**POINTS OF DIFFERENCE IN AFFILIATIONS WITHIN
WIRELESS INDUSTRY CONSORTIA**

by

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ABSTRACT

Salient constructs of 736 organizations affiliated with 9 associations, forums and alliances in the wireless industry are used to determine consortia points of difference. The comparison of consortia indicates that: (i) support for legacy technologies is focused on optimization, services, and cost reduction, (ii) support for newer technologies is focused on standards, research, hardware, and testing, (iii) two standards are paths of technological adoption, the third standard suggests new market entrants, (iv) motivation for membership to consortia is based on product certification and interoperability. Comparing consortia's identified points of difference to consortia's declared objectives three types of relationships are observed: (i) strong support, with a good mapping between the constructs and the objectives for two consortia, (ii) a definitional role, where the constructs provide suggestions for what six consortia's objectives mean, and (iii) weak support, with a poor mapping between the identified constructs and the objectives for one consortium.

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1. Introduction

Information and communication technology firms affiliate to industry associations, forums and alliances as well as standards development organizations that design or promote technical standards. Standard setting has become such a central technology-strategic activity that many of these firms make substantial financial investments in cooperative standard-setting organizations (Leiponen and Bar, 2008). Standards are increasingly recognised as a core alignment mechanism, in which the interests of various types of stakeholders are being negotiated. This process has major economic and political consequences, and covers not only technical but also many social, economic and legal aspects (Bekkers and Martinelli, 2010). Participation in associations, forums and alliances is very important for being able to contribute to new specifications and work items (Leiponen, 2008).

In this study the term *consortia* is used to identify industry associations, forums and alliances. Based on the definition suggested by Leiponen (2008), the *affiliation* is defined by the links firms have with consortia and not directly with one another. The indication of the links that firms have with consortia – or firms' affiliation with consortia - is based on consortia membership. The term *construct* is based on the definition provided by Carlile and Christensen (2005) and represents an abstraction that help us rise above the details to understand the essence of what the observed phenomena are and how they operate.

Anderson et al. (2006) identifies the *points-of-difference* as a building block of a successful customer value proposition and defines it as elements that make a supplier's offering either superior or inferior to the next best alternative. In this study the *points-of-difference* term refers to the relative importance of the salient constructs identified for each association, forum or alliance. For example, the Points of Difference Index (POD) for the "Hardware" construct, for the WiMAX Forum, provides a numerical value indicating the strength of the "Hardware" construct for members versus non-members of the WiMAX Forum in the sample analysed.

Although the literature has addressed the relationship between consortia and standard setting, and how standards affect – or are affected by - technological change, relatively little attention has been paid to what differentiate the associations, forums and alliances that support standards.

1.1 Objectives

The first objective of the research is to analyze the constructs that can be used to distinguish the members of 9 consortia: GSM Association (GSMA), CDMA Development Group (CDG), UMTS Forum, WiMAX Forum, LTE/STI Trial Initiative, Next Generation Mobile Networks (NGMN), Wireless Broadband Alliance (WBA), CDMA Certification Forum (CCF) and Open Patent Alliance (OPA). These organizations were created at various points over the last two

decades¹, in order to support the wireless standards and technologies of the day.

The second objective of this research is to provide a methodology for identifying the predominant constructs that characterize wireless industry organizations.

1.2 Deliverables

The research produced the following deliverables:

- A list of salient constructs for organizations that are members of associations, forums or alliances in the wireless industry
- The points of difference for each association, forum and alliance
- Interpretations of the points of difference to identify: (i) constructs of organizations involved in legacy or evolution technologies, (ii) trajectories for technological adoption, and (iii) the membership motivation
- Recommendations for designing non-profit keystone organizations

1.3 Relevance

This research is relevant to:

- Management teams and entrepreneurs who will be able to examine the salient constructs that define the focus areas, business models and collaborations of organizations at various stages of technology and standards development.

¹ 1987 - 2008

- Academic researchers who will be interested in the methodology used for searching for constructs; they will be interested in methods to automate the process of classifying organizations.

1.4 Contributions

The research makes at least three contributions:

- Constructs and points-of-difference identification can help improve member value proposition of associations, forums and alliances. The consortia can add value to their members by anticipating the changes in the standards and technologies they support, and the business models of their members.
- It improves the terminology used to describe the mobile communication industry attributes. The keywords identified from the organizations web sites could assist in subsequent automated searches that can improve the understanding of the evolution of standards, technologies and how keystone organizations adapt. The terminology and the method could provide a faster analysis of an industry and its evolution over time.
- The new approach for identifying the constructs improves the data mining methodologies used for mapping companies' attributes and industry trends.

1.5 Document Organization

This thesis is organized into six chapters. The first chapter includes the introduction and an overview of the research. The second chapter contains a

review of the literature pertaining to the mobile communication industry, web content analysis using keywords, hierarchical decomposition in relationship networks and factor analysis. The research strategy and method are described in chapter three. Chapter four provides the results of the data acquisition and analysis. Chapter five contains a discussion of the results. Finally, chapter six presents the conclusions, limitations and recommendation for future research.

2. Literature Review

This chapter provides the review of the literature. It is organized into five sections. Section 2.1 reviews the literature on wireless industry. Section 2.2 reviews the literature on networks of collaboration. Section 2.3 reviews the cluster and social network theory. Section 2.4 reviews the content analysis of websites. Finally, section 2.5 provides lessons learned.

2.1 Views on the Wireless Industry

2.1.1 Standards: competing through cooperation

The impact of standards can be articulated both in terms of the technologies and processes to which they are applied and in terms of economic issues that they may resolve in the market (Blind et al, 2010). Open system standards are defined by formal standard bodies and vendor consortia. The vendor consortia are organizations primarily composed of companies from industry that have a vested interest in defining standards for their own commercial products and who work together to achieve consensus on standard services and interfaces (Dargan, 2005). A standards strategy is a plan to achieve consistency between product development and public standards evolution. The focus of the plan is the alignment of the purpose of the firm's participation in standards development, the identification of the activities to be undertaken, and the structure required to implement these activities (Bailetti and Callahan, 1995). Organizations are motivated to come together to reach common objectives in order to create and develop new markets whose evolution depends on the

interoperability of the systems produced by different vendors and the interconnection of the networks of different operators. It is the drive of this common goal to move technology forward and create demand for the products or services in the market (Kazi, 2006).

Blind et al. (2010) study on the impact of the information and communication technology standards at firm and industry level, found that the most significant impact of standards were seen to occur in the product development and in the coordinating the structure of industries and markets. The study notes that “somewhat counter-intuitively”, formal standards were seen to actually increase product variety by facilitating a greater number of value-added combinations. Formal standards appear to have their greatest impacts at downstream application levels; major positive impacts were also seen on the globalization of markets and on market entry, but no overall impact in terms of changing market structure. Contrary to claims that standards level the competitive playing field, stakeholders perceived that formal standards may even increase the market share of dominant firms. Regarding the impact of different standardisation bodies, the same study shows that there is no particular variance according to the primary institutional affiliation of the respondent. The overall conclusion of the study is that the strategic impacts of the standards are more positive than the traditionally assumed cost and price impacts based on the exploitation of the economies of scale.

In a study of three generations of wireless standards development, Hemphill (2009) provides three standards development models, for TDMA (generation

2.0), CDMA (generation 2.5) and WCDMA (generation 3.0). The three conceptual models are shown to be generally similar in their designs and are shown in Figure 1.

Figure 1: Hemphill's Wireless Standards Development Model

The study findings are relevant to the competitive strategy chosen by wireless telecommunications firms. Manufacturing firms tend to have a greater stake in the development of standards than the network operators since they profit from the licensing fees on patents related to manufacturing to the standard. In the case of competing technologies, as was the case for CDMA adoption, the owner of the patents entered in joint testing arrangements with a number of network operators and cooperative working relationships with other manufacturers that lead to the move from the preliminary standards phase to the formal standards phase. The competition for the dominant design was won by the firm that made a concerted effort to place itself as de facto leader and establish a pre-conceived momentum for its technology. The study also highlights that in cases where there are questions about its technology, a competing firm must actively participate in public industry forums to address the technical concerns raised by

members of the industry. The strategic technology alliances, among manufacturers and manufactures and carriers, must be entered before the formal standards development phase begins, as these strategic alliances will provide concerted support for agenda-setting in the standards organizations, protecting the technology “champion” (Hemphill, 2010).

Keil (2002) argues that standards are increasingly created through alliances. The standardization through alliances combines elements of pure market-based and committee-based standardization. Its largest strength lies in enabling rapid standardization while decreasing the uncertainty that is caused by a large number of competing technologies. Standardization alliances are often semi-open in that the standard is developed by a limited number of firms while a larger number of companies support the standard as adopters.

Leiponen (2008) argues that affiliations with consortia, alliances, or committees are relevant in standardization due to the knowledge accumulation through joint research and development arrangements. The connections that firms form directly to one another are more important in the work item committee network. In the empirical study of the Third Generation Partnership Program (3GPP) Leiponen (2008) suggests that participating in consortia significantly enhances a firm contribution to the development of specifications in committees.

2.1.2 The evolution of the value chain in the mobile industry

The value chain analysis was introduced by Porter (1985) as an assessment tool for businesses that wanted to understand how they should position

themselves strategically amongst their suppliers, buyers and competitors. Porter argued that competitive advantage stemmed from many discrete activities a firm performs in designing, producing, marketing, delivering, and supporting its product. Porter's traditional value chain model proposed a sequential model for value creation at the firm level. The value chain concept has been broadened later to describe an entire industry

In applying this model to the wireless industry Maitland et al (2002) indicates that in this case the value chain is shaped by the underlying technology and does not fully determine firm and industry structure. As the industry evolves firms will re-position themselves, carving out specific roles and position themselves differently in the industry value chain. The wireless industry value chain maps the wireless industry in stages, showing how each stage feeds and supports the next. The value chains from Maitland et al. (2002) and Constance and Gower (2001) were modified and are presented in Figure 2.

Figure 2: Value Chain in the Wireless Industry

Maitland et al. (2002) value chain model for the third generation (3G) in the wireless industry was based on the second generation (2G) value chain with the addition of components from the Internet access value chain. This evolution in mobility is described through the addition of 'enablers' into the value chain – firms that bridge the gap between equipment, application and services.

Infrastructure providers design and manufacture the physical infrastructure needed for wireless communication to take place. In migrating to the next generation, one of the challenges for the infrastructure providers lied in replacing the proprietary service platforms with open network protocols and high capacity base stations. Their typical business models include hardware, software and service sales to the network operators. With the majority of the network equipment revenue coming from the base stations, the wireless equipment started to move into partnerships with application developers and at times come in conflict with network operators who did not want to see their roles degraded (Maitland et al, 2002). The network operator is the link between the infrastructure provider and the end-user. A wireless network operator licenses spectrum from the government and makes use of the infrastructure to provide mobile series to the end-user. With the introduction of fourth generation (4G) networks the traditional network carriers face increased competition from new entrants in the industry² - the new service providers. The typical business models for the operators are based on monthly fees, which are determined by the speed of connection and the volume of data flowing through.

