include all the keywords in the search. “OR” operator, on the other hand, identifies all the documents that include at least one of the keywords in the search.

4.2.3.1 Buzz words/indicators strategy

The first search strategy of the study is built using only buzzwords: single or multiple. Since buzzwords are specifically targeting towards the desired area, the query search was created to capture all the records that include at least one of the used keyword, therefore an “OR” operator was sufficient.

Three analyses have been performed following the above mentioned strategy with the purpose to use a larger variety of buzz words on which to base the final conclusions:

The first analysis includes several searches based on following four buzzwords: “Long Term Evolution”, “Super 3G”, “Evolved-UTRAN” and “Evolved UMTS Terrestrial Radio Access”. The terms were recommended by the experts within Ericsson.

Example of query:
ALL= (LTE OR long term evolution OR E-UTRA OR E-UTRAN OR Evolved UTRA OR Evolved UTRAN OR Enhanced UTRA OR Enhanced UTRAN OR Evolved UMTS Terrestrial Radio Access OR Enhanced UMTS Terrestrial Radio Access OR super3G or super-3G OR super 3G)

The second analysis includes a different nature of buzzwords based on following examples offered by the ABI Research Report “4G Intellectual Property and Royalties” an Analysis of LTE, WiMAX and UMB written in 2007: “Beamforming”, “Fast Power Control”, “Hybrid Automatic Repeat Request”, “Multiple in Multiple Out”, “Orthogonal Frequency Division Multiplexing”, ”Orthogonal Frequency Division Multiplexing Access”, “Single Carrier Frequency Division Multiple Access”, “Space Division Multiple Access”.

Example of query:
*ALL= (OFDM **OR** Orthogonal Frequency Division Multiplexing)*

The third analysis includes the buzzwords used in both the first and second analysis.

Example: *ALL=(LTE OR long term evolution OR E-UTRA OR E-UTRAN OR Evolved UTRA OR Evolved UTRAN or Enhanced UTRA OR Enhanced UTRAN OR Evolved UMTS Terrestrial Radio Access OR Enhanced UMTS Terrestrial Radio Access OR super3G or super-3G OR super 3G OR beamforming OR beam forming OR fast power control OR Hybrid ARQ OR HARQ OR H-ARQ OR Hybrid Automatic Repeat Request OR MIMO OR Multiple in Multiple Out OR OFDM OR Orthogonal Frequency Division Multiplexing OR OFDMA OR Orthogonal Frequency Division Multiplexing Access OR SC FDMA OR SCFDMA Single Carrier Frequency Division Multiple Access OR Space Division Multiple Access OR SDMA)*

The results obtained by using buzzwords search strategy suggested that **sensitivity is created not only at keyword level but also at patent section level.**

The details regarding the analyses around this strategy are found in Chapter 5 and Appendices A, B and C. The details regarding the patent section search can be read in the Chapter number 7 and Appendix D.

4.2.3.2 Technology breakdown strategy

The second search strategy meant to avoid the use of **only** buzzwords. The reason behind is the fact that not all the areas are characterized by buzzwords. An example in this sense could be emerging areas where most of new technologies are explained on old terminology and concepts.

The second search strategy had the purpose to avoid potential noise introduced by the misuse of buzzwords and also wanted to offer the opportunity to look into an area at different levels: technology and sub technology.
Therefore the keywords used in this search strategy were decided to be of any nature: single or multiple, generic or indicator.

In order to come with a different set of keywords the decision was taken that the LTE technology will be broken down into sub technologies and each sub technology analyzed separately. In this example extra effort has been put in both defining the sub technologies and come up with a list of keywords relevant for each area. The keywords obtained are mostly generic and thus common for other technologies as well, which makes it difficult to separate LTE of the rest. While in the previous strategy the effort, put into the identification of the keywords, was minimal, in this strategy most of the effort and resources were spent into the identification of the keywords to be included in the queries.

Example query used for the Multi Antenna Systems area (one of the LTE sub technologies analyzed in the Technology Breakdown analysis):
ALL= (Beam shape OR Reference Signal OR MIMO OR Scheduling OR Transmit Diversity) AND (antenna)

From a research perspective the uniqueness of this strategy, comes with the identification process of keywords and creation of the technological tree that identifies the LTE sub areas.

The details regarding the analyses around this strategy are found in Chapter 6 and Appendix E.

The third section of the chapter discusses the approaches taken in reaching the objectives of the chapter: the deductive approach taken for the buzz words/indicators search strategy, the inductive approach taken for the Technology Breakdown Search strategy, the qualitative and quantitative approaches used throughout the study.

4.3 Research Design and Methodology

4.3.1 Research approach

The research strategy was experimental and involved both a deductive and inductive approach.

4.3.1.1 Deductive approach

The deductive approach was used in order to test the existing theories and percepts that formulated some of the study's hypotheses. However in the deductive process a series of data were collected and used in order to create observations, patterns and theories (which involved an inductive approach as well). Therefore the thesis combines both "top down" as the "bottom up" methods of research. The top down approach and therefore the deductive approach can be identified while working with the searches around established keywords such "Long Term Evolution", "Beam Forming" or "Super 3G" such in the Buzz words/indicators search strategy while the inductive approach was mostly used as part of Technology Breakdown search strategy and Patent Section Search analysis.

4.3.1.2 Inductive approach

The inductive method of research consisted in observing patterns on the sets of data obtained from testing the initial hypotheses. The inductive thinking was used while working around the "patent section search sensibility" where observations were made on results obtained after applying statistical methods. Also the interviews part of the "technology breakdown analysis" required a more inductive way of thinking.

In the case of Patent Section Search Analysis presented in Chapter 7, the inductive approach consisted in selecting a set of data to observe, create observations and emphasize patterns. This process led to a set of conclusions meant to improve the future search strategies. The results of this inductive method will be elaborated in Chapter 7 related to the sensitivity of the patent section search.

The inductive thinking was also used in the Technology breakdown analysis. This analysis is a unique type of assessment, suggested in different literature studies[11], a more ambitious method meant to narrow down, through keywords based search, a specific technological area while avoiding the noise created by intentional introducing of certain terms.

Therefore in this case the idea behind was that, a more sophisticated analysis model with a visualization of the technology tree and a bottom up analysis, based on multiple queries that would encapsulate each separate subarea, would replace the simplistic model of query based on buzzwords.

In both of these approaches different tools have been used in both quantitative and qualitative purposes. For quantitative analyses the tools used were Thomson Innovation database and Thomson Data Analyzer. They were used in the process of isolating the area of search, extract reports and compare results. The quantitative approach was part of all the analyses performed.

4.3.1.3 Qualitative approach

If the Buzz words/indicators search strategy proves less complicated when selecting keywords and creating queries, the "technology breakdown analysis" strategy proves more complicated in this aspect. This is where a more qualitative way of identifying keywords was necessary,

[11] Evert Nujhof , Article "Subject analysis and search strategy-Has the searcher become the bottleneck in the search process?", March 2006

consisting in interviews, building a technology tree and suggesting keywords for encircling the desired area.

4.3.1.4 Quantitative approach

Straightforward statistics such standard deviation was used in order to represent the average and variability of occurrences and to draw any conclusions on the relationship between the variables analyzed. This part of statistics was mainly applied to the patent section search analysis in order to prove the sensitivity scenarios.

The fourth and last section of the chapter focuses on the actions taken to reach the objectives of the study: the keywords generation, the interviews, the queries construction, the results generations.

4.3.2 Research methods

4.3.2.1 Keywords generation

Part of the study was based on the *quantitative keywords generation* and part on the *qualitative keywords generation*. In this study the term data represents the numbers of patent families returned by each search.
The quantitative collection was part of the Patent Section Search analysis where more than 700 data points were analyzed before the results were concluded. This method of collection was permitted in this situation by the nature of the data analyzed: *numbers (quantity)* of patent families.

Qualitative keywords generation was applied on the Technology Breakdown Analysis. The sampling was done by interviews, direct observation and study. The purpose of the interviews was to collect keywords relevant for the area of search. For each area of search a similar interview was executed.

In this study interviews were included as method of keywords generation since the resources were available. For each area of interest, experts were available to offer the necessary input. If experts are not available to consult, direct observation and study should complement the interviews. However the direct observation and study of the field of interest should be thoroughly performed in order to include all the potential keywords relevant for the area of search and overcome the recommendations of an expert.

Therefore in the quantitative sampling process two sources of keywords generation have been used: the primary one consisted in direct observation and study and the secondary one consisted in interviews with experts.

When it comes to the nature of interviews the semi-structured in depth interview was preferred. The semi-structure method was preferred to unstructured or structured, due to the necessity to let the expert describe freely the area of interest while leading the discussion towards the direction of interest by gaining depth. Also since there was no need of gathering numerical data to apply statistics, more emphasize has been put in trying to understand the complexity of the technological area and generate insightful stories around the LTE technology.

Notes were taken for all the interviews.

Each interview was processed in a different way due to the uniqueness of the field covered, while ensuring the same pattern and outcome. The notes of each interview consisted mostly in pure descriptions of the technological areas with emphasize on the terms used. This was helpful both to collect the terms and to get a technical understanding on the area analyzed, which helped later on at creating search strategies.

All the data collected through both qualitative (interviews) and quantitative (Thomson Innovation reports) methods were handled respecting the process previously described.

4.3.2.2 Interviews

The interviews were mostly directed towards discussing the technical area analyzed and they are specific only to the Technology Breakdown Analysis. The purpose was to obtain a relevant set of keywords, which included in a search query, would isolate the desired search area while minimizing the noise. The keywords obtained where classified into terms that would either describe processes and phenomena or locations where processes would take place.

Since the interviews requested a high technical expertise, the interviewees were selected from inventors working with the Long Term Evolution Technology within Ericsson. Eight inventors were chosen to be interviewed, all of them experts in the area of interest, with years of experience in the previous technologies as well and a consistent number of inventions filed.

Each interview was thoroughly prepared in advance in order to ensure a constructive and fruitful outcome. Constant support during the interviews was offered by the Head of Ericsson LTE Patent Portfolio.

All the interviews were semi structured. When deciding upon the interview format the decision was taken in favor of this format due to the experimental status of the entire Technology Breakdown Analysis, with no previous similar interviews that could offer insight for the structure of the interview. Also a semi structure format of the interview was to be preferred in order to avoid the rigid structure of a structured interview, and allow interviewers to spontaneously add their comments and questions. An unstructured interview on the other hand would have proved too loose and risk to get off track by going to much in detail or missing the final objective. Therefore the semi structured interview ensured that discussion remained on the topic by allowing the interviewee and interviewer to interact, add explanatory remarks and comments.

4.3.2.3 Transcribing

All the interviews were note taken. Since the interviewees were part of Ericsson, no confidentiality agreement has to be put into place among the participants. Since the interviewees consisted only in purely describing and explaining the different LTE technological areas, no sensitive issues were discussed, thus the general knowledge nature of the content did not require back transcriptions of the interviews. Therefore due to the purpose of the interviews, to collect keywords relevant for each area of research, a traditional transcribing was not necessary but instead lists and classifications with keywords were created.
By creating lists of keywords particular to each technological area the analyst had the chance to match together the collected keywords from the interviews with the ones collected from own study of the technical field and direct observation. By going through all the interviews more insightful understanding of the field was created.

4.3.2.4 Queries

The two search strategies mentioned above were given by the nature of keywords included in the queries.

The first search strategy includes “identifier” or “buzz words” types of keywords such: LTE, Super 3G, Beam forming, HARQ, Fast Power Control etc. These types of keywords are meant to take the search in the desired direction. However they do not guarantee returning all the relevant records. For example early background patents which would not include terms of this nature would probably not be identified through this type of search. Therefore the setback of these searches is the fact that the returned records are the ones including only these specific keywords, which does not mean they are indeed relevant for the area of search nor does hint how many other records are excluded from the search.
For this study the queries were identified by studying the literature in the field, analyst reports and taking suggestions from the experts within Ericsson.

The second search strategy, part of the Technology Breakdown Analysis, includes a more elaborated methodology to create the query search. The keywords obtained from the interviews were of all types: single, multiple, generic, descriptive (phrases such “fast control”) , attributes (fast, performant etc.) or “buzzwords/identifiers” (OFDM). The number of records returned was very large for almost all the areas of interest which represented a problem both in the constructions of the queries (too large to be properly run in Thomson Innovation) and in estimating the noise. Therefore was needed a methodology to better combine the keywords and to narrow down the string to only the relevant keywords.