² <http://www.mobiledia.com/news/72122.html>, last accessed August 5, 2010

The analysis of the mobile industry through the evolution of the value chain provides a framework for the assessment of the technical and competitive landscape, and for value propositions of the industry. Sabat (2002) used this model to show that over time the traditional players in the industry are repositioning themselves from their old slots into newer niches even as new entrants are rushing to grab their slots. Competitive threats lead to forming synergistic partnerships in the value chain as the technological challenges and costs of the 4G have forced device manufacturers to seek alliances to better compete. Sabat (2002) indicates that customer demands for mobile business value has led to the convergence of functionality in products, which in turn necessitated the convergence of technology and standards and divergence of products coupled with differentiation of services along the value chain. Understanding the value chain and network economics will help the mobile wireless companies 'unleash the potential of the value chain and to sustain profitability levels' (Sabat, 2002).

The model for the wireless industry value chain proposed by Constance and Gower (2001) is shown in Figure 3, in a map of the largest players in the industry. A dotted line indicates an information exchange, while a solid line indicates both information and a monetary exchange.

Figure 3: Players in the Wireless Industry Value Chain

2.1.3 The layered model

In an attempt to characterize the evolution of the telecommunication industry Fransman (2002) proposes a layered model as a framework similar to the model used by telecom engineers and software developers. In this model, Layer 1 is defined by the Equipment and Software Layer (with solutions from infrastructure providers), Layer 2 is defined by the Network Layer (represented mainly by network operators), Layer 3 is the Connectivity Layer (Internet access, Web hosting), Layer 4 is the Navigation and Middleware Layer (browsers, portals), Layer 5 is the Application Layer (online information services) and finally Layer 6 is represented by the consumers. This approach allowed for identification of opportunities for new entrants when the new TCP/IP became a platform on

which new services were built. The model also allows the visualization of the industry modularization that facilitates entries of companies into all the layers by allowing them to focus on their activities and ignoring the complementary ones. The coordination of activities between layers and within layers, the comparison and contrast between industries are also cited advantages of the model. Fransman (2002) also highlights some of the shortcomings of the model: it is static by not including the processes of change, it does not explain the coordination among the players and it neglects the differences within layers. The model leaves out the role of regulatory and standards organization.

A similar layered model presented by Maitland et al (2002) shows the position of the mobile virtual network operators against a layered network architecture composed of: physical, radio access, network, call control, and service platform layers. The market orientation and business model of the network operator is explained by the number of layers encompassed in its operations.

2.1.4 The business ecosystem model and key players

It has been argued that networks studied in biology and other natural sciences provide an appropriate frame of reference and useful terminology for understanding business networks (Moore, 1996; Peltoniemi, 2006). The business ecosystem is "an economic community supported by a foundation of interacting organizations and individuals - the organisms of the business world" (Moore, 1993). A company should not be viewed as a member of a single industry but "as part of a business ecosystem that crosses a variety of

industries". In business ecosystems, firms compete and cooperate at the same time as they have a mutual interest in defending, developing, and growing an ecosystem (Moore, 2006).

Similar to biological ecosystems, participants in a business ecosystem are not all created equal and do not necessarily pursue the same strategies. Iansiti and Levien (2004a) identified three types of behaviours among actors, namely keystone players, dominators, and niche players, which are useful in understanding the strategies and positioning of participants in business ecosystems. Keystone players are active leaders in the ecosystem and tend to improve the overall health of the ecosystem. keystones tend to assume roles of hubs in the network; they often lie at the core's network as the most connected. However, any firm occupying a hub in a business ecosystem, often faces temptations to exploit their position - characteristic of a dominator, or hub landlord, strategy. Dominators are firms that control a large part of their networks. They take most of the value for themselves and leave little for other companies in the ecosystem. In mature industries, where little innovation takes place and change is slow, dominators can have a beneficial effect. In emerging industries, this behaviour can be highly destructive as it limits innovation. Niche players constitute the largest group in any ecosystem. They are non-dominant, large, and small, companies that specialize in specific capabilities to differentiate themselves from others in the ecosystem. Niche players collectively create much of the value in a niche and generally capture the value they create.

Their growth depends on their ability to leverage keystone platforms and to maintain a level of differentiation.

2.1.5 The mobile ecosystem

As early as 1980s, telecommunications industry was compared to an ecosystem (Young, 1980), where the “ecological enquiry evaluates the adaptability of the system”. There are several recent studies that have adopted the ecosystem perspective in the mobile industry context (Maitland et al., 2002; Tilson and Lyytinen, 2005; 2006). There are studies on the role of specific players in the industry, such as network operators (Peppard and Rylander, 2006) and device manufacturers (Dittrich and Duysters, 2007). Some have focused on mobile marketing (Becker, 2005), mobile multimedia (Balaji et al., 2005), mobile content (Peppard and Rylander, 2006), mobile business (Coursaris et al., 2006) and globalization of the mobile industry (Steinbock, 2003).

Basole (2009) presents a picture of the mobile ecosystem which consists of a variety of firms from numerous enabling and supporting segments of products and services. The incumbent (currently existing) segments are depicted by darker spheres and the emerging segments by lighter spheres as indicated in Figure 4.

Figure 4: Basole's Converging Mobile Ecosystem

2.1.6 The Double Helix model

The Double Helix model illustrates the evolution of industry structure over time. According to Fine (1998), a given industry oscillates between vertical/integral and horizontal/modular structure. Fine's model helps participants prepare for shifts in industry structure by emphasizing the notion of temporary advantage – participants must realize that current critical capabilities may become commodity capabilities in the future.

Figure 5: Fine's Double Helix Model

In this model the two drivers are the competitive intensity and technological innovation. When the industry structure is vertical and products architectures integral, the competitive intensity is low. Eventually the entry of competitors will force the vertical firms to disintegrate. The previously vertical firms become dependent on its new suppliers. These dynamics result in complete modularity, as participants specialize in the production of horizontally applicable components. The double helix model suggests an eventual reintegration of the horizontally oriented industry. Constance and Gower (2001) applied this model to the wireless industry in the 1990s to explain the device and infrastructure value chain dynamics.

2.1.7 The dynamic ecosystem model

The dynamic ecosystem model (DEM) proposed by Vesa (2003) is an analytical framework built on the business ecosystem concept and the Double Helix model. It combines the evolutionary ideas of the business ecosystem and the

cyclic nature of the development of product architecture and organizational structure. The DEM model is used to carry out a “macro-level” analysis of the fast moving wireless industry and is able to manage the complexity of the adaptive and dynamic nature of the industry and provides a network perspective.

2.1.8 Real options approach in the wireless industry evolution

The real options approach (ROA) is a strategic tool to evaluate business projects investment used by Kim et al (2009) to analyze the technology policy issues in wireless networks, network service provisioning, and network regulation and policy. Their study looked at the wireless industry migration path options to 3G by exploring two typical network migration alternatives: architectural innovation (infrastructure replacement) and modular innovation (upgrades to existing equipment). The two alternatives involved evolution to two different technologies (GSM-based or CDMA-based), and described by two different sets of standards (3GPP or 3GPP2). The approach is a blend of a comparative study and a “what if” study (or contingency study). Reaching relevant data for technology development was considered challenging and as a result the data used in the study was based on the market shares of competing technologies.

2.1.9 Strategic value assessment model

Pagani and Fine (2008) developed a map to analyze the dynamic forces that influence the structure and evolution of 3G wireless industry motivated by the

fact that this is an industry where competition is intense, growth is rapid, innovation is abundant, and technological options are increasingly complex. The dynamic of the industry creates great opportunities for the participants in the global value network but poses enormous challenges for participating organization and their business models. The resulting map focuses on the dynamic complexity of the value network and on the interdependencies among the wireless network providers, service providers, and the customers. The study proposes a range of behaviours and plausible scenarios that resulted from the discussions with several panels of experts and interviews. The 3G communication value network scenarios were: (1) cycles of entry and bankruptcy, where the combination of competition in infrastructure and service provision and the creation of global markets for 3G infrastructure and terminals may prove challenging for sustainable business models but good for customers, (2) stable oligopoly, where powerful incumbents can discourage market entry by new service providers, especially in the case of a breakdown in collaboration on telecoms and software standards worldwide, (3) free for all, where governments allow more unlicensed spectrum which could encourage market entry by service providers and the development of global standards that could help to reduce service and terminal prices, (4) appearance of a new dominant force, an innovator entrant becoming a dominant force which might increase the barriers to entry of other potential entrants while global standards help reduce service and terminal prices, and (5) piracy development, which could be characterized by slowing growth in profits for content providers, but could help to attract new

adopters and help network providers prosper from service to the customers. The use of such a theoretical map for the industry is tentative until further data collection could shed more light onto the likelihood of each scenario.

2.2 External Networks of Collaboration

Research into inter-firm networks has become prominent (Freeman, 1991; Langlois, 1992; Baldwin, 2007) as a firm is no longer seen as a closed entity that produces and markets products independently. The boundaries of the firm are expanding to include their external interactions and relationships with suppliers, customers, distributors, strategic partners and research organizations, each who provide a source of innovation and have opportunities to shape the final product. It has been found that product and industry structure have an impact on the shape of these external networks as well as its evolution among the firms within that industry (Hite and Hestley, 2001; Langlois, 1992; Langlois, 2002).

2.2.1 Modular industry structure

Modular product architectures can be an important source of strategic flexibility when they enable a firm to respond faster to changing markets and technologies by rapidly creating product variations based on new combinations of new or existing modular components. They also enable the coordination of a global network of component developers and suppliers (Sanchez and Mahoney, 1996). One important implication of product modularity is that it leads to more modular industry structure, with increased division of labour across companies,

specializing in different components within a given architecture. This demands tight cross-company interaction and coordination that can be performed by “system integrators” at the organizational and knowledge levels (Brusoni and Prencipe, 2001). Greater heterogeneity in the production process for an industry leads to a greater use of modular organization forms such as contract manufacturing, alternative work arrangements, and strategic alliances. The extent to which industries respond to heterogeneity partly depends on industry standards, the rate of technological change, and the degree of competitive intensity, which all facilitate the use of modular organizational forms (Schilling & Steensman, 2001). The effect of modularity on external networks is one of enablement (Baldwin, 2007). Transactions that previously were too expensive or not possible now can take place. Modularization creates new boundaries – transaction-free zones – where new entry can take place. For areas in the network where transactions are dense and complex, their costs can be minimized by moving them to transaction-free zones, thereby reducing the burden on the system. These new boundaries form breakpoints where firms (and industries) may split apart. The “modularity theory of the firm” (Langlois, 2002) suggests new roles for firms to facilitate the communication of rich information for purposes of qualitative coordination, innovation, and re-modularization. Hybrid forms like joint ventures and collaborative arrangements arise for similar reasons. Modularity can help inter-firm networks engage in knowledge exchanges, becoming brokers that specialize in the particular type of

knowledge exchanges within an industry – and extracting value from those exchanges by becoming the entities that can execute them most optimally.