Once the keywords were collected and classified, queries were creating respecting the structure: “processes/phenomena AND Locations”. All the keywords part of the processes group were combined together (operator “OR”) and then run (operator “AND”) against the group Location.

Processes	Location
Access selection	Traffic channel
OFDM	S1 control plane
Source coding scheme	Control channel

Table 1 Keywords categories

Example: *("access selection" OR "OFDM" OR "Source coding scheme") AND ("traffic channel" OR "S1 control plane" OR "Control Channel").*

The search strategy is meant to capture WHAT is happening in the area of search with WHERE the process/phenomenon is taking place (AND operator).

After the query structure has been defined the third step was to identify which of the keywords better target the area of search while reducing the noise. This was compelling since an initial search would start from a number of 50 keywords which would return a large number of records, from which mostly would be noise.

In order to be able to simplify the queries, a methodology to identify the relevant keywords was created. A keyword would be considered relevant when targeting the desired area of search by generating as little noise as possible (reducing the number of irrelevant records).

In order to decide if a keyword is targeting the area of search, Ericsson own LTE Portfolio of patents has been used to give the direction. Only the keyword which would identify considerable records within Ericsson Portfolio while creating moderate noise would be considered relevant and considered for the end query. The values for what was considered moderate noise and considerable number of records were decided in an iterative process in which the outcomes of each keyword would be compared with the other.

In this systematic way only the groups which would minimize the number of the records returned (and thus the noise) and maximize the number of records in the Ericsson LTE portfolio were kept in the final queries.

4.3.2.5 Results generation

Exports and reports is another method used in handling the data. This is a purely quantitative method of handling data compared with the interviews and transcribing which form the qualitative type of methods. Compared to the interviews, exports and reports are specific to both search strategies presented in the study.

The handling of data through exports and reports was made using Thomson Innovation and Thomson Data Analyzer tools. Once the queries have been run in Thomson Innovation, the results were being reported and exported in Thomson Data Analyzer. Thomson Data Analyzer offered its functionality to remove all the double counting and group all families by its representing entity.

Chapter 5 “Buzzwords” Search Strategy

5.1 Overview

As mentioned two search strategies are being presented in this study. The first search strategy focuses on using buzzwords in patent searches. The advantage of this approach is that is efficient and effective and does not require many resources in terms of time and effort. The search returns all the documents that include the specific buzz words which are related to the field of search. However the search excludes any other documents relevant for the field of study not identifiable by specific buzz words, e.g. typically older documents. The search is based on buzz words only and can be misled by intentional introduction of buzz words in patents not related to the field of study.

5.2 Implementation

The following section will focus on discussing the details of implementation of this search strategy.

The timeline used was for the patents with Earliest Priority Date 2005-current period and patent searches were conducted in Title, Abstract or Claim sections , using Thomson Innovation database, including All jurisdictions[12] and combining the keyword searches with International Patent Classification notation (H04). The results were limited to patent families. The data were imported in Thomson Data Analyzer and further analyzed.

The details of the analysis can be read in the Appendices A, B and C.

The idea behind creating the search was to use only indicator type of keywords (buzzwords), suggested by Ericsson experts. In this analysis were used: Long Term Evolution, Super 3G, EUMTS and E-UTRAN. The analysis included five different searches: one which included all the terms mentioned and four others including one term at the time.

5.3 Conclusions

The analysis revealed the extent of keywords sensitivity, exemplified further.

Figure 2 illustrates the results of the search including only the variations of the term “**Long Term Evolution**”, where Ericsson is ranked first, followed closely by Qualcomm and Nokia. The search query is (*“LTE”* ***OR*** *“Long term evolution”).* The effect is that this landscape is favoring Ericsson and Qualcomm.

[12] By All jurisdictions the study refers at the following Patent collections extracted using Thomson Innovation Database: US Granted, US Applications, WIPO Applications, European Granted, European Applications, British Applications, French Applications, German Utility Models, German Granted, German Applications and Asian Translated (Japanese Utility models. Japanese Granted, Japanese Applications, Chinese Utility Models, Chinese Applications, Korean Utility Models, Korean Granted/Examined, Korean Applications)

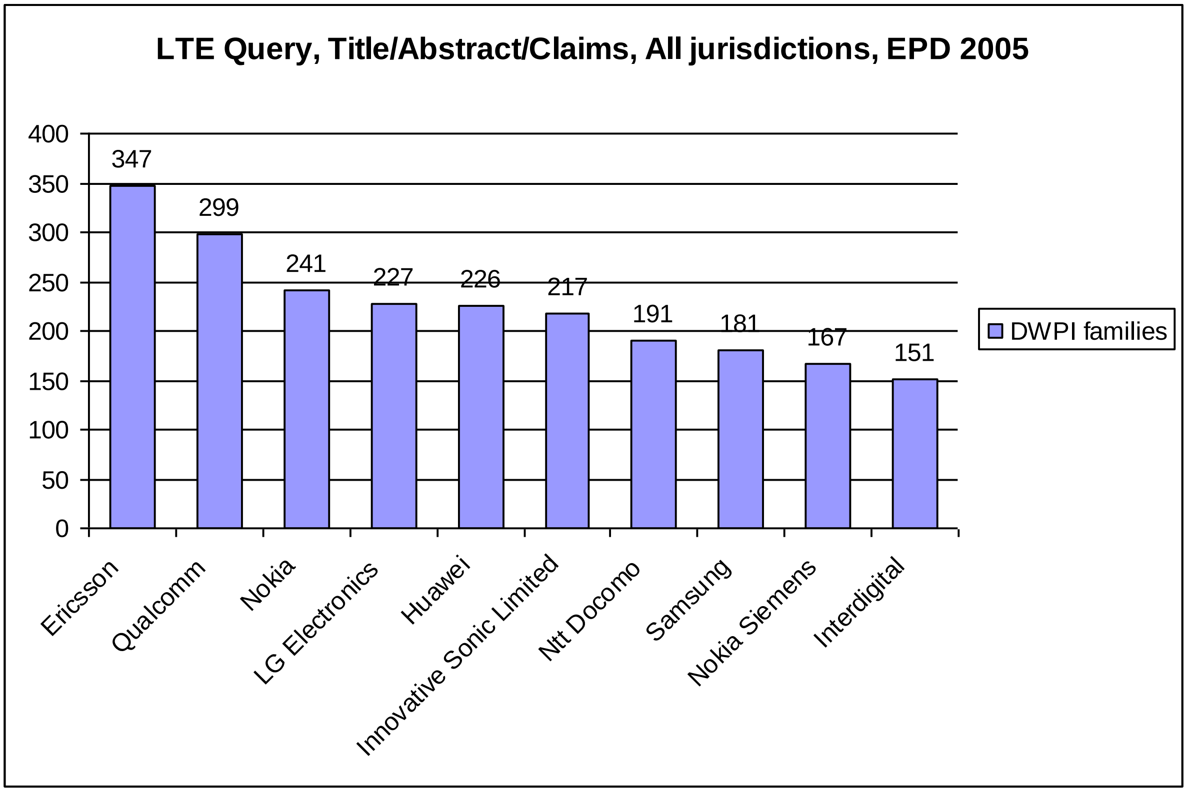

Figure 2: LTE Query, Patent Section Title/Abstract Claims, All jurisdictions, Earliest Priority Date 2005

In a different example query including the variations of **E-UTRAN** term favored Qualcomm and Nokia instead of Ericsson. Ericsson is ranked the third in this example followed by Interdigital and LG as the fifth.

The search query of this scenario is: *("E-UTRA" or "E-UTRAN" or "Evolved adj UTRA" or "Evolved adj UTRAN" or "Enhanced adj UTRA" or "Enhanced adj UTRAN")*

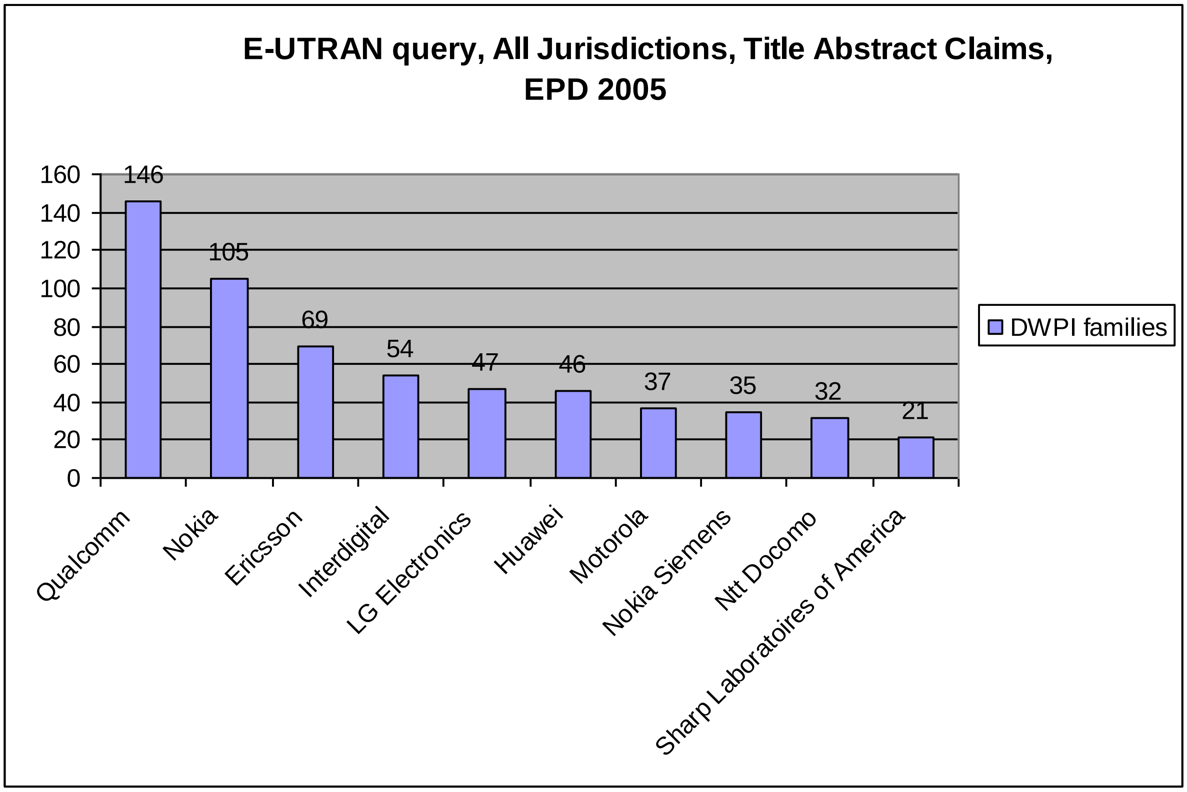

Figure 3: E-UTRAN Query, Patent Section Title/Abstract Claims, All jurisdictions, Earliest Priority Date 2005

When looking at the results it is also important to notice the absolute number values of the results in order to avoid taking wrong conclusions. An example in this sense is Figure 3, where the first ranked company Qualcomm counts over 140 patent families while the last ranked company Sharp laboratories of America counts around 20 patent families (1/7 of Qualcomm own portfolio). These values give the information that Qualcomm has a much larger portfolio of patents than all the other companies. In Figure 2, the difference between the first ranked company Ericsson (counts around 350 patent families) and Interdigital (150 patent families, only 1/2 of Ericsson value) is much smaller. This tells us that patent sizes of each top ten companies presented in Figure 2 are closer in value, which brings us to the conclusion that the top ten companies present similar weight of their portfolios.

When analyzing the results of the query search including the term **Super 3G** the rakings favored NTT Docomo who shows up first in ranks. This is a landscape in which the leader is NTT Docomo. Qualcomm (leader in the previous rankings) does not even appear in the ranking. But the conclusion of this search versus the previous ones is not that NTT Docomo is the leader but rather that super 3G is not a term used by Qualcomm in their patents. The search query of Super 3G example includes: *(“super3G” OR "super-3G" OR "super 3G”)*

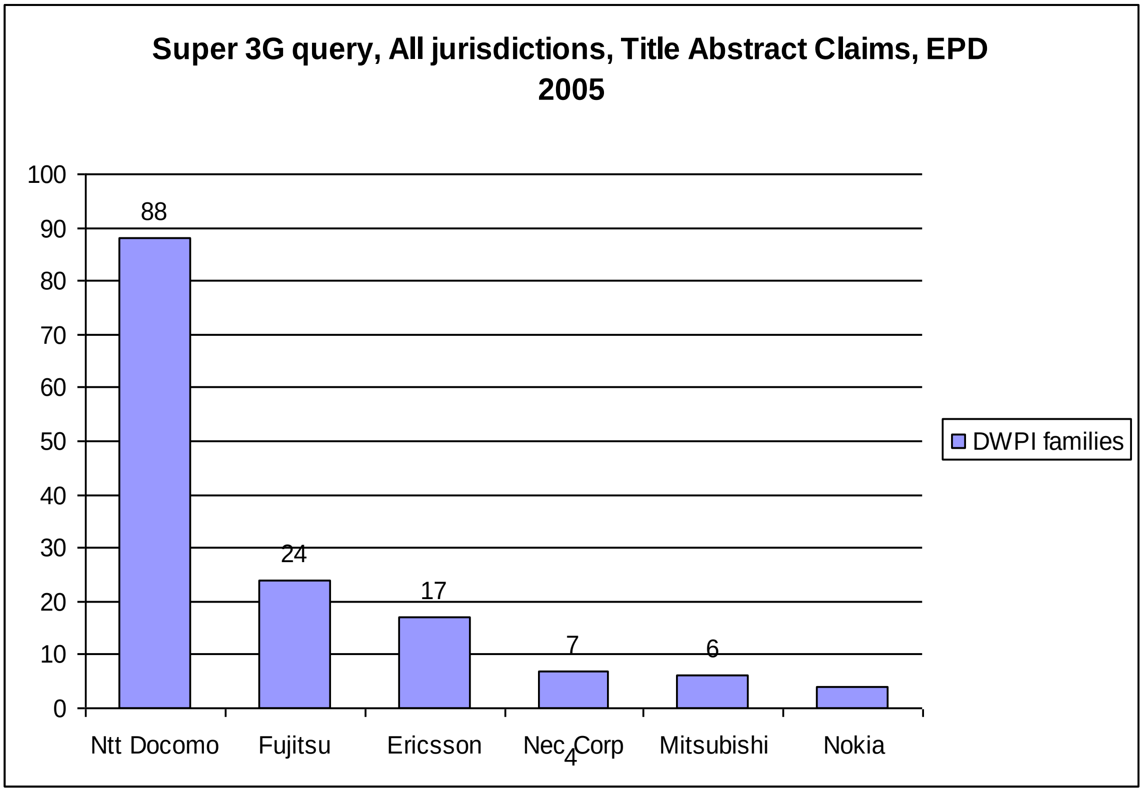

Figure 4: Super 3G Query, Patent Section Title/Abstract Claims, All jurisdictions, Earliest Priority Date 2005

IN a fourth example, E-UMTS Query favored LG Electronics who is ranked second (in the E-UTRAN query LG Electronics was the ranked the fifth and in the LTE query the 4th). The E-UMTS query would include the variations *("Evolved UMTS Terrestrial Radio Access" or "Enhanced UMTS Terrestrial Radio Access")*

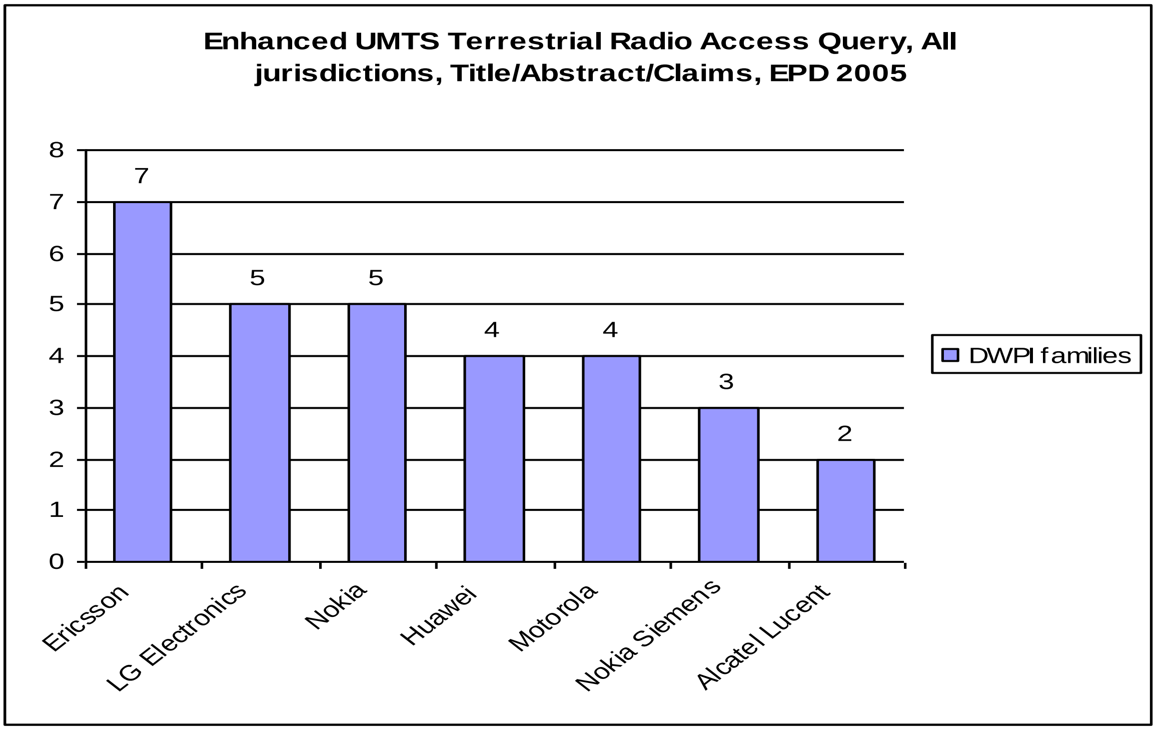

Figure 5: E-UMTS Query, Patent Section Title/Abstract Claims, All jurisdictions, Earliest Priority Date 2005

Analyzing the extent of different results the conclusion is that very likely **companies use different terminology when writing their patents** which enforces the importance to make sure to include in a query all the possible buzzwords (variations, synonyms, preferences) pertaining to a field when pursuing such analyses.

Such conclusion raise questions regarding the limitations of this strategy when it comes to narrowing down the search to the desired area. If a company does not use the established terminologies in their patent applications they might be kept outside from the landscape. This can be used also as a strategy for a company not to show the size of its own portfolio.

The sensitivity can be used also with the purpose to create landscape scenarios in which an actor is being favored against the other. An example of Matrix where scenarios can be created is part of Appendix F. Same sensitivity can be observed not only when looking at keywords but also at the section of the patent. This issue will be debated in the Chapter number 7.

Chapter 6 Technology Breakdown Search Strategy

6.1 Overview

This analysis was conducted in order to provide extra input on the keywords based search by testing a different approach and thus using a different methodology.
In this analysis more attention was put into defining the areas of search and identifying keywords for each area. The commonality with the previous search strategy is the technological scope. The analysis should benefit patent landscapes targeting less defined technologies or where buzz words only, cannot be used.

For the patent priority years 2005-current period, patent searches were conducted in Full Text sections of the patents, using Thomson Innovation databases, including All Jurisdictions and narrowing the searches by International Patent Classifications. The results were limited to patent families. The data were imported in Thomson Data Analyzer and further analyzed.

The strategy proposed through the Technology Breakdown Analysis targets the LTE at a detailed level offered by its sub technologies. This creates a different context which requires a different search strategy. The Technology Breakdown Analysis requires several search queries, one per each area observed. Each search query includes a different group of keywords targeting the area of search. In order to come with different groups of keywords a better variety of terms is necessary which goes beyond the indicator or buzz words types.

This approach requires more time, resources and knowledge than the buzz words strategy. A comparison with the previous strategy is useless due to their different nature and purposes. The analysis provided a lot of insightful information on the keywords based patent landscape assessment and also helped at raising new questions. This leaves room for further analyses within the field of keyword based patent landscaping. However a sensitivity analysis as in the case of Buzz words/indicators analysis could not be realized due to the complexity of this analysis. In return the analysis focused its attention on the relevance of “generic” vs. “specific” terms to be used in queries.

The chapter contains just the description of the entire analysis with exemplifications in the Appendices.

6.2 Implementation

The first ambition of this strategy is to come with an interesting LTE technology breakdown proposal.

This step required extended technical expertise and a focus group of LTE experts within Ericsson was consulted in this sense. The group included experts with extensive experience in both patent and R&D organizations of Ericsson.

Due to the complexity of the field and limited resources of the study only two levels of visualizations were decided to be analyzed. A first top LTE level and a second level composed of ten sub areas. A more detailed visualization was nice to have but would have been too time consuming for the study of this thesis. Out of the ten LTE sub areas only six have been selected to be analyzed which would stand for 80% of Ericsson LTE portfolio. .

Each sub area was analyzed separately. The results of each sub areas have been merged into a top level result across the entire LTE technology.

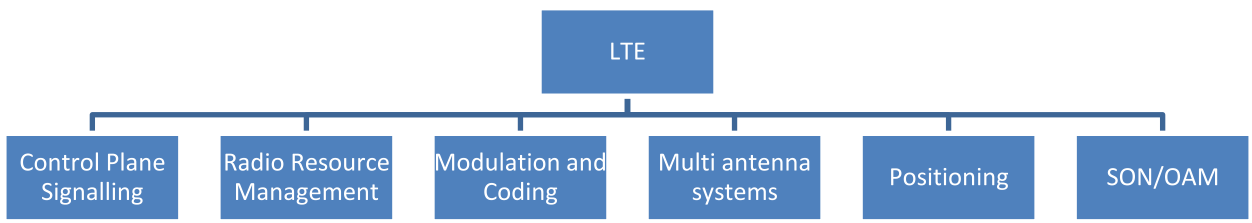

Figure 6: LTE Technology Breakdown

Once the areas to analyze were defined a search strategy for each of them was put in practice. For each area of search a new set of keywords was identified. There was no rule on the nature of the keywords included in the queries. The only particularity consisted in the way the keywords were combined in the search query. As mentioned in the Research methodology chapter the keywords were generated using two methods: a) study and direct observation; b) interviews

Interviews with inventors in Ericsson were organized for each area. Prior each interview a study of the area has been prepared and at the interview participated representants of both R&D (interviewee) and patent organizations (interviewers).

6.3 Query construction

The search query was constructed grouping keywords into processes (WHAT) and locations (WHERE). An example of query: *("access selection" OR "OFDM" OR "Source coding scheme") AND ("traffic channel" OR "S1 control plane" OR "Control Channel").*

6.4 Query simplification. A quantitative approach

Since the initial queries would generate a lot of noise there was a need of simplification. Therefore a method to resume to the relevant keywords was necessary for each area of search. A relevant keyword would target the desired area by creating as little noise as possible.

An iterative process has been used in order to resume to the relevant keywords in the search.

The iterative process is illustrated in the Appendix E for exemplification and was applied for each of the six areas of search.

The quantitative method of selecting the relevant keywords was challenged by the experts inside Ericsson consulted for this analysis, because of the keywords returned by the method as being more relevant. The keywords were considered by the experts as being very generic and not very related to the area of search.

The reason the quantitative method was challenged by the experts within Ericsson was the fact that the final set of keywords obtained, was seen as purely arbitrary and not necessarily relevant for the area observed. The keywords obtained, too generic, would have not been recommended by any of the experts within Ericsson was part of the final queries.

To challenge the quantitative method a more qualitative selection of keywords was proposed in which, from the same initial set of keywords, only the ones judged by the experts on a purely qualitative basis was selected as part of the end queries. Basically all the iterative process described in the quantitative approach was replaced by the pure judgment of the experts on what should be the keywords specific to the area of search. The keywords selected by the experts were characteristic to the area of search therefore more specific.

The results returned by the qualitative search query were compared with the results returned by the quantitative query (obtained through the iterative process proposed) and the conclusion was that the quantitative method proved more efficient in terms of encircling better the area of search by better target.

Therefore once the suggestion of the experts being tested, the quantitative method of creating a query cannot be contested further.

6.5 Conclusions

What the experts consider as being a relevant keyword for the area of search is not really mirrored in the patents. An assumption in this sense might be the fact that the patents are written using different terminologies. Therefore coming with that set of keywords that would best capture the search area, one should probably start with understanding how the patents are written. Is it really true that generic terms target better the desired search area then specific terms (better precision)? If yes then why? Is there a different terminology preferred by companies when writing the patents? Is a difference in language between a technical expert and a patent engineer?

In order to answer these questions a similar process of generating keywords should be conducted, in which the interviews with inventors would be replaced by study sessions in which the patent content to be analyzed. This would be considered a highly demanding process in terms of resources involved such experts, time and costs. In return the results would be contested on different bases just like many other qualitative reports on the market.