2.2.2 Evolution of a firm's networks of collaboration

The evolution of firm's networks is based on the firm's requirement to adapt to the firm's resource needs and challenges (Hite and Hesterly, 2001). The main driver is the resource availability, access and uncertainty. The identity-based networks characterize the emergence phase. In this phase the networks are egocentric, the ties are personal or socially related and who the ties are matter more than the economic functions or resources that the tie provides to the firm, because these ties are more likely to provide the resources. The ties are few and strong. The identity-based networks do not possess the breadth of resources needed to meet the information and knowledge requirements and are more path-dependent. By comparison, the calculative networks characterize the later, early growth phase of a firm. The calculative networks provide greater resources, the functions of the networks are more important than the identity of the ties, which are motivated by economic benefits. They have a greater density, the majority are weak ties and more likely to be less redundant and better able to bridge structural holes. The evolution of the firm networks "will be dominated by path-dependent processes during emergence but will become intentionally managed as the firm moves into early growth". An organization needs to map the ecosystem in terms of inter-firm interconnections and adapt to it as it evolves in order to have access to the complementary assets through relationships (Iyer, 2006).

In the evolution of firms' strategic alliances, the alliance-based learning is vital in the initial phase, when learning is associated with exploration. This learning becomes more internalized, intra-firm and exploitative in the later phases (Oliver, 2001). It has been proven that a lack of a strategic alliance can be associated with organizational death. But participating in a network exposes organizations to risks of being exploited by unpredictable and opportunistic partners. There are liabilities associated with alliances. At the early stages, a lack of alliances suggests inability to attract partners and thus inability to learn, leading to organizational failure. The benefits from an increased number of learning opportunities outweigh the risks and firms in this explorative phase follow a path of increasing the number of alliances. In the later phases of the lifecycle the alliances become more exploitative, it is a period of alliance rationalization, as firms realize that the new alliances are too demanding in terms of the communication energy they require, while they get too little in return. Another view of this exploitative phase is that organizations already raised enough funds so the alliances are not needed anymore. The organization has already acquired the external knowledge from the new technologies and enters a period of more internalized learning.

2.2.3 Dynamics of entry and network position

Orsenigo et al (2001) indicates that firms have found serious difficulties in modifying their structural position within a network. Specialized firms have tended to remain specialists, while early entrants have enjoyed significant first-mover advantages, precisely because they have been able to embody

knowledge at a high level of generality. Thus, a major asymmetry seems to have characterized the evolution of the network: while in many cases “generalist” firms have been able to gradually absorb increasingly specific knowledge, specialist firms found it much harder to move in the opposite direction. As the locus of innovation moves from the firm to the network, the firm position in the network becomes a competitive advantage (Iyer, 2006). The network path length, clustering coefficient, and degree can be used to understand an individual firm’s position and relationships in the network compared to competitors.

2.2.4 Industry lifecycle

The waves of diffusion and concentration in the networks evolution have been observed since the late nineteenth century (Freeman, 1991). The initial upsurge in the inter-firm linkages is a transitory phenomenon of adaptation to the diffusion of new generic technologies. Once firms have become familiar with these technologies they will wish to shift the strategically sensitive areas under their control and internalize some of the networks. According to this view, this phase will be followed by a new wave of “rationalization and industrial re-concentration”. In the early formative period of any major new technology system, almost by definition there are no dominant designs or standards and a state of organizational flux. As technology becomes more mature the economies of scale become more important and standardization takes place (Freeman, 1991). The patterns of inter-firm linkages are linked to industry’s development lifecycle (Gloor et al, 2007). The need to innovate places pressures on the

evolution of the network structures in the lifecycle of an industry. When firms in the pharmaceutical industry entered a more mature era, the industry witnessed a series of defensive mergers with direct rivals and takeovers of small biotechnology firms, but the 'bureaucratic solidity' of the pharmaceutical firms reduced the innovativeness of the biotechnology firms significantly. Pharmaceutical firms were forced to change their strategy towards establishing more loosely coupled linkages (Gloor et al, 2007).

Chesbrough and Prencipe (2008) propose a model for the innovation lifecycle, which suggests that the evolutionary dynamics of modularity is reflected in the innovation network evolution. In particular, they argue that firms should align their innovation networks with phases of technology modularity, and focus their openness in specific directions at specific stages of technology development. In order to cope with changes in the information and knowledge requirements that characterize the modularization process of technologies, firms must change their innovation networks in terms of their search approach (explorative vs. exploitative), intensity of relationships (weak vs. strong ties), number and type of partners (research centers, startups, complementary asset holders) (Chesbrough and Prencipe, 2008).

2.3 Clusters and Social Network Theory

The analysis of organizations through multidimensional constructs has a long history, but it created a conceptual challenge in that a vast array of combinations could be developed along multiple dimensions (Ketchen and

Shook, 1996). The response to the challenge was to identify the organizational configurations: sets of firms that share a common profile along conceptually distinct variables (Miller and Mintzberg, 1983). For example, an “entrepreneurial” configuration is one that consists of firms that are small, young, informal, and have centralized decision making; similar organizational configurations are the organizational typologies and taxonomies.

One of the particularities of exploratory factor analysis is that the results cannot be inferred from the sample to the population (Field, 2005). The use of factor analysis in literature (Opoku, 2005; Hicks, 2006; Lombardi, 2008; Allen, 2009) indicates that the sample is defined based on well-defined criteria rather than selecting random cases from a population. The cluster analysis approach takes a sample of elements (e.g. organizations) and groups them together such that the statistical variance among the elements grouped together is minimized while between-group variance is maximized (Ketchen and Shook, 1996). The cases from the literature where databases with large sets of cases were available (Hicks, 2005; Costello and Osborne, 2005) the variables for selecting the clusters as samples for further factory analysis were clearly defined. In other studies, the cluster selection was based on the researcher experience with the subject matter and was based on a manual selection process (Allen, 2009).

Social and collaborative network theory provides us with a number of tools and models for analyzing the relationships among actors in a network and for creating clusters of actors with shared characteristics. Social network theory models persons as nodes of a graph and their relationships as edges of the

graph (de Nooy, 2005; Caldarelli, 2007). Thus two actors are connected directly if they have a relationship with each other, in which case they are one link away from one another. More distant relationships are modeled as paths through the graph. Collaborative networks are variations of social networks, where the relationships are collaborations, e.g., open source software development (Madey et al., 2002), or co-authors on research papers (Newman, 2001). Often entire populations are connected into one large cluster with characteristic cluster coefficients (Watts, 1999). Highly prolific actors or authors are linchpins in collaborative networks. Linchpin actors or researchers play key roles in bridging disparate groups into one large cluster by being the only joint participant in two different projects.

2.4 Content Analysis of Websites

2.4.1 Corporate identity

The vast majority of companies use their corporate websites to reach a diverse group of target audiences including investors, customers, employees, researchers and the media (Insch, 2008). Companies use websites to advertise their corporate identity and their aspirations, and to describe their products, actions in the marketplace, and organizational credentials. This has led to a wealth of research focusing on the content companies place on their website and on why and how it is reflective of the company's position in the marketplace. Almost every organization's website has an "About Us" page stating company description, values and history. Heldal et al. (2004) discussed the usability,

human computer interaction and branding to demonstrate how each field alone is insufficient but taken together they can offer optimal communication through the Internet to maintain and build sustainable customer relationships.

Hicks et al. (2006) found that most websites are not used to interact with potential customers. Most firms go beyond describing their current identity; they describe their potential and their aspirations. Pollach (2005) found that even large and well established companies use their about page to make themselves look better than other firms in the industry. For example, many organizations claimed dominance of the same market. Positive attributes were written in a passive voice to insinuate a general acceptance of them. Hicks et al. (2006) show that in defining their corporate identity, companies relate their current situation as well as their aspirations. "A successful web site satisfies the goals of both the users and the provider of the website" (Pollach, 2005).

2.4.2 Content analysis

The corporate website can be used as a valuable tool by researchers for collecting information. Data is much more readily available than using interviews or questionnaires and can be gathered quickly and efficiently using harvesting tools. A number of tools that can scour a website searching for relevant information can be used to find lists of sites based on a particular topic, can search for specific content within a predefined set of websites or choose search results based on any number of factors. Perry and Bodkin (2000) examined self promotion by Fortune 100 companies on their websites. McMillan (2000)

surveyed 19 different studies using web content analysis. Pollach (2005) examined how companies present themselves on their websites. Porter et al. (2007) described a method for collecting technical intelligence and Opoku (2005) investigated the most innovative business schools. A number of researchers have recently used keyword based search techniques to build theory and/or test hypotheses in the field of management science (Ferrier, 2001; Hicks et al, 2006; Opoku, 2005; Lombardi, 2008; McGinnis, 2008).

Ferrier (2001) conducted an exhaustive manual search of keywords in thousands of press releases of sixteen firms over seven years to study the aspects and performance of different classes of competitive attacks within a population of high tech firms. Hicks et al. (2006) used web mining techniques to gather data on the commercialization strategies of innovative small high tech firms. Opoku (2005) studied brand personality of US business schools using a dictionary of terms representative of the dimensions of brand personality. The frequencies of the words on the schools' websites were obtained and the pattern of occurrence assessed to classify the schools. Lombardi (2009) used web content analysis of keywords to assess and classify the interactions between Eclipse Foundation Members and Eclipse Projects. McGinnis (2008) used the same methodology to assess and classify the competitive actions of companies reliant on open source software for revenue. Allen (2009) used the content analysis of keywords to assess and classify the activities that organizations employ to enable value co-creation with customers and end users.

Various tools are available to support the web searches required to gather the data for these analyses. Of the many commonly available search engines, those with the most readily available and adaptable Application Programming Interfaces (API) includes Google's Ajax API, Microsoft Live Search API, Yahoo! Search API and KSAT³.

Exploratory Factor Analysis (EFA) has a long history in the social sciences. While it has been used most often for research on human psychology, recently it has been shown to be an effective tool to reduce the large volumes of data gathered through internet mining by extracting the base constructs underlying how small and medium firms do business (Hicks et al, 2006; Lombardi, 2009; McGinnis, 2008; Allen 2009). In simple terms, factor analysis is used to discover patterns in the relationships among a number of variables. It specifically seeks to explain these relationships using a much smaller set of variables called factors. A number of recent texts and papers provide excellent treatments of how to perform exploratory factor analysis using SPSS (Darlington, 2010; Field, 2005; Costello & Osborne, 2005; Reinard, 2006; Stevens, 2009).

2.5 Lessons Learned from the Literature

The following are the major insights from the literature review.

Social network theory, content analysis and factor analysis can be used to analyze the relationships among actors in a network.

³ <http://github.com/mwnorman/KSAT>

The participants in business ecosystems and networks of collaboration are identified by various roles and behaviours. The keystones or the hubs assume leadership role while niche players focus on specific capabilities.

Data on the wireless industry from public sources is scarce. The theoretical studies use panels of experts and the ones from public data sources are most often one-sided. The more detailed and complete studies of the wireless industry use data from private sources.