To replace the human factor that could be contested on terms of human error, or biasing, one can use a data mining tool. These tools started to appear on the market and with a representative sample of patents a set of keywords could be generated and compared with the ones proposed by the inventors or technical experts. This tools would allow to compare different sets of words and give a hint on why more arbitrary keywords (if still the case), by their nature very generic, prove more efficient in a search then the ones judged by the experts in the area. However that does not mean the results cannot be further questioned. If the tool cannot be questioned the selected sample of patents (decided by a certain group of people) would certainly be.

But until these tools really prove their value one would continue keywords based patent landscaping the conventional way. And in the process, shouldn't be that any keyword proposed by an expert could be questioned on the base of language nuance? To be more extreme one can even question if the right people to ask for relevant keywords should be the technical experts at all? Why not, in the pursuit of patent searches, ask the people writing the patents themselves?

And since the keywords in the final query seem so arbitrary one can also question how much time and effort should be invested into coming with the "right" keywords. Maybe a more relaxed brainstorming session of generating keywords is sufficient.

Chapter 7 Patent Section Search

7.1 Overview

This analysis was conducted in order to provide information regarding patent landscaping searches from a **patent section perspective**. This means that the variable observed in this case is not the nature of the keywords, rather the section of the patent where the search is being performed. The analysis was initiated at the observation that different results were obtained when performing the same search but in different sections of the patent.

As it can be observed in Figure 7, Figure 8 and Figure 9, a search based on the LTE buzz words (LTE, Super 3G, EUMTS and E-UTRAN) returns different results (rankings) when performed in the Full text versus the Claims or versus the Title. This means that while the keywords were kept identical, for every search, the variable observed was the section of the patent: same search but in different sections of the patent. Since the results are so different the question is which search to be taken into account. With other words there is a need to know if a search in Full Text is more reliable than the one if the Title/Claims section for example or vice versa.

For example, Figure 7 illustrates the LTE search performed in Full text Section of the patent, where LG Electronics is ranked the 1st, followed closely by Qualcomm and Ericsson. From this table the conclusion is that the Top 3 dominant actors are: LG Electronics, Qualcomm and Ericsson.

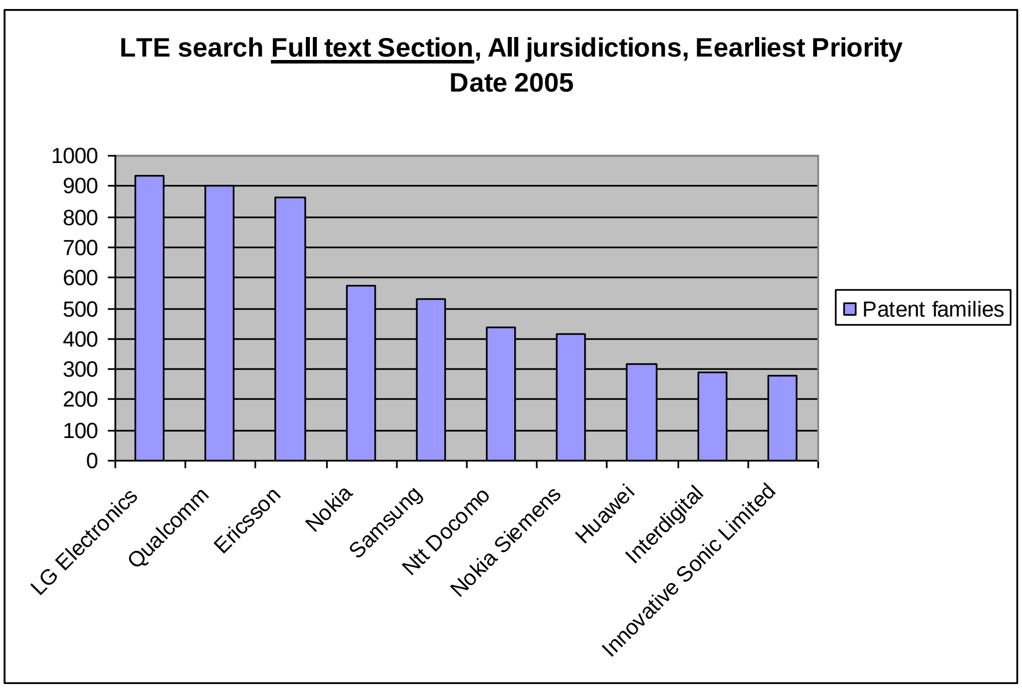

Figure 7: LTE Query, Patent Section Full Text, All jurisdictions, Earliest Priority Date 2005

However when performing the same search but in the Claims section of the patents, as illustrated in Figure 8, the landscape presents itself differently. Huawei ranked the 8th in the Full Text search (Figure 7) is ranked now as the 1st in the Claims search (Figure 8).

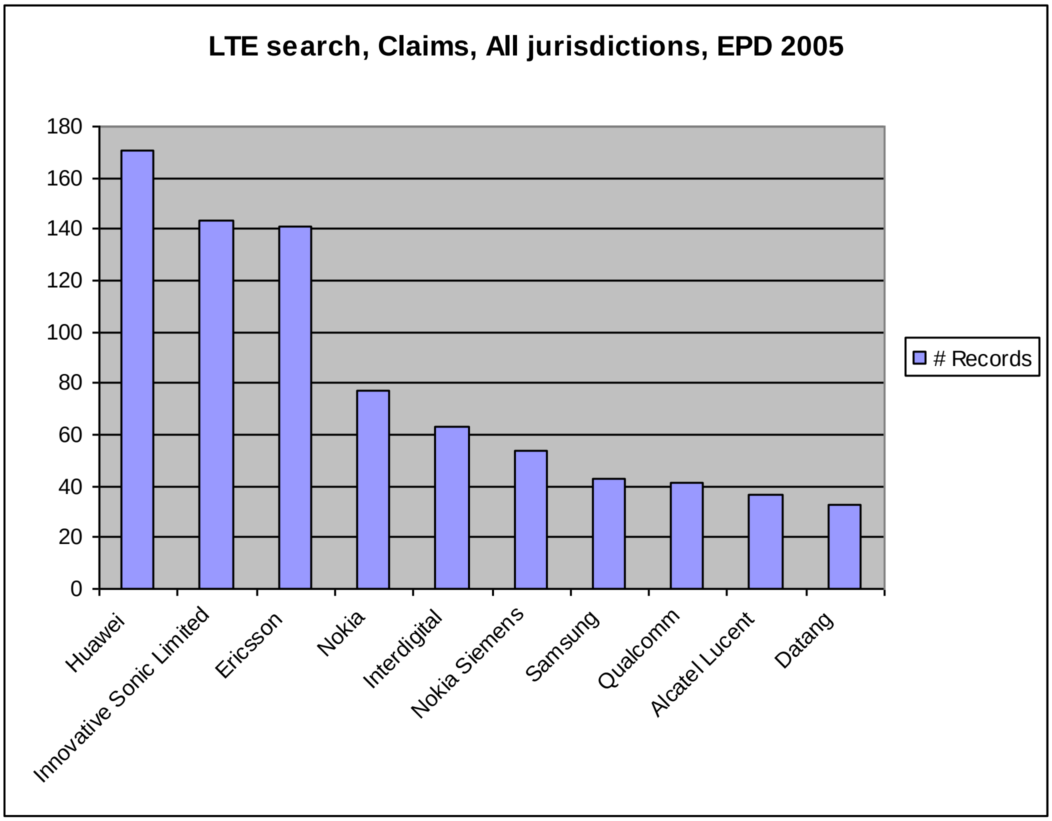

Figure 8: LTE Query, Patent Section Abstract, All jurisdictions, Earliest Priority Date 2005

When performing the same search but in the Title Section of the patent, the landscape changed again.
Figure 9 illustrates now Innovative Sonic Limited ranked the 1st in Title search (Figure 9), while being ranked the 10th in the Full text search (Figure 7).

In conclusions, using same keywords but changing only the section of the patent in which the search was being performed, Huawei changes positions form number 8 to number 1, Innovative Search from number 1 to number 10 and so on.

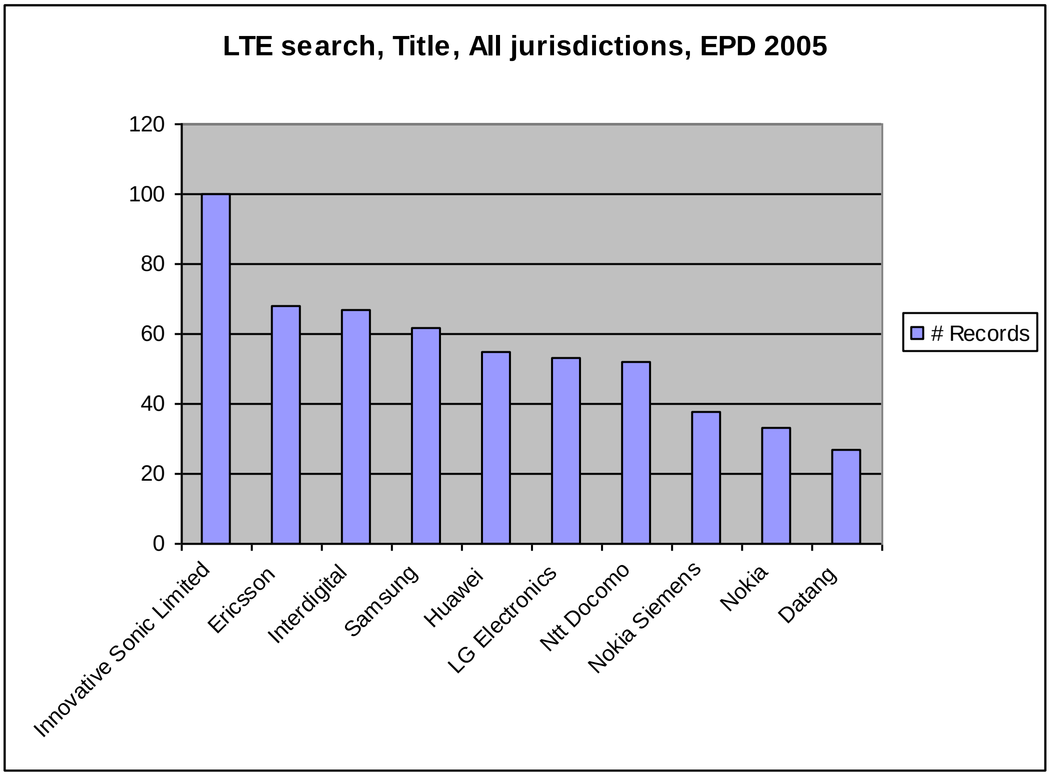

Figure 9: LTE Query, Patent Section Title, All jurisdictions, Earliest Priority Date 2005

Looking at so different results it was easily assumed that **sensitivity** is **not only** presented at **keyword** level, as demonstrated in Chapter 5, but also at **Patent Section Level**. One could see that some companies present themselves more volatile than the others. In this example the above Figure 8 and Figure 9 exemplify companies such Huawei or Innovative Sonic Limited to be very volatile, jumping from the bottom of the ranking to the top, in different searches.

Given this hypothesis the next step is to find out if these results (high volatility given by the patent section) present themselves in a pattern or are isolated cases.

For a better visualization the Table 2 was created, which illustrates the representation of patent families obtained by ten companies of interest while applying the LTE query in the different sections of the patent. The value in each box counts for the representation (%) of the absolute number obtained by a company in the total number of patent families obtained by the search. For example Qualcomm in the Full Text field obtained a hit of 902 patent families out of a Total Number of records across the companies of 9259 patent families (approximately 10%). In the Title Field, same actor Qualcomm obtained only 21 patent families out of a total of 863 (approximately 2 %)

The same query and variables have been used for exemplification While observing each company one can notice that some of them behave constantly across all the patent section searches such Nokia Siemens (with a ratio interval of 4%-5% out of the total-yellow marking) while others are more volatile such Qualcomm (with a ratio interval of 2% to 10% out of the total-orange marking)

Company	All text	All text DWPI	Title/Abstract	Title/Abstract/Claims	Title	Title DWPI	Abstract	Abstract DWPI	Claims	Description
Qualcomm	10%	9%	9%	8%	2%	2%	9%	9%	3%	11%
LG Electronics	10%	7%	7%	6%	6%	7%	7%	7%	1%	11%
Samsung	6%	5%	5%	5%	7%	8%	5%	5%	3%	6%
Nokia	6%	7%	7%	7%	4%	4%	7%	7%	6%	7%
Ericsson	9%	9%	9%	9%	8%	8%	9%	10%	11%	10%
Interdigital	3%	4%	4%	4%	8%	4%	4%	4%	5%	3%
Motorola	3%	3%	3%	3%	1%	1%	3%	3%	1%	3%
Huawei	3%	5%	5%	6%	6%	8%	5%	5%	13%	2%
Nokia Siemens	4%	5%	4%	5%	4%	5%	4%	5%	4%	5%
Innovative Sonic Limited	3%	6%	6%	6%	12%	13%	6%	6%	11%	1%

Table 2 Representation Patent families in Total results , across companies in patent section searches

Observing trends as presented in Table 2 the hypothesis obtained is that there is sensitivity generated by the section of the patent which influences the final results such the position of each actor in the final ranking. Therefore the next step taken was to identify which sections of the patent create volatility.