Web sites are used to communicate the identity and aspirations of organizations; the industry associations, forums and alliances are created to promote the interests of their members, but there is little evidence on how this information can be verified or validated; this creates an opportunity to confirm this information by analyzing member's web pages.

Standards are increasingly created and influenced by consortia. This type of standardization combines elements of pure market-based and committee-based standardization. Its largest strength lies in enabling rapid standardization while decreasing the uncertainty that is caused by a large number of competing technologies. Standardization alliances are often semi-open in that the standard is developed by a limited number of firms while a larger number of companies support the standard as adopters.

A firm is no longer seen as a closed entity that produces and markets products independently. The boundaries of the firm are expanding to include their external interactions and relationships with industry stakeholders that contribute

to the development and commercialization of the firm's products. An organization's identity is shaped by its external networks of collaboration.

As technology evolves and new standards emerge a firm's relationships in its networks of collaboration are changing. By understanding the evolution cycles in the industry a firm can shape its entry points and strategic alliances.

3. Research Methodology

This chapter describes the research design and method. It is organized into eleven sections. Section 3.1 provides an overview of the research strategy. Section 3.2 describes the steps carried out in this research. Section 3.3 describes the sample selection. Section 3.4 discusses the keyword selection process. Section 3.5 describes how the data used in this research was collected. Section 3.6 includes a description of the factor analysis method used in this research. Section 3.7 describes the results from the initial analysis. The methodology for creating the clusters is presented in Section 3.8. Section 3.9 discusses the use of multiple factor analyses. Section 3.10 covers the criteria for results validation, and finally Section 3.11 presents the instruments for data analysis and interpretation.

3.1 Research Strategy

This research uses data mining techniques and website content analysis to identify the main characteristics of consortia in the wireless industry. The approach is based on grounded theory and follows the recommendations of Carlile and Christensen (2005).

A dataset comprised of information on members of several consortia in the wireless industry was developed using search engines and keywords associated with wireless technologies, standards and business models. Factor analysis was used to reduce the dimensions of the information in the dataset. As the goal of this research is to uncover the diversity of constructs, a multiple

non-probability sample approach was used to gain a better understanding of the diversity of organizations' constructs.

This approach builds on the research of Hicks et al. (2006) and Opoku (2005) for web search and analysis methods and on social network theory (de Nooy et al, 2005) and Caldarelli (2007) for clustering methods.

The factor analysis results were grouped together, based on their similarity, to form constructs. The relative importance of the constructs is used to present two point-of-difference views: (i) how consortia ranks based on a construct, and (ii) how the constructs rank for a consortium. The identified salient constructs represent the points-of-difference for consortia.

3.2 Research Steps

Table 1 identifies the steps carried out to complete this research:

Table 1: Research Method

Research Method Step		Activity
1	Literature review	<ul style="list-style-type: none"> • Select and review literature on: <ul style="list-style-type: none"> • business models, technologies and standards in the wireless industry • web data mining techniques • clustering and similarity • statistical techniques for dimension reduction • develop lessons learned from the literature review
2	Select sample of	<ul style="list-style-type: none"> • Select a non-probability sample of consortia from the wireless industry: GSM Association, CDMA

Research Method Step		Activity
	industry consortia	<p>Development Group, UMTS Forum, WiMAX Forum, LSTI Forum, NGMN Alliance, Wireless Broadband Alliance, CDMA Certification Group, Open Patent Alliance</p> <ul style="list-style-type: none"> Criteria: <ul style="list-style-type: none"> From wireless industry news, websites, conferences Consortia from the major wireless technologies Consortia with diverse members: network operators, infrastructure providers, equipment and device manufacturers, service and application providers, etc.
3	Select sample of organizations	<ul style="list-style-type: none"> Sample: <ul style="list-style-type: none"> Websites with at least 10 pages in English
4	Select keywords	<ul style="list-style-type: none"> Keyword sets selected based on: <ul style="list-style-type: none"> Concepts from literature Concepts from 30% of sample websites Create keyword sets using AND/OR for stronger meaning
5	Data acquisition	<ul style="list-style-type: none"> Search websites using Keyword Search and Analysis Tool <ul style="list-style-type: none"> Capture keyword set scores = count / website number of pages
6	Design factor analysis method	<ul style="list-style-type: none"> SPSS factor analysis selections: <ul style="list-style-type: none"> Principal component analysis Varimax rotation method Retain keywords with loadings > 0.4 Minimum 3 variables with loadings > 0.5

Research Method Step		Activity
		<ul style="list-style-type: none"> ○ Select number of factors: Kaiser criterion and Scree plot
7	Initial factor analysis	<ul style="list-style-type: none"> • Initial factor analysis <ul style="list-style-type: none"> ○ Assess the degree of homogeneity of the sample ○ Determine the number of factors that can be extracted and the level of diversity of the factors
8	Clustering	<ul style="list-style-type: none"> • Introduce dissimilarity as control variable • Create networks of organizations that are linked if they share similar scores for the same keywords <ul style="list-style-type: none"> ○ Similar to four-point Likert scale ○ 4 networks: organizations are linked if they share keywords in the 1st, 2nd, 3rd and 4th quartile of the keyword range • Use hierarchical decomposition on each of the 4 networks <ul style="list-style-type: none"> ○ Create clusters of organizations in each network ○ Each cluster is defined by a dissimilarity index • Retain all clusters with more than 200 organizations: <ul style="list-style-type: none"> ○ Clusters A, B, C, D, E, F, G, H
9	Multiple factor analyses in all sample groups	<ul style="list-style-type: none"> • Run multiple factor analyses in each cluster • Analyze the factors in each cluster • As some clusters overlap retain only the clusters with diverse and relevant factors
10	Validate factor analysis	<ul style="list-style-type: none"> • Select factor analysis solution only if: <ul style="list-style-type: none"> ○ Keywords associated in one factor make sense to the experienced researcher ○ Correlation table determinant $> 1.0 \times 10^{-5}$ ○ KMO sampling adequacy test > 0.5

Research Method Step		Activity
		<ul style="list-style-type: none"> ○ Bartlett's significance test < 0.05
11	Validate results	<ul style="list-style-type: none"> • Repeat the factor analysis for the solutions retained for interpretation with a sample or organizations not involved in the wireless industry
12	Rank consortia	<ul style="list-style-type: none"> • In each sample create a ranked list of consortia based on the relative importance of each construct using the POD Index as defined in Section 3.11
13	Rank constructs	<ul style="list-style-type: none"> • In each sample create a ranked list of constructs based on their relative importance in each consortium, using the POD Index as defined in Section 3.11
14	Validate factor groups	<ul style="list-style-type: none"> • Check that factor analysis identified factors are part of the same factor analysis solution
15	Draw conclusions	<ul style="list-style-type: none"> • Synthesize conclusions and insights

3.3 Sample Selection

The unit of analysis is the website of an organization which is a member of one of the wireless industry consortia included in this research. Neuman (2003) identified two types of sampling: probability and non-probability sampling.

Eisenhardt (1989, 2007) and Patton (1990) highlight the inappropriateness of random sampling when searching for diversity of phenomena. This type of sampling is used in similar research (Hicks et al., 2006) where factor analysis methods are exploratory in nature and their results are not expanded to the population from which the sample was selected.

In this study, the primary purpose of sampling is to collect a diverse enough group of organizations that could help understand as many characteristics as possible of the organizations in the wireless industry consortia. Random (probability) sampling could carry the risk of samples too homogenous to allow for meaningful cluster analysis and also of disproportionate representation of organization types.

Regarding the size of the sample of consortia to include, this study followed the recommendations made by Eisenhardt (1989, 2007) to include between four and ten cases. Patton (1990) indicates that the validity and the insights generated from qualitative research have to do more with the information richness of the cases selected and the analytical capabilities of the researcher than with the sample size.

3.4 Keywords Selection

The keywords are intended to represent as many of the characteristics of the wireless industry consortia as possible. Keywords were collected through an exhaustive search of the literature and supplemented with additional words found through a theoretically informed contextual search of the 9 consortia' web pages and from 30% of the selected organizations' web pages. The initial set of keywords was rationalized to eliminate words that either produced negligible successful searches or were found to be ubiquitous (Hicks et al, 2006).

Since the Keyword Search and Analysis Tool (KSAT) supports logical "OR" and "AND" operations it was possible to combine many keywords to form sets of

keywords that allow a stronger and more focused meaning. In this study the factor analysis is used with a large number of keywords aiming to uncover the diversity of features in our samples.

3.5 Data Acquisition

Data was collected following a web data mining approach similar to Hicks et al. (2006) and Opoku (2005). The Keyword Search and Analysis Tool (KSAT) is an open source tool used to perform web searches and is based on the Google Ajax search API. The tool uses text files containing lists of keywords and website URLs to automate the search of applicable web-pages for the presence of the desired keywords (Hicks et al., 2006). The output is an Excel comma separated variable file containing counts of “hits” for each search term at each website normalized by the total number of web pages present at the website. The tool was configured to allow for English pages only. This change was considered necessary because many of the firms searched maintain a global presence and since the search terms were comprised of only English language words, web pages in other languages artificially lowered the keyword frequencies reported for those global firms.

3.6 Factor Analysis Method

The factor analysis is an exploratory research method used to identify the main dimensions underlying the variation of a large number of variables. In our research we are studying the patterns of relationships among the keywords used on the web sites of organizations involved in the wireless industry.

The factor analysis was performed with IBM SPSS Statistics 18 software by selecting the dimension reduction option with factor analysis.

As the factor analysis technique is complex in nature, with many options, this research used the recommendations of Costello and Osborne (2005). There are two statistical techniques used by researchers conducting exploratory factor analysis, Common Factor Analysis (CFA) and Principal Component Analysis (PCA). Recent publications generally recommend the use of CFA over PCA but most acknowledge that usually both PCA and CFA produce equally valid results and suggest that researches try multiple approaches and select the one that produces the best fit of results with theory (Stevens, 2009). For this research PCA was selected as it produced the best fit of the results with the knowledge on the mobile communication industry.

While the literature differs on the strengths of the various extraction methods, it indicates that a large sample size (300) results in similar results regardless of extraction technique. In this sense researchers should choose the method providing the clearest structure and the best fit with theory (Reinard, 2006). SPSS allows the researcher to specify the number of factors to extract and provides a scree plot as an aid tool. Kaiser's criterion and examination of the scree plot are the two main approaches suggested in the literature for determining the number of factors to extract. Kaiser's criterion assumes that all factors with Eigenvalues > 1.0 represent a significant contribution to the overall variation in the data. The scree plot can be used to identify a threshold for factor selection because only factors that contribute a relatively high degree of

variation are above the knee. Like selecting the optimal extraction method, many recent authors recommend that researchers examine the results of extraction with a range of factors and select the set that provides the best structure (Darlington, 2010).