7.2 Implementation

In the pursuit to demonstrate the sensitivity created by the section of the patent, two analyses have been performed with the purpose to look into different scenarios and see if they present the same results. The details of the analyses can be read in the Appendix D.

The first analysis is based on LTE buzz words such: LTE, Super 3G, EUMTS and E-UTRAN. The second is based on LTE buzz words pointing to the underlying technologies such: beam forming, HARQ, Fast Power Control, OFDM, OFDMA, MIMO, SC-FDMA, SDMA. The selection of terms was done as a recommendation of the Ericsson experts in the LTE area or by study literature and analyst reports[13].

Ten different sections of the patents have been analyzed: Full Text, Full Text DWPI, Title/Abstract/DWPI, Title/Abstract/Claims, Title, Title DWPI, Abstract, Abstract DWPI, Claims and Description. The particularities of each section are being mentioned in the Appendix D of the paper.

The results from both analyses included 8 different keywords search results across the ten different sections of the patent, counting for a total of 77 different sets of company results and 770 data points. A data point stands for the numbers of patents generated in a specific search.

[13] ABI Research Report "4G Intellectual Property and Royalties" an Analysis of LTE, WiMAX and UMB written in 2007

Example the 902 patent families obtained by Qualcomm in a Full Text search represents a data point. A set of results at company level is represented by all the hits obtained by one actor (for example LG Electronics) across ten sections in different sections of the patent.

7.3 Conclusions

Analyzing the above mentioned data, it turned out that there is a sensitivity presented at section patent level. In some sections of the patent some companies returned more than their average expected hits, in some other sections returned less than their average expected hits, both of the situations making them volatile.

An overrepresented company would obtain a larger number of records in that section of the patent than its average hits. On underrepresented company would return a smaller number of records in that section of the patent than its average hits.

Table 3 illustrates the number of patent families obtained by ten companies of interest while applying the LTE query in the different sections of the patent. In this example LTE query includes the terms LTE, Super 3G, EUMTS and E-UTRAN. The data in Table 3 are mainly used to reach the percentages presented in the Table 4.

Company	Full text	All text DWPI	Title/A bstract	Title/A bstract /Claim s	Title	Title DWPI	Abstra ct	Abstract DWPI	Claims	Description
Qualcomm	902	270	282	299	21	10	277	270	41	900
LG Electronics	936	194	222	227	53	44	220	193	13	931
Samsung	532	143	169	181	62	52	165	142	43	512
Nokia	573	206	215	241	33	24	213	206	77	572
Ericsson	864	273	290	347	68	50	283	272	141	864
Interdigital	291	115	138	151	67	27	119	114	63	290
Motorola	244	88	91	94	7	5	91	88	8	242
Huawei	318	149	160	226	55	52	159	141	171	133
Nokia Siemens	414	137	142	167	38	32	140	137	54	414
Innovative Sonic Limited	281	168	187	217	100	86	187	161	143	119
Others	3904	1146	1345	1517	359	267	1297	1132	535	3434
Total	9259	2889	3241	3667	863	649	3151	2856	1289	8411

Table 3: Patent families (absolute numbers) across companies in ten separate patent sections searches

In order to visualize trends, the percentage of each company (its representation in the Total results per section search) is calculated (example: Qualcomm, Full Text presents 902 families in the Total of all actors of 9259). The representation of each company into the total records generated by the search is chosen in order independently measure the patent section searches of any other section searches. So the variable of interest in this case is the patent section not the company. In this way it is excluded any possibility to bias a result obtained by a company in a patent section search with another result obtained by the same company in a different section search (for Example in Table 3 the result obtained by Nokia Siemens in Full Text-414 families is independent on the result obtain by same Nokia Siemens in All Text DWPI-137 families)

This can be also easily visualized in the Table 4. Example the 10% that corresponds to Qualcomm in the Full text search is the results of the ratio between 902 patent families obtained by Qualcomm only in the specific Full text search and 9259 total number of patent families obtained across all the companies in the same search.

Using basic statistics, such standard deviation, the volatility in different sections of the patent could be now highlighted.
An average value and standard deviation of results obtained by each company across the different sections of the patent was calculated. The standard deviation and the average value are meant to offer the interval in which the hits (patent families) obtained by each company are considered as being in normal intervals. The normality is given by the inferior and superior limit calculated using the average value across different sections of the patent per company and standard deviation. The inferior limit was calculated as a difference between the average and standard deviation at company level. The superior limit was calculated as a sum of the average/company and the standard deviation. All the results obtained outside the inferior and superior limit of the interval were considered outside the normal interval in a positive or negative way. A smaller result than the inferior limit of the interval would highlight the fact that the company obtained smaller hits than what is considered its normal hits. A lager results than the superior limit of the interval would highlight the fact that the company obtained larger hits than what is considered its normal hits.

The Table 4 illustrates the theory of before. The Table 4 represents ten different searches of the LTE query in the different sections of the patent. The value in each box counts for the representation (%) of a company in the total number of patent families obtained by the search. The average value, the standard deviation, Inferior and Superior limits of the interval are calculated at company level. Color red highlights the values obtained outside the normal interval calculated at company level and marks the unusual smaller or larger hits obtained by each company in the different searches. The variable that has to be observed in Table 4 is **patent section**.
The sections of the patent that counted the largest numbers of unusual larger or smaller hits were considered as creating volatility. That means that when performing searches in those sections companies might act unusually, by obtaining a larger or smaller number of hits than normally, and thus not illustrating the real landscape.
The standard deviation is also an indicator of volatility. The higher the standard deviation obtained, the more volatile the company.

Comp	Full Text	All text DWPI	Title/ Abstract	Title/Abstract/Claims	Title	Title DWPI	Abstract	Abstract DWPI	Claims	Description	Average	St dev	Inf Limit	Sup Limit
Qualcomm	10%	9%	9%	8%	2%	2%	9%	9%	3%	11%	7%	3%	4%	11%
LG Electronics	10%	7%	7%	6%	6%	7%	7%	7%	1%	11%	7%	3%	4%	10%
Samsung	6%	5%	5%	5%	7%	8%	5%	5%	3%	6%	6%	1%	4%	7%
Nokia	6%	7%	7%	7%	4%	4%	7%	7%	6%	7%	6%	1%	5%	7%
Ericsson	9%	9%	9%	9%	8%	8%	9%	10%	11%	10%	9%	1%	8%	10%
Interdigital	3%	4%	4%	4%	8%	4%	4%	4%	5%	3%	4%	1%	3%	6%
Motorola	3%	3%	3%	3%	1%	1%	3%	3%	1%	3%	2%	1%	1%	3%
Huawei	3%	5%	5%	6%	6%	8%	5%	5%	13%	2%	6%	3%	3%	9%
Nokia Siemens	4%	5%	4%	5%	4%	5%	4%	5%	4%	5%	5%	0%	4%	5%
Innovative Sonic Limited	3%	6%	6%	6%	12%	13%	6%	6%	11%	1%	7%	4%	3%	11%
Others	42%	40%	41%	41%	42%	41%	41%	40%	42%	41%	41%	1%	40%	42%

Table 4: Volatility trend across companies in ten separate patent sections searches based on LTE buzz words

The same exercise was performed for all 77 sets of results per company counting for 770 data points across the ten different sections of the patent.

Another example based on a different search and set of results is exemplified in Table 5. The search is being performed looking for the buzz words Beamforming using the same variables as all the previous searches and the same analysis process. The value in each box counts for the representation (%) of a company in the total number of patent families obtained by the search. The average value, the standard deviation, Inferior and Superior limits of the interval are calculated at company level. Color red highlights the values obtained outside the normal interval calculated at company level and marks the unusual smaller or larger hits obtained by each company in the different searches. As it can be noticed the same sections are being highlighted.

Comp	Text Field	All text DWPI	Title Abstr acts	Title Abstracts/ Claims	Title	Title DWPI	Abstr act	Abstract DWPI	Claims	Descrip tion	Avera ge	St dev	Inf limit	Sp limit
Qualcom m	20%	6%	6%	5%	5%	3%	6%	6%	3%	21%	8%	5%	3%	13%
Samsung	11%	17%	16%	14%	16%	21%	16%	18%	20%	11%	16%	3%	13%	19%
Broadco mm	5%	3%	3%	4%	2%	2%	3%	3%	6%	5%	3%	1%	2%	5%
Ericsson	4%	3%	3%	4%	3%	4%	3%	3%	6%	4%	4%	1%	3%	5%
LG Electroni cs	4%	1%	1%	1%	1%	1%	1%	1%	1%	4%	2%	1%	0%	3%
Res in Motions	3%	0%	0%	0%	1%	0%	0%	0%	0%	3%	1%	1%	0%	2%
Canon	2%	1%	1%	1%	0%	0%	1%	0%	1%	2%	1%	1%	0%	1%
Motorola	2%	2%	1%	2%	1%	1%	2%	2%	3%	2%	2%	1%	1%	2%
Marvell/M itsubishi/ Samsung	2%	1%	1%	2%	3%	1%	1%	1%	3%	2%	2%	1%	1%	2%
Intel	1%	3%	2%	2%	2%	2%	2%	3%	3%	2%	2%	0%	2%	3%
Konink Philips	1%	2%	2%	1%	2%	2%	2%	2%	3%	1%	2%	1%	1%	3%
Nokia	1%	2%	1%	2%	2%	2%	2%	2%	2%	2%	2%	0%	1%	2%
Electroni cs and Telecom municatio ns Research Institute	1%	3%	2%	2%	3%	4%	2%	2%	2%	1%	2%	1%	1%	3%
Huawei	1%	2%	3%	2%	3%	5%	3%	2%	0%	0%	2%	1%	1%	3%
ZTE	1%	5%	5%	4%	5%	6%	5%	5%	0%	0%	4%	2%	2%	6%
Cisco	1%	5%	5%	3%	8%	10%	5%	6%	5%	1%	5%	3%	2%	8%
Datang	1%	2%	3%	2%	1%	2%	3%	1%	0%	0%	2%	1%	1%	2%
Total records	1221	238	277	385	149	108	263	217	261	1152				

Table 5: Volatility trend across companies in ten separate patent sections searches based on LTE buzz word "beamforming"

Overall the other searches who have been analyzed as well, including the ones presented in the above Table 4 and Table 5, the sections that were identified as creating volatility were Description, Claims, Text Field (Full text), Title and Title DWPI. This means that in order to avoid any unusual results, it is safer to be perform searches outside the mentioned sections and focus on sections such Title/Abstract Claims, Full Text DWPI, Abstract etc.

This way the awareness of potential sensitivity given by a patent section should overcome confusion that can be created by analyzing results of similar search in different sections of the patent.

Chapter 8 Limitation of the Study and Criticism

In the effort to prove its objectivity the following chapter will focus on highlighting the limitations of the study.

Overall the thesis tackled issues such choice of keywords and sections of patents when performing patent landscape assessments. It tried to distinguish search strategy based on the nature of keywords and highlight the sensitivity created by either the keywords or the section of the patent.

8.1 "Buzz words/Indicators" Search Strategy

The first search strategy was based on buzz words. A first limitation of this strategy is the fact that such searches return only records that include the specific buzz words. This way, records that do not include the specific terms will not be identified by the search. Patents written before the buzz words were adopted, such background patents, would not be captured by these types of search.

A second limitation of this strategy is the fact that buzz words are not equally adopted by all the actors in their patent language. The reasons behind can be multiple. While some actors might start using buzz words in their descriptions later than the others, some of them might just avoid using any of these terms In this situations some of the patents would be left out and the landscape incomplete.

8.2 Technology Breakdown Search Strategy

The second search strategy was based on a more diverse set of keywords including also buzz words and generic terms. The idea behind was to create a search query that would be able to identify also the patents that might not be captured with buzz words. However the first setback of this strategy was the large noise returned by using so diverse set of terms. Another limitation was the difficulty to separate the LTE related patents of the other technology using similar terminology (like the previous 3G technologies). While the first strategy would ensure more targeting, by employing LTE specific buzz words, the second search strategy was challenged in this sense.

In the same analysis another limitation was identified when deciding on the measurement test of the search direction. The fact that all the keywords were measured against Ericsson LTE portfolio of patents could be contested as biasing the results in the favor of Ericsson. The Ericsson LTE portfolio of patents was used in this case because it was the only one available. For better results a more diverse set of patents would be preferred as for example patents part of the other actors' portfolios as well. However proving Technology Breakdown Analysis was biased or not it can be observed by looking at the analyses results targeting same technical scope (LTE) performed during the study. Comparing the Technology Breakdown analysis results with the other two analyses, the results proved quite similar, thus is hard to prove the analysis could have been biased towards Ericsson in the case of Technology Breakdown.

It can also be argued that maybe more keywords could have been tested for each area of search or that using more diverse combinations of keywords within the query could have offered improved results. This analysis is built after a model which can always be improved. However since the purpose of the analysis was to build a replicable model, time and effort put into it had to be kept realistic.

A lot of skepticism has been shown already, by Ericsson experts, regarding the keywords obtained as part of the end queries of the Technology Breakdown analysis. The keywords were considered too generic and not specific to the area of search. The combination of the keywords in the query was also contested as creating a lot of noise. However these were the keywords obtained with the measurement applied and considered as being the most relevant to the area of search.

To test the tool of measurement a more qualitative method of creating the queries, from the same initial set of keywords was proposed. Comparing the quantitative method of selection proposed with the qualitative method it seems that the first option is more efficient in narrowing down the search area and minimizing the search. This can be left open to further analysis.

8.3 Thomson Database Tool Limitations

The main limitation was offered by Thomson Innovation Database. The major limitation encountered was the impossibility to create more elaborated search queries and this applied in the case of Technology Breakdown Analysis. Some search scenarios have been proposed for the study but due to the limitations of the tool they have never been tested. Another limitation is offered by the reports functionality. No matter the size of the field of analyze, the maximum number of records to be reported was 30, 000. This means that each search strategy had to be created in such a way to obtain reports smaller than 30, 000 records. Sometimes results of the searches have been questions and answers could not be brought due to a lack understanding of the algorithms behind the tool.

Chapter 9 Discussions

The current study comes with a set of findings and conclusions in three different directions. This section will discuss the thinking behind the study approach, the findings and their implications and come with a set of recommendations.

The study was initiated from the assumption that performing keywords searches using buzz words such as LTE or Super 3G might mislead the results, since these types of keywords can easily be included in a patent application body with the purpose of generating high hits in the results.
The study could not prove the initial assumption, but it could prove the sensitivity created by this type of keywords. The conclusion of the "buzz words" search strategy was that there is a variety of buzz words specific to a certain area and they have preferential use by the companies. **In order to obtain complete landscapes, one should take into consideration the entire spectrum of existing buzz words, specific to an area, and include all of them into the query search**. However background patents (of interest for the area of search which do not include the buzz words since they were written before the buzz words were established) or patents who simply do not include buzz words from one reason or another, would be excluded from these searches.
This could be verified by seeing that even patents in Ericsson LTE portfolio of patents could not be found through a buzz word search. So the buzz words search strategy might prove insufficient or incomplete.

Given the initial conclusions, a **second approach of the study was initiated in the attempt to find a way to capture the patents unidentifiable by buzz words,** such for example background patents. Comparison among the two strategies could now be obtained. The new approach didn't limit to the usage of a single type of keywords, such in the case of buzz words search. The new search strategy started from bottom up by initially defining the area, identify relevant keywords and then perform searches. **The main advantage of this approach was that it offered possibility to visualize a certain area at different levels of technology.** However **this approach proved very challenging** since, more types of keywords automatically create a lot of noise. Another challenge came from the fact that, in this context, it was difficult to separate the area of interest (LTE) of others who use similar terms. This is where the buzz words search succeeds over the second approach: **buzz words searches direct the search to the desired group of patents/portfolio/technological area**. Though no conclusive results could be reached, technology breakdown leaves behind some questioning regarding the types of keywords to be used in a search. The analysis could be taken further by testing the approach in which prior performing patent searches, the analyst would try to first understand the language used in writing the patents, and use this information in ulterior structuring the search strategies.

Patent section search analysis offered good insight when it comes to which sections of the patent one should trust when performing keywords patent landscaping. Sections such Title, Claims, Full Text or Description proved to create volatility among the company results. This means that **volatility is not created by keywords only, but by section of the patent as well**.

This is important information when taking the decision in which section of the patent one should perform its search. Considering the conclusions of this paper, the analyst might reconsider using, for example, the Full Text section in its search because he/she might miss obtaining an unbiased result. This could happen, for example, due to practices such intentional “dropping” of keywords with the purpose to ensure a visibility of the patent in the specific search.

The sensitivity offered by keywords and patent sections- variables studied in this paper- prove the complexity of keyword patent landscapes. Extra time should be put into deciding the parameters behind these analyses. All the variables behind a search should be well countered before performing a landscape, since it is so easy to take the search in the wrong direction through actions such missing one keyword, looking into the wrong section of the patent or incomplete definition of the searched technological area.

One has to understand also the limitations of patent landscaping. All the industry reports mentioned in Chapter 3 generally have applied also qualitative analyses on top of the quantitative ones.

In general keyword patent landscapes are used in analyses as a first step, to narrow down the area of search to a relevant and manageable number of documents. This first step is usually continued by at least one more step before reaching the final conclusions. The results of keyword based patent assessment should not be taken as the ultimate reality. A lot of noise could be created by these types of searches. However what is the most important with these searches is to lead the analyst in the desired direction.

Chapter 10 Conclusions

As mentioned throughout the entire paper, keyword based patent landscape assessments, can be performed in different ways. The method of choice is to be decided by the analyst considering the purpose of the landscape and the resources available.

The current study has focused on two different methods of performing patent landscaping. A first method which is based on patent searches based on buzz words such the term "LTE" or "Super 3G" and another method based on patent searches which use different types of keywords such buzz words or more generic terms.

Figure 10 summarizes the Pros and Cons of the two search strategies: Buzz Words Search vs. Technology Breakdown Strategy.

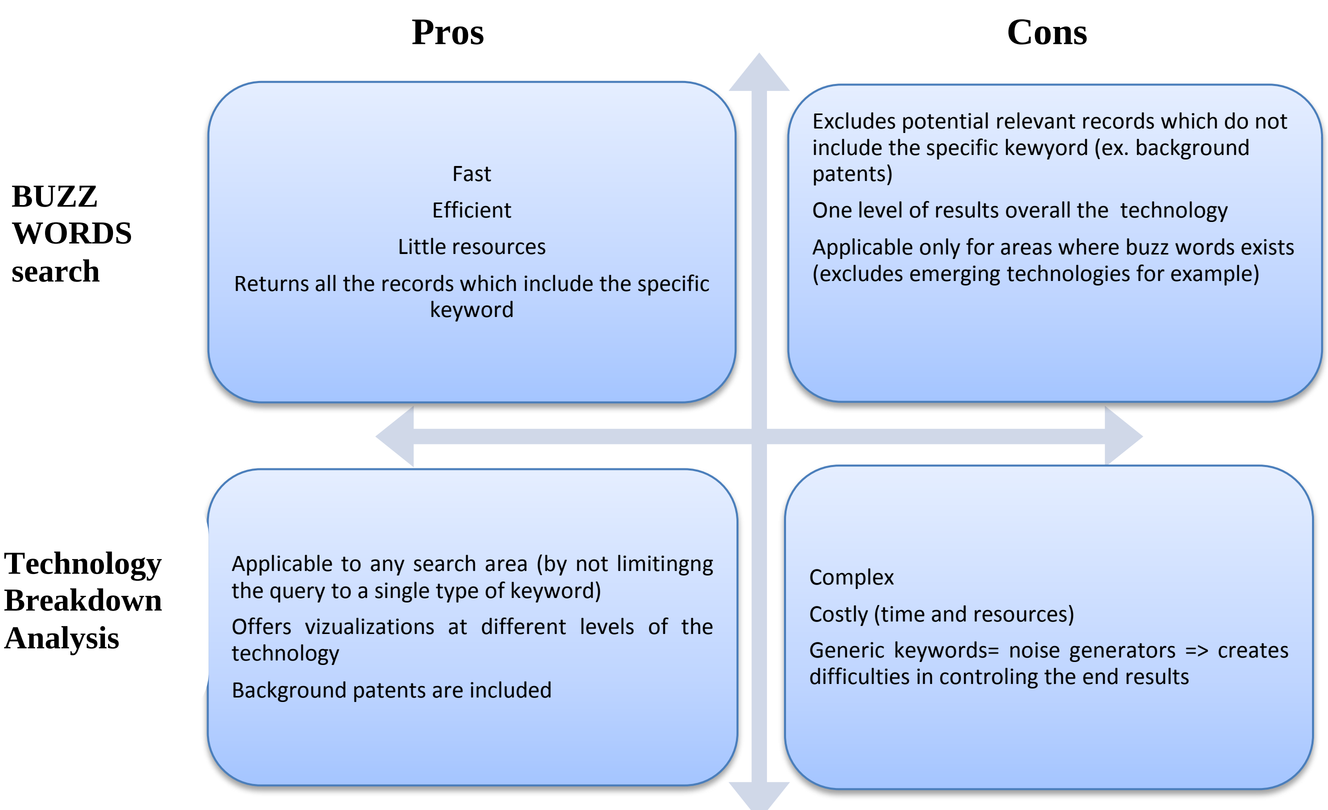

Figure 10: Buzz words vs. Technology Breakdown

Beside the two search strategies, the study analyzed also the sensitivity offered by the patent section, as parameter in a search. Following the three directions of the study: "buzz" words search strategy, technology breakdown search strategy and Patent Section Analysis, the key findings are summarized in the Figure 11:

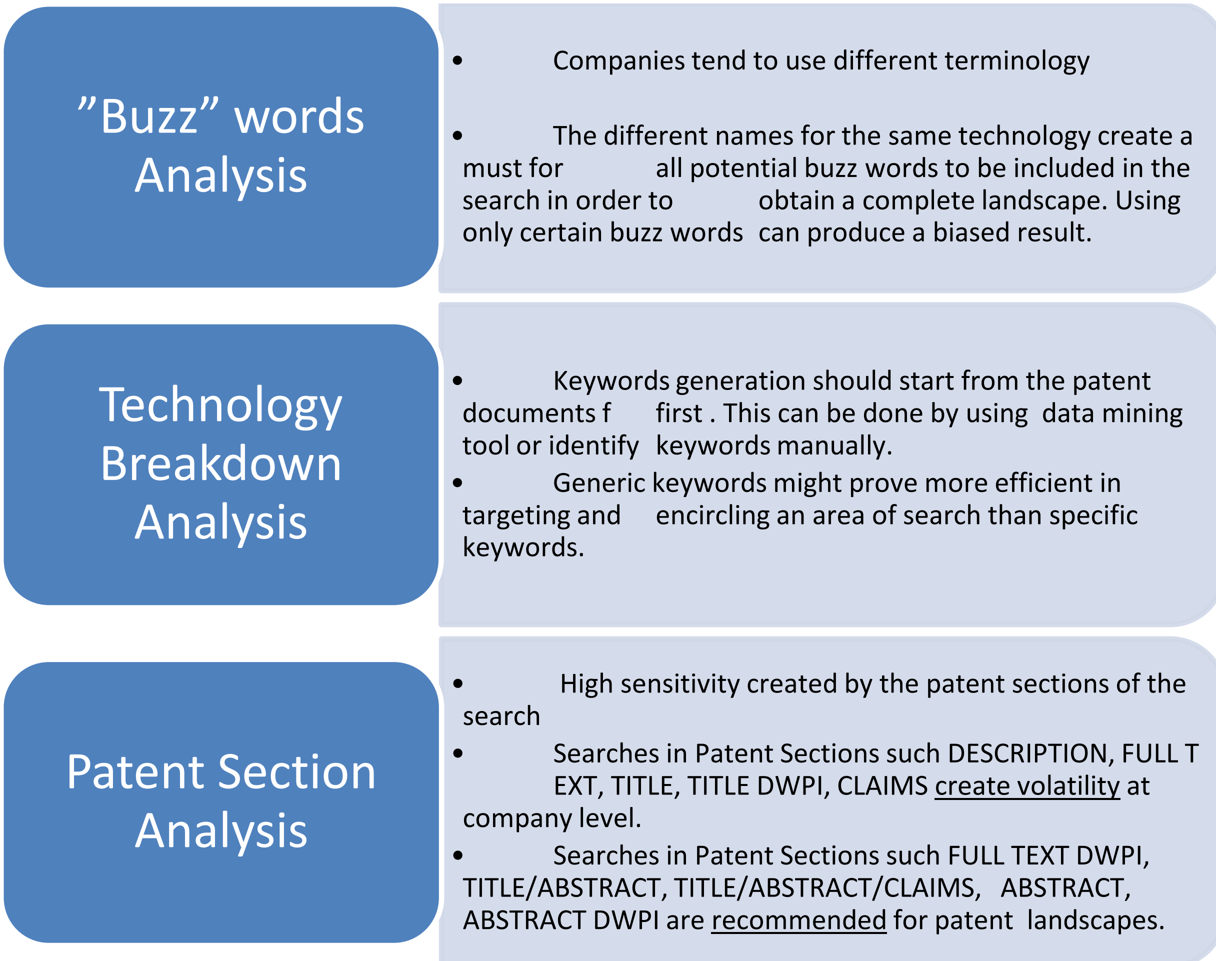

Figure 11 Findings "Keywords based" patent landscaping

In Chapter 4, four initial hypotheses are being mentioned, which represent the starting point of the entire study and which are concluded in Figure 12.