Rotation is used to “find the best distribution of factor loadings in terms of the meanings of the factors” (Reinard, 2006, p. 417). SPSS supports the five distinct factor rotation methods: Varimax, Quartimax, Equamax, Promax and Direct Oblimin. Orthogonal rotation such as Varimax is generally used for factors which are expected to be uncorrelated (Field, 2005).

3.7 Initial Factor Analysis

An initial factor analysis was run on the results from the KSAT which contained the scores of all keywords from the initial sample of websites. The use of a large number of keywords is necessary with this type of exploratory research but impedes significantly the selection of all the relevant factors. In this sample group several factor analyses solutions were identified. The factors identified are relevant but they do not reflect completely the diversity of the sample, due to the heterogeneity of the sample and the strict criteria for acceptance as indicated in *Section 3.10 Validation of Results*. The reduction in the number of keywords provided factor analysis solutions at the expense of losing meaningful information.

As the purpose of this study is to uncover as many constructs as possible, the results from the initial factor analysis suggested a focus on more similar groups

of organizations in a sample. The literature on factor analysis indicates that the methodology is used primarily for dimension reduction. In this study the content analysis using factor analysis is meant to uncover as many factors as possible and therefore the use of multiple sub-samples is warranted. The process for identifying the sample groups is described in *Section 3.8 Clusters as sub-samples*.

3.8 Clusters as sub-samples

The literature on sampling for factor analysis indicates that in the cases studied, the criteria for sample selection were based on ‘organizational configuration’: sets of firms that share a common profile along conceptually distinct variables (Meyer et al., 1993). Studies which have identified “entrepreneurial” organizations (Miller and Mintzberg, 1983) or “highly innovative” firms (Hicks et al., 2006) are examples of creating clusters used as samples for further content analysis with factor reduction. This is an accepted technique since the results from exploratory factor analysis cannot be generalized outside the sample. This study proposes a clustering methodology that is more suitable for large sets of keywords which is meant primarily to map the characteristics of the cases in the sample.

3.9 Multiple Factor Analysis

The literature on factor analysis indicates that the methodology is used primarily as a factor reduction for understanding a few dimensions for the cases under study. In this study the methodology is used for identifying and mapping the

main characteristics in an industry. In an attempt to find as many factors as possible multiple solutions are searched for. This approach needs to meet two conditions: (1) once a factor is identified any subsequent solutions that use this factor must find it as a factor too and the factor's keywords must not be shared, and (2) any final interpretation of results that use multiple factors must have all the factors from the same solution, in other words, it needs to prove that the factors are independent from each other or that they are not correlated. As exemplified in Table 2, the second solution is valid only if by removing factor F2 and adding a new factor, F5, the factor analysis solution finds the rest of the factors intact and there is no sharing of keywords among any of the factors. In this example factors F2 and F5 should never be used together as they were not validated for correlation.

Table 2: Multiple Factor Analysis Solutions

Factor Analysis Solution 1	F1	F2	F3	F4	
Factor Analysis Solution 2	F1		F3	F4	F5

3.10 Validation of Results

Successful exploratory factor analysis demands that the data set meet specific criteria for correlation, sampling adequacy and statistical significance (Field, 2005). The statistical analysis tool SPSS was used to perform these validity tests on the data. Every solution in the multiple factor analyses that was retained met the criteria indicated in Table 3.

Table 3: Factor Analysis Data Validity Test Criteria

Metric	Limit
Correlation table determinant	$> 1.0 \times 10^{-5}$
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy.	> 0.5
Bartlett's test of Sphericity Significance test	< 0.05

Hicks et al (2006) suggest that the results from factor analysis should be validated against a control sample. There is no readily available database of firms which are not members of the studied consortia in the wireless industry. A control sample was constructed from the first 250 firms from the 2009 Fortune 1000 companies that were not members of the 9 consortia studied. The factor analysis was run with the keywords from the solutions used in the final interpretation and the results and assessed for correlation, sampling validity and statistical significance.

3.11 Points of difference as measure of alternatives

Anderson et al. (2006) indicates that there are three building blocks of a successful customer value proposition: points of parity, points of difference and points of contention.

- *Points of difference* are elements that make a supplier's offering either superior or inferior to the next best offer

This type of value proposition explicitly recognizes that the customer has an alternative. To make customer value propositions persuasive, suppliers must be

able to demonstrate and document them. Anderson et al. (2006) recommends the use of *value word equations* to express in words and simple mathematical operators how to assess the differences in functionality of performance.

Following the model suggested by Anderson et al. (2006), this study defined the *points of difference* as a numerical value for the relative strength or importance of a construct.

3.12 Instruments

The following instruments are used in the analysis and interpretation of the results:

Table 4: Instruments of Analysis and Interpretation

Instrument	Description
Keyword Score	The number of instances the keyword is found on a web site, normalized to the number of web pages. The value is provided by the Keyword Search and Analysis Tool (KSAT).
Factor	The keywords grouped by factor analysis in one sample.
Factor Score	For each website the factor score is calculated as the sum of the keyword scores of the variables loaded on the factor. This approach follows the recommendations described in Reinard (2006)
Factor Average Score	Represents the average of a group of organizations' factor scores in a sample.
Construct	The abstract concept represented by similar factors from all samples. In a sample the construct is defined by a single factor.

Instrument	Description
Points of Difference Index (PODI)	<p>The points-of-difference index (PODI) represents the relative importance of a factor.</p> <p>In a sample, the PODI compares a factor's average scores for members against non-members of a consortium. This provides an indication of the factor or construct relevance for the consortium.</p> <p>The numerical value for the points-of-difference is represented by the POD Index and is defined as:</p> $PODI(F, Y, G) = \frac{\sum_1^m (Factor\ Score)}{\sum_1^n (Factor\ Score)} * \frac{n}{m}$ <p>F – Factor Y – Consortium Y G – Sample group G m – Number of organizations which are members of Y n – Number of organizations which are not members of Y</p>
Salient Construct	<p>The criterion for a salient construct is defined as follows:</p> <p style="text-align: center;">PODI > 1.5</p> <p>The criterion is based on the assumption that a consortium's members with a factor that is 50% larger than the rest of the sample is sufficiently large to be indicative of a salient construct.</p>
Construct PODI List	<p>It is used to rank consortia based on one construct.</p> <p>It is defined as a ranked list of POD Indexes for a factor in a sample group for all consortia:</p> <p>{ PODI (F_x, A₁, S), ..., PODI (F_x, A₉, S) }</p> <p>F_x – Factor X in sample S A – Consortium: WiMAX, GSMA, UMTS, CDG, CCF, LSTI, NGMN, WBA, OPA S – Sample Group: E, F, G, H or I</p>
Consortium	It is used to rank the constructs for one consortium.

Instrument	Description
PODI List	<p>It is defined as a ranked list of POD Indexes for all factors in a sample group for one consortium:</p> <p>{ PODI (F₁, A_x, S), ..., PODI (F_n, A_x, S) }</p> <p>F_n – All factors in sample S</p> <p>A_x – One of the:</p> <p style="padding-left: 40px;">WiMAX, GSMA, UMTS, CDG, CCF, LSTI, NGMN, WBA, OPA</p> <p>S – Sample Group: E, F, G, H or I</p>
Salient Construct Groups	<p>Several salient constructs can be used together at the same time only if they do not correlate.</p> <p>In cases where one consortium has more than one construct that satisfies the criteria for a salient construct (PODI > 1.5) then these constructs can be used together only if they are not correlated. The lack of correlation is indicated by the fact that there is at least one factor analysis solution that includes these factors.</p> <p>{ PODI (F₁, A, S), ..., PODI (F_x, A, S) }</p> <p>F₁, ..., F_x are factors in at least one factor analysis solution in sample group S, for consortium A.</p>

A graphical representation for the PODI Lists is shown in Figure 6:

		Consortium PODI List				
Construct PODI List		Consortium 1	...	Consortium Y	...	Consortium M
	Construct 1	PODI (1,1)	...	PODI (1,Y)	...	PODI(1,M)
	...	...	...	...	...	...
	Construct X	PODI(X,1)	...	PODI(X,Y)	...	PODI(X,M)
	...	...	...	...	...	...
	Construct N	PODI(N,1)	...	PODI(N,Y)	...	PODI(N,M)

Figure 6: Construct and Consortium PODI Lists

In summary, the *points-of-difference* term refers to the favourable points of difference (Anderson et al., 2006) and is defined by the groups of salient constructs:

Points of Difference (POD) = Groups of Salient Constructs

4. Research Results

This chapter is comprised of eight sections. Section 4.1 discusses the research sample. Section 4.2 explains the multiple samples. Section 4.3 presents the keywords and the samples. Section 4.4 presents the constructs identified from the factor analysis. Section 4.5 identifies the constructs. Section 4.6 presents the consortia points of difference. The multiple membership ranking is presented for several factors in Section 4.7. A visualization of the construct groups is presented in Section 4.8.

4. 1 Research Sample

Focusing on the diversity of the sample the study selected consortia that: (1) represent organizations with interests in the major wireless technologies in the last twenty years: GSM, CDMA, UMTS, WiMAX and LTE, (2) use the main wireless communication standards: 3GPP, 3GPP2 and IEEE 802.16, and (3) have different sizes.

Based on these recommendations, the selected organizations are members of 9 consortia⁴: GSM Association (GSMA), CDMA Development Group (CDG), UMTS Forum, WiMAX Forum, LTE/STI Trial Initiative, Next Generation Mobile Networks (NGMN), Wireless Broadband Alliance (WBA), CDMA Certification Forum (CCF) and Open Patent Alliance (OPA).

From the complete list of members found on the consortia web sites, the selected organizations have a good description in “About Us”, and contained at

⁴ Based on the membership analyzed in January 2010

least ten pages in English, to avoid spurious results caused by sites with minimal content (i.e. few keyword hits). From this population an initial research sample of 889 organizations was extracted. When compiling the dataset, an organization was identified as a member of one or more of the selected consortia.

The GSM Association⁵ (GSMA) was launched in 1987 and represents the interests of the worldwide mobile communications industry involved in GSM and 3GSM (WCDMA). With members from 219 countries, nearly 800 of the world's mobile operators, and more than 200 companies in the broader mobile ecosystem, including handset makers, software companies, equipment providers, Internet companies, and media and entertainment organisations, the GSMA is "focused on innovating, incubating and creating new opportunities for its membership, all with the end goal of driving the growth of the mobile communications industry"⁶

The CDMA Development Group⁷ (CDG), founded in 1993, is an international consortium of 121 companies who have joined together to lead the adoption and evolution of CDMA wireless systems around the world. The CDG is comprised of CDMA service providers and manufacturers, application developers and content providers, who work together to ensure the interoperability among systems, while expediting the availability of CDMA technology to consumers⁸.

⁵ <http://www.gsmworld.com>, last accessed July 10, 2010

⁶ <http://www.gsmworld.com/about-us/index.htm>, last accessed July 10, 2010

⁷ <http://www.cdg.org>, last accessed July 10, 2010

⁸ <http://www.cdg.org/about/index.asp>, last accessed July 10, 2010

The CDMA Certification Forum⁹ (CCF) is a partnership between CDMA operators and CDMA device vendors to establish and maintain a core global device certification process that helps improve quality through consistent interoperability, conformance and performance testing. Currently it has 58 members¹⁰.

The UMTS Forum¹¹ is a non-profit organization founded in 1996 to help its members “understand and profit from the opportunities of 3G/UMTS networks and their Long Term Evolution (LTE)”. The forum supports the interests of its membership with a range of studies and reports on markets trends, mobile broadband services and applications, key growth markets, spectrum and regulation, technology and implementation. Currently the forum has 38 members¹²

The WiMAX Forum¹³ is an industry-led, not-for-profit organization formed to certify and promote the compatibility and interoperability of broadband wireless products based upon the harmonized IEEE 802.16/ETSI HiperMAN standard. The WiMAX Forum’s goals are to accelerate the introduction of these systems into the marketplace and to ensure that the products are fully interoperable and support broadband fixed, portable and mobile services. The WiMAX Forum works with service providers and regulators to ensure that its certification programs meet customer and government requirements. The forum was

⁹ <http://www.globalccf.org>, last accessed July 10, 2010

¹⁰ http://www.globalccf.org/about_us.php, last accessed July 10, 2010

¹¹ <http://www.ums-forum.org>, last accessed July 10, 2010

¹² <http://www.ums-forum.org/content/view/2002/125/>, last accessed July 10, 2010

¹³ <http://www.wimaxforum.org>, last accessed July 10, 2010

launched in 2001 and today has more than 500 members involved in 592 WiMAX network deployments, in 148 countries¹⁴.

The WBA¹⁵ (Wireless Broadband Alliance) was founded in 2003 and it currently has 36 members from leading operators offering wireless services across Wi-Fi, WiMAX and Mobile broadband networks and roaming providers¹⁶.

The NGMN¹⁷ (Next Generation Mobile Networks) is an alliance between the major mobile service providers that was formed in 2006 to define the requirements and recommendations for the next-generation broadband wireless networks. Its mandate is to complement and support the work provided by the standardization bodies. Currently the alliance has 58 members¹⁸

The LSTI Forum¹⁹ (Long Term Evolution / System Architecture Evolution Trial Initiative) is a global, collaborative technology trial initiative focused on accelerating the availability of commercial and interoperable next generation LTE mobile broadband systems. One of the stated goals of the forum is to “develop an open industry ecosystem by involving all stakeholders (manufacturers, operators, regulators, research community, and application developers) in the process”. Launched in 2007, today the forum has 40 members²⁰.

¹⁴ <http://www.wimaxforum.org/about>, last accessed July 10, 2010

¹⁵ <http://www.wballiance.net>, last accessed July 10, 2010

¹⁶ <http://www.wballiance.net/history.html>, last accessed July 10, 2010

¹⁷ <http://www.ngmn.org>, last accessed July 10, 2010

¹⁸ <http://www.ngmn.org/aboutus.html>, last accessed July 10, 2010

¹⁹ <http://www.lstiforum.org>, last accessed July 10, 2010

²⁰ <http://www.lstiforum.org/about/intro.html>, last accessed July 10, 2010

The OPA²¹ (Open Patent Alliance) was formed in 2008 “to foster a global ecosystem that will help ensure the successful and broad adoption of 4G wireless” by creating a fair, transparent and balanced IPR licensing structure to accelerate the global adoption of WiMAX, which will significantly lower the barriers to entry for those companies wishing to develop innovative technologies using WiMAX. It currently has 12 members²².

Organizations with websites with less than 10 web pages were excluded from the sample to avoid spurious results caused by sites with minimal content (i.e. few keyword hits), resulting in the initial research sample, named Group I, consisting of 736 organizations from 9 consortia as indicated in Table 5.

Table 5: Consortia Membership

Consortium	WiMAX	GSMA	CDG	NGMN	CCF	LSTI	UMTS	WBA	OPA
Members	346	265	111	54	47	39	36	32	12
Percentage of total [%]	47.01	36.01	15.08	7.34	6.39	5.30	4.89	4.35	1.63

Note: some organizations are members of multiple consortia

Multiple sub-samples are used for further analysis as indicated in *Section 4.2*.

4. 2 Sub-sampling

Typically, the use of factor analysis is performed on a selected sample that complies with a criterion that is tied later with the results. Our study contains a large number of heterogeneous companies and organizations that were

²¹ <http://openpatentalliance.com>, last accessed July 10, 2010

²² <http://openpatentalliance.com/about>, last accessed July 10, 2010

selected based solely on the membership in wireless industry consortia. The literature on content analysis of web pages using factor analysis provides little evidence of the effect of samples on the final result. This study uses multiple samples for two reasons: (i) capture as many diverse constructs as possible and (ii) provide a better understanding on the impact of samples on the results.

From the initial research sample (Group I) the sub-samples were obtained in 2 steps. A visual inspection of the table with the score results from the KSAT analysis suggests that there are “pockets” of organizations that share the same keywords with scores values in the same range. Based on this observation, in the first step, the keywords were grouped based on the quartile they belong to. This approach is similar to the four-point Likert scale used in questionnaires processed subsequently by factor analysis. The Q1, Q2, Q3 and Q4 are the four networks created based on the shared keyword in the four quartiles. An example is provided in Figure 7: the score for the keyword K1 is in the first quartile for the organizations X1 and X2. If $X1(K1) = q1$ and $X2(K1) = q1$ then X1 and X2 share an edge or a link in network Q1.

$$X1(K1) = q1 \text{ \& } X2(K1) = q1 \Rightarrow Q1(X1, X2) = 1$$

	K1	K2	K3	K4
X1	q1	q3	q4	q1
X2	q1	q2	q4	q1
X3	q4	q2	q4	q3
X4	q2	q3	q3	q3

Q1	Q2	Q3	Q4
X1 X2 2	X2 X3 1	X1 X4 1 X3 X4 1	X1 X2 1 X1 X3 1 X2 X3 1

Figure 7: Networks Based on Keyword Scores

In each of the four networks, the nodes are organizations with links based on the shared score of the keywords. $Q1(X1, X2) = 2$ indicates that X1 and X2 share 2 keywords with similar scores.

The second step in clustering is based on hierarchical decomposition – a concept built on the theory that 2 nodes in a network are similar if they share the same neighbors. This study used Pajek²³ as the tool for creating the hierarchical decomposition in each of the Q1, Q2, Q3 and Q4 networks. The hierarchical decomposition is characterized by a dissimilarity index which defines the level of dissimilarity among the clusters created. It is up to the researcher to select the number of clusters created. As the generated clusters are used for further factor analysis, this study followed the recommendations of Costello and Osborne (2005) and aimed at obtaining clusters with at least 200 nodes. A dedrogram is the graphical representation of hierarchical decomposition and could help researcher in identifying the number of clusters to retain (de Nooy et al., 2005). As exemplified in Figure 8, cluster C1(X1, X2, X3, X4) is characterized by Dc1 dissimilarity index.

Figure 8: Clustering Dendrogram

²³ <http://pajek.imfm.si/doku.php>

The dissimilarity index is the control variable used in this study for creating the clusters used as sub-samples for further factor analysis. The results are presented in Table 6 and Table 7:

Table 6: Sub-sampling Step 1

Nr. Firms Sample Group I	Group	Nr. Firms	Nr. Keywords
736	Q1	508	46
	Q2	729	133
	Q3	733	205
	Q4	735	255

Table 7: Sub-sampling Step 2

Q Group	Partition	Nr. Firms	HDd1	Sub- sample Groups
Q1	P2	295	10.33	A
Q2	P1	218	0.86	B
	P2	269	0.59	C
	P1 + P4	336	2.27	D
Q3	P1	312	0.18	E
	P2	202	0.28	F
Q4	P1	305	0.36	G
	P2	228	0.48	H

Node: HDd1 = dissimilarity index for d1

For the complete results from the hierarchical decomposition see Appendix B: Hierarchical Decomposition.

The factor analysis was run for the initial research sample (Group I) and for every of the sub-sample groups: A, B, C, D, E, F, G and H. The E, F, G and H groups produced multiple and meaningful factor analysis results and were

retained for further study. The groups E and F do not share organizations and have a combined size of 514. The organizations in Groups G and H are also different with a combined size of 533. The sub-samples contain a total number of 611 organizations, while the initial sample, Group I, contains 736 organizations. A graphical view of the initial sample, Group I, and the sub-samples, Groups E, F, G, and H is presented next in Figure 9:

Figure 9: Sample I and sub-samples E, F, G, H

The list of organizations' website URLs, the split samples groups and the consortia they belong to is provided in Appendix A: URLs, Samples and Membership.

4. 3 Keyword Selection

The initial list of keywords was selected based on the readings of mobile communication literature including published academic works as well as books, and from scanning the websites of the wireless industry consortia and their

members. About 200 websites were analyzed representing 30% of the number of organization in the sample. These organizations were selected based on their identification as members of the wireless industry consortia, with proportional representation from each one. Additional criteria included organizations with various business models and diverse number of website pages.

Individual keywords were grouped into sets of synonyms using logical “OR” operations. In cases where a unique phrase was required instead of a single word, the phrase was delimited with quotation marks (“”). The logical “AND” operator was used to strengthen the meaning of the individual keywords in cases where keywords were often used together in a context that offers a more meaningful interpretation.

After the preliminary 297 sets of keywords were defined, the list was rationalized by performing multiple factor extractions on groups E, F, G, H and I. The number of the sets of keywords retained from the solutions which complied with the recommended values for the determinant of the correlation matrix and the KMO tests are presented in Table 8 below:

Table 8: Number of keyword sets in each sample

Group	Size	Keywords	Nr. Factors (Keywords)
E	312	53	5(24), 5(24), 5(25), 5(24), 5(24), 5(23), 5(22), 5(23), 5(21), 5(22), 6(26)
F	202	48	4(17), 4(16), 4(17), 4(17), 4(17), 4(16), 4(16), 4(17), 4(17), 5(22)
G	305	41	5(22), 4(18), 6(25), 4(17), 4(17), 4(17), 4(16)
H	228	38	4(21), 4(21), 4(23), 3(18), 4(21)
I	736	61	8(30), 7(31), 8(33), 8(32), 8(31)

The Keyword Search and Analysis Tool is based on the Google Ajax Application Programming Interface (API) and counts the number of instances that each of the logical combinations of the keywords is found in the web pages at each site specified in the sample list. The tool also returns the total number of pages at each site and the normalized keyword frequency by dividing the keyword counts by the number of web pages found. The tool counts all instances of the keyword sets and can provide normalized keyword frequency in excess of 100%. This is not an issue since the factor extraction is concerned with correlations and not with the specific value of an individual keyword frequency.