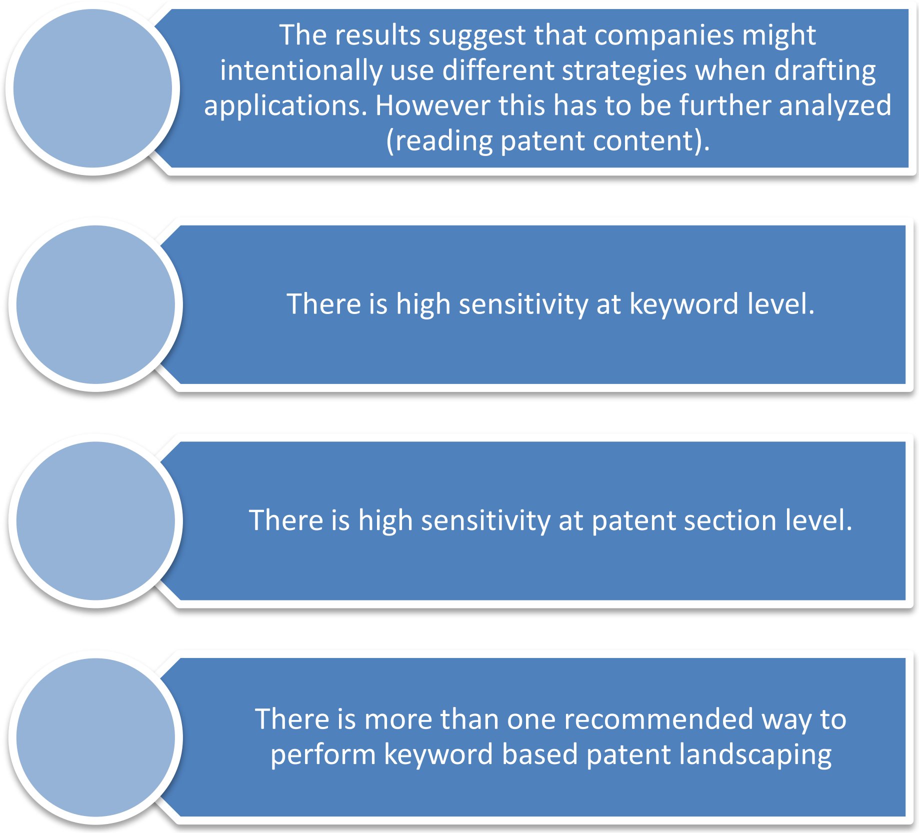

Figure 12 Conclusions Research Hypotheses

Chapter 11 Next steps

The current paper could be followed up in any of the three directions studied.

In the case of **Buzz words/indicators search strategy**, more study could be put in trying to understand when is the best moment to start relying on these types of searches. When is the moment the buzz words, start being widely used across all the actors active in the specific technology? How this search strategy can be improved in such a way to make sure background patents are being included by the search? In this sense, should this search analysis be complemented with more qualitative methods, such citation analysis?

The **Technology Breakdown analysis** questions the nature of the language used in defining the same aspects of a technology. Do technical experts have a different language than the patent engineers? The Technology Breakdown Analysis suggests that more effort should be put in trying to understand how the patents are written, before performing keyword based patent landscaping. The model presented in this analysis, puts a value on the importance of every keyword to the search result, and surprisingly generic terms proved more valuable than the specific, technology related terms. Of course the model was and can be challenged further but a closer look can be taken in trying to understand if the assumptions created by the analysis in its conclusions are even close to the truth. Taking that closer look could prove though too time and resource consuming. Instead the opportunity should be taken in the area of data mining tools which start to appear on the market. By automatically extracting the most used keywords in a certain set of documents (that could belong to a certain area of interest), the nature of keywords defining the specific set could be better understood.

Patent Section Search could also be taken further with a more qualitative approach in order to bring an understanding of the quantitative results presented in the study. The study highlighted, using basic statistics that, sections of the patent such Full Text, Description, Claims, Titles should be avoided in patent searches. The reason behind is that companies prove more volatile when performing keyword searches in the specific sections of patents. The reason behind this volatility could be further analyzed. Maybe understanding the nature of the patent sections could explain the conclusions brought by the current study. This effort however would require a more qualitative approach and experts in charge with writing patents could have the answers.

References

Badger, E. Techniques for analyzing literature search results, World Patent Information 30 (2008) 326-334

Dahlman, E., Parkvall, S., Sköld, J., Beming, P., (2008) 3G Evolution, HSPA and LTE for Mobile Broadband. Burlington: Elsevier Ltd.

Ernst, H. The use of Patent Data for Technological Forecasting: The Diffusion of CNC-Technology in the Machine Tool Industry, Small Business Economics, 361-381, 1997

Ernst, H., Patent Information for Strategic Technology Management, World Patent Information 25 (2003), 233-242

Fabry, B., Ernst, H. , Langholz, J., Köster, M., Patent Portfolio Analysis as a useful tool for identifying R&D and business opportunities- an empirical application in the nutrition and health industry, World Patent Information 28 (2006), 215-225

Lee, S., Yoon, B., Park, Y., An approach to discovering new technology opportunities: Keywords based patent map approach, Science Direct, Technovation 29 (2009), 481-497

Lee, S., Yoon, B., Lee, C., Junwoo, P., Business planning based on technological capabilities: Patent analysis for technology driven roadmapping

Merriam, S. B. (1998). Qualitative Research and Case Study, San Francisco: Jossey-Bass Publishers.

Miles, M.B. and Huberman, M. (1994) Qualitative Data Analysis: A Source Book of New Methods. London: Sage Publications.

Nijhof, E. (2006) Subject analysis and search strategies- Has the searcher become the bottleneck in the search process?, World Patent Information 29 (2007) 20-25

Pilkington, A., Dyerson, R., Tissier, O., The electric vehicle: Patent data as indicators of technological development, World Patent Information 24 (2002), 5-12

Sternitzke,C., Bartkowski, A., Schwanbeck, H., Schramm, R., Patent and Literature Statistics-The case of optoelectronics, World Patent Information 29 (2007), 327-338

Sternitzke, C., Bartkowski, A., Schramm, R., Visualizing patent statistics by means of social network analysis tool, World Patent Information 30 (2008), 115- 131

Wicenec, B. (2008) Searching for the Patent Space, Short Communication, World Patent Information 30 (2008) 153-155

Industry Reports

ABI Research, "4G Intellectual Property and Royalties" an Analysis of LTE, WiMAX and UMB, 2007

ABI Research, Mobile Device Royalties, Intellectual Property Rates for GSM, WCDMA and LTE, 2008

Fairfield Resources International, Analysis of Patents Declared as Essential to GSM as of June 6, 2007, December 31st 2007

Fairfield Resources International, Review of Patents Declared as Essential to WCDMA through December 2008, January 6 2009

Fairfield Resources International, Inc., Review of Patents Declared as Essential to LTE and SAE (4G wireless standards) through June 30, 2009, January 6, 2010

Intellectual Property Office Patent Informatics Project Report, UK Innovation Nanotechnology patent landscape analysis, 16 April 2009

Japan Patent Office, Asia-Pacific Industrial Property Center, JIII, Guide Book for Practical Use of "Patent Map for Each Technology Field" , 2000

Maravedis, WiMAX/LTE 4G Intellectual Property Rights Policy&Market Report, 1st Edition, February 2007

Appendix List

Appendix A – Analysis 1 –LTE Buzzwords (Ericsson experts input)

Appendix B – Analysis 2 –Indicators LTE specific technologies (ABI report)

Appendix C – Analysis 3- Indicators LTE and LTE specific technologies

Appendix D – Analysis 4 – Patent Section Search

Appendix E – Analysis 5- Technology Breakdown Analysis

Appendix F – Sensitivity Matrix

Appendix A – Analysis 1 – LTE Buzzwords analysis (Ericsson Experts input)

This section described the details of the first LTE analysis.

1. **Title of the analysis**

LTE analysis

2. **Scope and purpose of the analysis**

This is a quantitative patent assessment of the Long Term Evolution area, based on keywords search defined in the thesis as indicators towards the area of search. The purpose of the analysis was to obtain a set or results (company ranking) for observation. The analysis was also observed in terms of numbers of total records returned (level of noise) and how many Ericsson own LTE Patent Portfolio are captured by this search. The observation was necessary to compare at the end which search strategy returns least noise (total number of records) and most relevant patents (% Ericsson LTE Patent portfolio captured by the search)

3. **Questions to be answered**

What are the main players in the field?

4. **Description (the section includes level of the analysis, time frame and methodology)**

Timeframe: 2005-present
Databases: Ex. All jurisdictions.
Process and methodology:

1. Definition of the area of search as Long Term Evolution.
2. Set the parameters in Thomson Innovation in order narrow down the database search to the LTE area as following

Search query composed of the following keywords (and their variations): LTE, E-UTRAN, UMTS, Super 3 G.
Narrow down the search to IPC class H04
Narrow further the search to Earliest Priority Date filing patents as 2005-present.

3. Export the report in Thomson Data Analyzer.
4. Analyze the rankings.
5. Register the total number of Records returned and Ericsson LTE Patent Portfolio included in the search, for further comparison.

5. **Tools and Resources (human resources, costs, materials, software etc.)**

Tools: Thomson Innovation, Thomson Data Analyzer.

Appendix B – Analysis 2 –Indicators LTE specific technologies (ABI report)

This section described the details of the second LTE analysis.

1. Title of the analysis

LTE sub technologies analysis

2. Scope and purpose of the analysis

This is a quantitative patent assessment of the Long Term Evolution area, based on keywords search defined in the thesis as indicators towards the technologies specific to LTE. The purpose of the analysis was to obtain a set or results (company ranking) for observation. The analysis was also observed in terms of numbers of total records returned (level of noise) and how many Ericsson own LTE Patent Portfolio are captured by this search. The observation was necessary to compare at the end which search strategy returns least noise (total number of records) and most relevant patents (% Ericsson LTE Patent portfolio captured by the search)

3. Questions to be answered

What are the main players in the field?

4. Description (the section includes level of the analysis, time frame and methodology)

Timeframe: 2005-present
Databases: Ex. All jurisdictions.
Process and methodology:

6. Definition of the area of interest as Long Term Evolution.
7. Set the parameters in Thomson Innovation in order narrow down the database search to the LTE area as following

Search query composed of the following keywords (and their variations): beam forming, HARQ, Fast Power Control, OFDM, OFDMA, MIMO, SC-FDMA, SDMA

Narrow down the search to IPC class H04

Narrow further the search to Earliest Priority Date filing patents as 2005-present.

8. Export the report in Thomson Data Analyzer.
9. Analyze the rankings.
10. Register the total number of Records returned and Ericsson LTE Patent Portfolio included in the search, for further comparison.

5. Tools and Resources (human resources, costs, materials, software etc.)

Tools: Thomson Innovation, Thomson Data Analyzer.