4. 4 Factor Analysis

Both Kaiser's criterion and the Scree plot criteria were used for extracting the number of factors from the multiple factor analysis which were run on groups E, F, G, H and I. Group E, with a size of 312 and average commonalities between 0.59 and 0.62, offers a sample large enough to allow reliance on the Scree plot. For group F, with a size of 202 and average commonalities above 0.7 (except for one analysis out of eight) only the factors with Eigenvalues above 1 were selected. Group G, with a size of 305 and average commonalities between 0.59 and 0.64 has a size large enough to allow reliance on the Scree plot. For the group H, with a size of 228 and average commonalities between 0.58 and 0.61 only the factors with Eigenvalues above 1 were selected. For Group I, with a size of 736, the factors selected based on the Scree plot all have Eigenvalues above 1.

Table 9: Factor Analysis Results

Group	Nr. Firms	Solution	DCM	KMO	AVC	Nr. Keywords	Nr. Factors	Total Variance (%)
E	312	1	1 18E-05	0 772	0 623	24	5	62 3
		2	6 49E-05	0 756	0 591	24	5	59 1
		3	1 51E-05	0 748	0 599	25	5	59 9
		4	2 26E-05	0 732	0 608	24	5	60 8
		5	2 11E-05	0 758	0 614	24	5	61 4
		6	8 30E-05	0 751	0 601	23	5	60 1
		7	8 20E-05	0 749	0 622	22	5	62 1
		8	5 18E-05	0 761	0 616	23	5	61 6
		9	1 00E-03	0 738	0 585	21	5	58 5
		10	2 20E-05	0 772	0 648	22	5	64 8
		11	3 60E-05	0 757	0 604	26	6	60 4
F	202	1	1 38E-05	0 772	0 713	17	4	71 3
		2	3 05E-05	0 729	0 727	16	4	72 6
		3	1 57E-05	0 755	0 712	17	4	71 2
		4	2 29E-05	0 755	0 708	17	4	70 7
		5	3 51E-05	0 76	0 701	17	4	70 1
		6	1 96E-05	0 737	0 727	16	4	72 6
		7	4 76E-05	0 747	0 716	16	4	71 5
		8	4 84E-05	0 748	0 681	17	4	68 1
		9	3 37E-05	0 741	0 689	17	4	68 9
		10	1 40E-05	0 797	0 649	22	5	64 9
G	305	1	3 19E-05	0 775	0 642	22	5	64 2
		2	2 00E-03	0 767	0 593	18	4	59 3
		3	7 11E-05	0 756	0 612	25	6	61 2
		4	1 00E-03	0 792	0 653	17	4	65 3
		5	1 00E-03	0 786	0 644	17	4	64 3
		6	2 00E-03	0 762	0 597	17	4	59 7
		7	1 00E-03	0 802	0 658	16	4	65 8
H	228	1	2 74E-05	0 767	0 612	21	4	61 2
		2	2 15E-05	0 766	0 613	21	4	61 3
		3	1 27E-05	0 757	0 584	23	4	58 4
		4	2 18E-05	0 795	0 61	18	3	61
		5	2 32E-05	0 791	0 613	21	4	61 32
I	736	1	3 65E-05	0 742	0 599	30	8	59 9
		2	3 98E-05	0 745	0 569	31	7	56 8
		3	9 43E-05	0 739	0 565	33	8	56 5
		4	6 44E-05	0 761	0 576	32	8	57 6
		5	9 20E-05	0 696	0 578	31	8	57 75

The factor analysis run in each group provided multiple solutions with unique factors which don't share any keywords across different solutions. This allowed for selecting the most appropriate solutions for final interpretation when the results from the main sample and its sub-samples were analyzed together. The number of factors retained for each factor analysis is presented in Table 9.

The determinant of the correlation table, the results of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett's significance tests are the criteria used for determining the success of the factor extraction. In order to avoid singularities (multicollinearity) in the correlation table the determinant must be greater than 1.0×10^{-5} for effective factor extraction (Field, 2005). As shown in Table 9, the determinant of the correlation matrix (DCM) is greater than the minimum required for all solutions, indicating that the correlation data are of adequate quality for good factor extraction.

For the results to be considered statistically valid, the KMO measure of sampling adequacy must be larger than 0.5 (Field, 2005). In our study, the KMO is greater than the minimum required for all solutions, within the range 0.696 - 0.802. Field (2005) recommends that the values in the range 0.6 – 0.8 be considered as "good". The Bartlett's test of sphericity must show a significance of less than 0.5 indicative of an adequate degree of correlation for the factor analysis to converge (Field, 2005). The result of 0.000 for all solutions indicates that data are well within the acceptance range to permit extraction of good factors.

The amount of variance in each variable that can be explained by the retained factors is represented by the communalities after extraction. Together with the sample size it provides an indication of the reliability of the factor analysis. This research followed Costello and Osborne (2005) recommendation of keeping only the items with communalities above 0.4. The average communalities (AVC) for each factor extraction solution are presented in Table 9 and suggest that the analyses are adequate.

Rotation is used to simplify and clarify the data structure, by maximizing the loadings of the variables of all components without affecting the relative loadings of the variables. Most texts recommend the use of Varimax (orthogonal) rotation for uncorrelated components (Field, 2005). The total variance in our factor extraction solutions show that the factors extracted account in all cases for the majority of the variation in the data. Table 9 shows that the total variance in this study is in the range 56.5% - 72.6%.

Reinard (2006) recommends excluding variables with loadings less than 0.6 and cross-loadings larger than 0.4 from being used when interpreting the meaning of a factor. Costello and Osborne (2005) recommend a minimum loading of 0.32 and suggest that researchers should drop cross-loadings for factors with loaders greater than 0.5. Stevens (2009) suggest that only variables with loadings larger than 0.4 should be considered for interpretation purposes based on the suggestion that a variable should share at least 15% of its variance with the factor. In this study only items with loadings greater than 0.5 and with cross-loadings below 0.4 were retained.

Costello and Osborne (2005) indicate that factors with fewer than three items are generally weak and unstable. A solid factor has 5 or more items with loadings greater than 0.5. Stevens (2009) indicates that when the average of the four largest loadings is larger than 0.6 then the factors are reliable. In this research, the majority of the factors have at least three variables with loadings of 0.5 or greater, which indicates that most of the factors are solid with a few considered adequate.

The factor analysis solutions for Group E are presented in Table 10.

Table 10: Group E Factor Analysis Solutions

Solution	Factors											
1	E1	E2	E3	E4	E5							
2		E2	E3	E4	E5	E6						
3		E2	E3	E4		E6	E7					
4		E2	E3			E6	E7	E8				
5		E2	E3			E6	E7		E9			
6		E2	E3				E7		E9	E10		
7		E2	E3				E7		E9		E11	
8		E2	E3				E7		E9			E12
9		E2		E4					E9	E10	E11	
10	E1	E2				E6			E9		E11	
11	E1			E4		E6				E10	E11	E12

The factor analysis solutions for Group F are presented in Table 11.

Table 11: Group F Factor Analysis Solutions

Solution	Factors										
1	F1	F2	F3	F4							
2	F1		F3	F4	F5						
3	F1		F3		F5	F6					
4	F1		F3		F5		F7				
5	F1		F3				F7	F8			
6	F1		F3					F8	F9		
7	F1		F3					F8		F10	
8	F1		F3							F10	F11
9	F1		F3	F4							F11
10		F2	F3			F6			F9	F10	

The factor analysis solutions for Group G are presented in Table 12.

Table 12: Group G Factor Analysis Solutions

Solution	Factors									
1	G1	G2	G3	G4	G5					
2		G2	G3	G4		G6				
3	G1	G2	G3	G4			G7	G8		
4	G1	G2	G3						G9	
5	G1	G2	G3							G10
6	G1			G4					G9	G10
7	G1		G3		G5				G9	

The factor analysis solutions for Group H are presented in Table 13.

Table 13: Group H Factor Analysis Solutions

Solution	Factors						
1	H1	H2	H3	H4			
2	H1	H2		H4	H5		
3		H2			H5	H6	H7
4	H1					H6	H7
5	H1	H2		H4			H7

The factor analysis solutions for Group I are presented in Table 14

Table 14: Group I Factor Analysis Solutions

Solution	Factors														
1	I1	I2	I3	I4	I5	I6	I7	I8							
2									I9	I10	I11	I12	I13	I14	I15
3	I1	I2	I3	I4		I6		I8		I10		I12			
4	I1	I2	I3	I4		I6	I7	I8		I10					
5	I1	I2		I4	I5	I6		I8				I12			I15

For more details on the factor analysis results see Appendix C: Factor Analysis Results.

4.5 Constructs

The solutions retained from factor analysis identified factors corresponding to companies' business models, technologies and standards. Based on the knowledge about the industry and the definition of the keywords derived from the literature each factor was interpreted to produce a descriptive definition for each distinguishing characteristic of the wireless industry consortia.

The *POD Index (factor, consortium, sample)* is used to indicate the numerical importance for each factor, consortium and sample as defined in *Section 3.11* .

The *Construct PODI List* provides a ranked list of POD Indexes for all the factors comprising the construct. Similar factors from each sample are grouped together to form the following constructs:

Mobile Services

Table 15: Mobile Services

E1: Mobile Services (I)	G1: Mobile Services (II)																																								
<p>a) "mobile AND content AND delivery" b) "mobile AND services AND (commerce OR billing)" c) "(consulting OR engineering) AND services" d) "mobile AND messaging AND services" e) "customization OR customize OR customized OR personalize OR individualize"</p> <p style="text-align: center;">PODI(E1, All, E)</p> <table border="1"> <thead> <tr> <th>Network Type</th> <th>PODI Value</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.5</td></tr> <tr><td>CCF</td><td>0.7</td></tr> <tr><td>WIMAX</td><td>0.8</td></tr> <tr><td>CDG</td><td>1.0</td></tr> <tr><td>WBA</td><td>1.3</td></tr> <tr><td>GSMA</td><td>1.4</td></tr> <tr><td>NGMN</td><td>1.8</td></tr> <tr><td>LSTI</td><td>2.7</td></tr> <tr><td>UMTS</td><td>3.0</td></tr> </tbody> </table>	Network Type	PODI Value	OPA	0.5	CCF	0.7	WIMAX	0.8	CDG	1.0	WBA	1.3	GSMA	1.4	NGMN	1.8	LSTI	2.7	UMTS	3.0	<p>a) "(consulting OR engineering) AND services" b) "mobile AND content AND delivery" c) "database AND services" d) "mobile AND services AND (commerce OR billing)"</p> <p style="text-align: center;">PODI(G1, All, G)</p> <table border="1"> <thead> <tr> <th>Network Type</th> <th>PODI Value</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.2</td></tr> <tr><td>CDG</td><td>0.4</td></tr> <tr><td>CCF</td><td>0.9</td></tr> <tr><td>WIMAX</td><td>1.2</td></tr> <tr><td>GSMA</td><td>1.2</td></tr> <tr><td>WBA</td><td>1.3</td></tr> <tr><td>NGMN</td><td>2.5</td></tr> <tr><td>LSTI</td><td>2.5</td></tr> <tr><td>UMTS</td><td>3.4</td></tr> </tbody> </table>	Network Type	PODI Value	OPA	0.2	CDG	0.4	CCF	0.9	WIMAX	1.2	GSMA	1.2	WBA	1.3	NGMN	2.5	LSTI	2.5	UMTS	3.4
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H6: Mobile Services (II)																																									
<p>a) "mobile AND applications" b) "mobile AND messaging AND services" c) "device AND management" d) "mobile AND services AND (commerce OR billing)" e) "mobile AND (advertising OR marketing)" f) "(data OR voice) AND plans" g) "(consulting OR engineering) AND services"</p>	<p style="text-align: center;">PODI(H6, All, H)</p> <table border="1"> <thead> <tr> <th>Network Type</th> <th>PODI Value</th> </tr> </thead> <tbody> <tr><td>UMTS</td><td>0.3</td></tr> <tr><td>WIMAX</td><td>0.5</td></tr> <tr><td>CCF</td><td>0.6</td></tr> <tr><td>WBA</td><td>0.6</td></tr> <tr><td>NGMN</td><td>0.6</td></tr> <tr><td>LSTI</td><td>0.7</td></tr> <tr><td>OPA</td><td>0.8</td></tr> <tr><td>CDG</td><td>1.0</td></tr> <tr><td>GSMA</td><td>2.5</td></tr> </tbody> </table>	Network Type	PODI Value	UMTS	0.3	WIMAX	0.5	CCF	0.6	WBA	0.6	NGMN	0.6	LSTI	0.7	OPA	0.8	CDG	1.0	GSMA	2.5																				
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The keywords in Table 15 represent services that enable network operators to efficiently manage and profit from mobile data services, content and commerce. The customized mobile services for messaging, commerce or billing are typically provided by the application or content providers.