Appendix C – Analysis 3- Indicators LTE and LTE specific technologies

This section described the details of the second LTE analysis.

1. **Title of the analysis**

LTE and LTE sub technologies analysis

2. **Scope and purpose of the analysis**

This is a quantitative patent assessment of the Long Term Evolution area, based on keywords search defined in the thesis as indicators towards LTE and the technologies specific to LTE. The purpose of the analysis was to obtain a set or results (company ranking) for observation. The analysis was also observed in terms of numbers of total records returned (level of noise) and how many Ericsson own LTE Patent Portfolio are captured by this search. The observation was necessary to compare at the end which search strategy returns least noise (total number of records) and most relevant patents (% Ericsson LTE Patent portfolio captured by the search)

3. **Questions to be answered**

What are the main players in the field?

4. **Description (the section includes level of the analysis, time frame and methodology**

Timeframe: 2005-present
Databases: Ex. All jurisdictions.
Process and methodology:

11. Definition of the area of interest as Long Term Evolution.
12. Set the parameters in Thomson Innovation in order narrow down the database search to the LTE area as following

Search query composed of the following keywords (and their variations): LTE, Super 3G, E-UTRAN, UMTS, beam forming, HARQ, Fast Power Control, OFDM, OFDMA, MIMO, SC-FDMA, SDMA

Narrow down the search to IPC class H04

Narrow further the search to Earliest Priority Date filing patents as 2005-present.

13. Export the report in Thomson Data Analyzer.
14. Analyze the rankings.
15. Register the total number of Records returned and Ericsson LTE Patent Portfolio included in the search, for further comparison.

5. **Tools and Resources (human resources, costs, materials, software etc.)**

Tools: Thomson Innovation, Thomson Data Analyzer.

Appendix D – Analysis 4 – Patent Section Search

1. **Title of the analysis**

Patent Section Search

2. **Scope and purpose of the analysis**

This is a quantitative patent assessment of the Long Term Evolution area, based on keywords search defined in the thesis as indicators towards LTE and the technologies specific to LTE. The purpose of the analysis is to look into the sensitivity created by sections of the patent in which the search is being performed. In order to capture the variation of patent section search variable, all the other parameters have been kept constant throughout the different searches.

3. **Questions to be answered**

Is there any sensitivity offered by patent section search?
If yes, what is the extent and effects of this sensitivity?
Is there any trend to be noticed?

4. **Description (the section includes level of the analysis, time frame and methodology**

Timeframe: 2005-present
Databases: Ex. All jurisdictions.
Process and methodology:

1. Definition of the area of interest as Long Term Evolution.
2. Set the parameters in Thomson Innovation in order narrow down the database search to the LTE area as following
3. Search queries composed of the following keywords (and their variations): LTE, Super 3G, E-UTRAN, UMTS, beam forming, HARQ, Fast Power Control, OFDM, OFDMA, MIMO, SC-FDMA, SDMA
4. Narrow down the search to IPC class H04
5. Narrow further the search to Earliest Priority Date filing patents as 2005- present.
6. Export the report in Thomson Data Analyzer.
7. Analyze the rankings.
8. Register the total number of Records returned and Ericsson LTE Patent Portfolio included in the search, for further comparison.

Parameters such keywords in the queries, IPC class, time frame and databases have been kept constant. The only variable to be changed in the different searches was the section of the patent. Ten different sections of the patent have been tested as following: Full Text, Full Text DWPI, Title/Abstract, Title/Abstract/Claims, Title, Title DWPI, Abstract, Abstract DWPI, Claims, and Description.

Different query searches have been used in the analysis: a query including LTE+ Super 3G, E-UTRAN and UMTS keywords and their variations and 8 different queries including the 8 following keywords and their variations: beam forming, HARQ, Fast Power Control, OFDM, OFDMA, MIMO, SC-FDMA, SDMA

Using the different keyword queries and different patent section searches more than 800 data points have been analyzed at quantitative level on which basic statistic has been applied and trends observed.

5. **Tools and Resources (human resources, costs, materials, software etc.)**

Tools: Thomson Innovation, Thomson Data Analyzer.

Appendix E – Technology Breakdown Analysis. Exemplification Iterative process for query simplification- A quantitative approach.

The two values considered in evaluating a keyword as being relevant for the search was the "representation of the keyword in the Ericsson LTE portfolio of patents" and the "Total number of records returned". The Ericsson portfolio of patents (classified for this exercise to follow the technology tree structure) was used as reference of a group of patents validated as being "true LTE patents", with the purpose to measure the targeting of the search: the more Ericsson LTE patents returned by the search, the better the encircling of the desired area. The encircling of the area of search would measure the precision of the search. The less noise generated the better for the search since the keywords would prove better not only in directing towards the relevant group of patents but also in narrowing it down.

To exemplify in this sense:

Considering A,B ,C and D the keywords part of the initial query meant to encircle "Control Plane Signaling" sub area (note that in reality the number of keywords in the initial query was close to 50) and (A OR B) AND (C OR D) the initial query (following the general model used for all the queries as described in Query Construction section)

Considering X the number of Ericsson LTE patents corresponding to "Control Plane Signaling" sub area, generated by the initial query and Y the "Total number of records" generated by the initial query search corresponding to "Control Plane signaling".

The purpose of the iterative process is to reduce the initial query to only the keywords that influenced the X value more than the Y value. With other words to identify those keywords who would direct the search towards the desired area (measured by the value of X: the more returned LTE patents classified by Ericsson as pertaining to "Control Plane Signalling" would translate to a better targeting of the areas) and create as little noise as possible (measured by the value of Y: a lower value of Y would translate through less records identified outside the are of interest).
Every keyword A,B, C and D would have a certain contribution to the total numbers of X and Y, respectively X1,X2,X3,X4 and Y1,Y2,Y3,Y4.

The ratios X1/Y1, X2/Y2, X3/Y3 and X4/Y4 would be calculated and only the keywords with the largest ratios would be included in the end query. If X1/X2 is larger than X2/X3 then corresponding keyword A is considered more relevant than corresponding keyword B.
A larger ratio would translate through a larger numbers of Ericsson LTE patents identified by the respective keyword (meaning a better targeting of the area of search) vs. a lower number of total numbers of records generated (meaning less noise).

The proposed iterative method of simplification does not require a specific set of skills since the method is quantitative. The decision making on what is considered to be relevant keywords versus another is based on the search values returned by the specific keywords.

- Each query was simplified from an initial query of 50 keywords to an end query of 4-8 keywords.
- Using this model of optimization across the 6 queries encircling the 6 LTE sub areas, the noise was reduced by 67% while keeping 80% of all the relevant documents in Ericsson LTE portfolio.
- *Overall end queries include less than 10% of the initial number of keywords and returning in average 80% of the initial relevant documents, by maintaining only 33% of the initial noise.*

Following the above mentioned iterative process of reducing the queries following end queries have been obtained for each of the six analyzed areas:

1) Keywords proved most efficient and effective in encircling the **Control Signaling** area:

Process	**Location**
Scheduling	Control channel
Noise covariance	Radio channel
	Random access channel
	Radio bearer

QUERY: Full Text = (Scheduling OR Noise covariance) AND (Control channel OR Radio Channel OR Random access channel OR Radio bearer)

Efficiency of Iterative process of reducing the number of keywords in absolute numbers:

Control signaling	% no records End Query in no records Full query	% Noise reduction
Families	46%	54%

2) Keywords proved most efficient and effective in encircling the **RRM** area:

Process	Location
Downlink	User equipment
Handover	Radio base station
Co-channel interference	X2 interface
Mobility Management Entity	Cellular system

QUERY: Full Text = (downlink OR handover OR co-channel interference OR Mobility Management Entity) AND (User equipment OR Radio base station OR X2 interface OR Cellular system)

Efficiency of Iterative process of reducing the number of keywords in absolute numbers:

RRM	Full Query	End Query	% no records End Query in no records Full query	% Noise reduction
Families	25081	11184	45%	55%
Records	80058	22550	28%	72%

3) Keywords proved most efficient and effective in encircling the **Query Multi Antenna Systems** area:

Process	Location
Beam shape	Antenna
Reference signal	
MIMO	
Scheduling	
Transmit diversity	

QUERY: Full Text = (beam shape OR reference signal OR MIMO OR Scheduling OR Transmit diversity) AND (Antenna)

Efficiency of Iterative process of reducing the number of keywords in absolute numbers:

Multi Antenna Systems	Full Query	End Query	% no records End Query in no records Full query	Noise reduction
Families	22873	15189	66%	34%
Records	73134	28649	39%	61%

4) Keywords proved most efficient and effective in encircling the **Modulation and coding** area

Process	**Location**
Delay	OFDM system
PAR	Wireless communication system

QUERY: Full Text = (delay OR PAR) AND (OFDM system OR Wireless communication system)

Efficiency of Iterative process of reducing the number of keywords in absolute numbers:

Modulation and Coding	Full Query	End Query	% no records End Query in no records Full query	Noise reduction
Families	28727	11453	40%	60%
Records	167304	22642	14%	86%

5) Keywords proved most efficient and effective in encircling the **Positioning** area

Process	**Location**
UTDOA	RSRQ
Fingerprint	UE

QUERY: Full Text = (UTDOA OR Fingerprint) AND (RSRQ OR UE)

Efficiency of Iterative process of reducing the number of keywords in absolute numbers:

Positioning	Full Query	End Query	% no records End Query in no records Full query	Noise reduction
Families	13454	82	1%	99%
Records	24766	112	0%	100%

6) Keywords proved most efficient and effective in encircling the **SON/OAM** area

Process	**Location**
Self organizing network	eNB

OSS	eNodeB
Performance management	

QUERY: Full Text = (Self organizing network OR OSS OR Performance management) AND (eNB OR eNodeB)

Efficiency of Iterative process of reducing the number of keywords in absolute numbers:

SON/OAM	Full Query	End Query	% no records End Query in no records Full query	Noise reduction
Families	472	91	19%	81%
Records	727	70	10%	90%

Appendix F- Sensitivity Matrix

The matrix contains results when performing different searches in different sections of the patent. Except the query search and section of the patent all the parameters of the different searches were kept the same.
The first query includes the keyword LTE and its variation, the second includes the term E-UMTS and its variations and the third includes the word E-UTRAN and their variations.

Different rankings have been highlighted per actor, at keyword and patent section level in order to visualize the different scenarios that can be obtained, each favoring an actor against the other. The number inside each box represents the ranking of each company in the specific search according to the keywords used and the section of the patent.

The red colored box highlights the scenario in which the company obtains the best results. The orange colored box highlights an average result obtained by the company and the yellow a low result. The N/A value signifies the fact the company is outside Top 10 companies ranking of the specific search. The scenario is set by a search done in a specific patent section using a specific keyword. For example a query search performed in the Claims section using the LTE keyword and its variations would favor Ericsson against the other competitors. On the other side a search based on E-UTRAN keywords and performed in Text field DWPI would favor Qualcomm.

Ericsson					
		Text fields	**Title/Abstract/Claims**	**Claims**	**Text field DWPI**
	LTE	5	2	1	2
	E-UMTS	5	N/A	N/A	N/A
	E-UTRAN	6	5	1	5
Qualcomm					
		Text fields	**Title/Abstract/Claims**	**Claims**	**Text field DWPI**
	LTE	1	1	3	1
	E-UMTS	3	7	2	N/A
	E-UTRAN	1	2	4	1
Interdigital					
		Text fields	**Title/Abstract/Claims**	**Claims**	**Text field DWPI**
	LTE	4	3	2	5
	E-UMTS	6	6	N/A	3
	E-UTRAN	3	3	1	4
Samsung					
		Text fields	**Title/Abstract/Claims**	**Claims**	**Text field DWPI**
	LTE	6	6	6	6
	E-UMTS	9	6	3	N/A
	E-UTRAN	N/A	N/A		N/A

LG Electronics					
		Text fields	**Title/Abstract/Claims**	**Claims**	**Text field DWPI**
	LTE	2	5	N/A	4
	E-UMTS	1	3	N/A	2
	E-UTRAN	4	7	N/A	6
Nokia					
		Text fields	**Title/Abstract/Claims**	**Claims**	**Text field DWPI**
	LTE	3	4	4	3
	E-UMTS	2	2	1	2
	E-UTRAN	2	2	2	2
Motorola					
		Text fields	**Title/Abstract/Claims**	**Claims**	**Text field DWPI**
	LTE	7	7	N/A	7
	E-UMTS	4	1	N/A	1
	E-UTRAN	5	4	N/A	3