Testing Solutions

Table 16: Testing Solutions

E2: Testing Solutions (I)	F9: Monitoring Solutions																																								
<p>a) "measurement" b) "instrumentation OR instrument" c) "(performance OR optimization) AND (analysis OR audit)" d) "test AND evaluation AND equipment" e) "test AND equipment AND manufacturer"</p> <p style="text-align: center;">PODI(E2, All, E)</p> <table border="1"> <thead> <tr> <th>Standard</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>GSM</td><td>0.5</td></tr> <tr><td>WBA</td><td>0.5</td></tr> <tr><td>CDG</td><td>0.6</td></tr> <tr><td>OPA</td><td>0.6</td></tr> <tr><td>UMTS</td><td>1.2</td></tr> <tr><td>WiMAX</td><td>1.5</td></tr> <tr><td>NGMN</td><td>1.5</td></tr> <tr><td>LSTI</td><td>2.4</td></tr> <tr><td>CCF</td><td>2.5</td></tr> </tbody> </table>	Standard	PODI	GSM	0.5	WBA	0.5	CDG	0.6	OPA	0.6	UMTS	1.2	WiMAX	1.5	NGMN	1.5	LSTI	2.4	CCF	2.5	<p>a) "solutions AND network AND monitoring AND analysis" b) "(performance OR optimization) AND (analysis OR audit)" c) "solutions AND (telematics OR metering OR tracking OR alarms OR monitoring)" d) "automation"</p> <p style="text-align: center;">PODI(F9, All, F)</p> <table border="1"> <thead> <tr> <th>Standard</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>NGMN</td><td>0.7</td></tr> <tr><td>OPA</td><td>0.8</td></tr> <tr><td>WiMAX</td><td>1.0</td></tr> <tr><td>GSM</td><td>1.0</td></tr> <tr><td>CDG</td><td>1.1</td></tr> <tr><td>WBA</td><td>1.4</td></tr> <tr><td>LSTI</td><td>1.6</td></tr> <tr><td>UMTS</td><td>2.0</td></tr> <tr><td>CCF</td><td>2.7</td></tr> </tbody> </table>	Standard	PODI	NGMN	0.7	OPA	0.8	WiMAX	1.0	GSM	1.0	CDG	1.1	WBA	1.4	LSTI	1.6	UMTS	2.0	CCF	2.7
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G10: Testing Solutions (II)	H3: Testing Solutions (III)																																								
<p>a) "(performance OR optimization) AND (analysis OR audit)" b) "measurement" c) "test AND coverage" d) "research AND testing"</p> <p style="text-align: center;">PODI(G10, All, G)</p> <table border="1"> <thead> <tr> <th>Standard</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>CDG</td><td>0.4</td></tr> <tr><td>WBA</td><td>0.6</td></tr> <tr><td>GSM</td><td>0.7</td></tr> <tr><td>OPA</td><td>0.8</td></tr> <tr><td>UMTS</td><td>0.9</td></tr> <tr><td>WiMAX</td><td>1.4</td></tr> <tr><td>NGMN</td><td>1.7</td></tr> <tr><td>LSTI</td><td>2.0</td></tr> <tr><td>CCF</td><td>2.1</td></tr> </tbody> </table>	Standard	PODI	CDG	0.4	WBA	0.6	GSM	0.7	OPA	0.8	UMTS	0.9	WiMAX	1.4	NGMN	1.7	LSTI	2.0	CCF	2.1	<p>a) "test AND coverage" b) "solutions AND (VoIP OR 'Voice over IP' OR RCS OR 'Rich Communication Suite' OR VCC OR 'Voice Call Continuity')" c) "system AND solution" d) "multi-standard" e) "automation"</p> <p style="text-align: center;">PODI(H3, All, H)</p> <table border="1"> <thead> <tr> <th>Standard</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>WBA</td><td>0.4</td></tr> <tr><td>UMTS</td><td>0.4</td></tr> <tr><td>OPA</td><td>0.7</td></tr> <tr><td>CDG</td><td>0.7</td></tr> <tr><td>GSM</td><td>0.9</td></tr> <tr><td>NGMN</td><td>0.9</td></tr> <tr><td>CCF</td><td>1.1</td></tr> <tr><td>WiMAX</td><td>1.1</td></tr> <tr><td>LSTI</td><td>1.3</td></tr> </tbody> </table>	Standard	PODI	WBA	0.4	UMTS	0.4	OPA	0.7	CDG	0.7	GSM	0.9	NGMN	0.9	CCF	1.1	WiMAX	1.1	LSTI	1.3
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The keywords in Table 16 suggest that the test equipment manufacturers provide instrumentation that allows measurement, performance and optimization analysis for the infrastructure providers and network operators. The infrastructure provider and device manufacturers' equipment needs to be calibrated or certified for compliance before is accepted by the network operators. The service providers provide software systems for monitoring the mobile networks subscribers and customer's traffic flow. These solutions maximize network performance, provide monitoring and analysis tools for services and customer experience. The test coverage and automation for multi-standard solutions is aimed at interoperability. This could help network operators expand their coverage for mobile operations.

Fee Based Business Solutions

The network operator is the link between the infrastructure provider and the end-user. A mobile phone network operator makes use of the infrastructure to provide mobile services to the end-user. The typical business models, identified in Table 17, are based on monthly fees from data and voice plans.

Table 17: Fee Based Business Solutions

E3: Fee Based Business Solutions (I)	F7: Fee Based Business Solutions (II)																																								
<p>a) “(data OR voice) AND plans” b) “unlimited AND (calling OR text OR distance)” c) “(“Mobile Terminal Supplier” OR “Mobile Terminal” OR manufacturer) AND mobile AND phone” d) “internet AND mobile” e) “customer AND (options OR choice OR choose)”</p> <p style="text-align: center;">PODI(E3, All, E)</p> <table border="1"> <thead> <tr> <th>Provider</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>WIMAX</td><td>0.8</td></tr> <tr><td>OPA</td><td>0.8</td></tr> <tr><td>NGMN</td><td>0.9</td></tr> <tr><td>CCF</td><td>1.0</td></tr> <tr><td>UMTS</td><td>1.1</td></tr> <tr><td>GSMA</td><td>1.2</td></tr> <tr><td>LSTI</td><td>1.2</td></tr> <tr><td>CDG</td><td>1.4</td></tr> <tr><td>WBA</td><td>2.0</td></tr> </tbody> </table>	Provider	PODI	WIMAX	0.8	OPA	0.8	NGMN	0.9	CCF	1.0	UMTS	1.1	GSMA	1.2	LSTI	1.2	CDG	1.4	WBA	2.0	<p>a) “phones OR smartphones OR PDA OR accessories OR cards” b) “customer AND (options OR choice OR choose)” c) “(data OR voice) AND plans” d) “unlimited AND (calling OR text OR distance):” e) “choose AND different AND plans”</p> <p style="text-align: center;">PODI(F7, All, F)</p> <table border="1"> <thead> <tr> <th>Provider</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>WBA</td><td>0.4</td></tr> <tr><td>NGMN</td><td>0.5</td></tr> <tr><td>OPA</td><td>0.5</td></tr> <tr><td>WIMAX</td><td>0.5</td></tr> <tr><td>CDG</td><td>0.7</td></tr> <tr><td>LSTI</td><td>1.0</td></tr> <tr><td>GSMA</td><td>1.4</td></tr> <tr><td>UMTS</td><td>1.4</td></tr> <tr><td>CCF</td><td>2.2</td></tr> </tbody> </table>	Provider	PODI	WBA	0.4	NGMN	0.5	OPA	0.5	WIMAX	0.5	CDG	0.7	LSTI	1.0	GSMA	1.4	UMTS	1.4	CCF	2.2
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G3: Fee Based Business Solutions (III)	I10: Fee Based Business Solutions (IV)																																								
<p>a) “subscription OR activation OR contract” b) “ringtones OR games OR songs OR wallpaper OR screensavers OR tones OR IM” c) “service AND mobile AND (banking OR payment OR money OR financial)” d) “new AND (contract OR collaboration OR partner)”</p> <p style="text-align: center;">PODI(G3, All, G)</p> <table border="1"> <thead> <tr> <th>Provider</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.6</td></tr> <tr><td>WIMAX</td><td>0.8</td></tr> <tr><td>CDG</td><td>0.9</td></tr> <tr><td>CCF</td><td>0.9</td></tr> <tr><td>NGMN</td><td>1.0</td></tr> <tr><td>LSTI</td><td>1.1</td></tr> <tr><td>GSMA</td><td>1.5</td></tr> <tr><td>UMTS</td><td>1.5</td></tr> <tr><td>WBA</td><td>1.6</td></tr> </tbody> </table>	Provider	PODI	OPA	0.6	WIMAX	0.8	CDG	0.9	CCF	0.9	NGMN	1.0	LSTI	1.1	GSMA	1.5	UMTS	1.5	WBA	1.6	<p>a) “(data OR voice) AND plans” b) “unlimited AND (calling OR text OR distance)” c) “phones OR smartphones OR PDA OR accessories OR cards” d) “customer AND (options OR choice OR choose)” e) “(“Mobile Terminal Supplier” OR “Mobile Terminal” OR manufacturer) AND mobile AND phone”</p> <p style="text-align: center;">PODI(I10, All, I)</p> <table border="1"> <thead> <tr> <th>Provider</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>WIMAX</td><td>0.6</td></tr> <tr><td>OPA</td><td>0.8</td></tr> <tr><td>NGMN</td><td>1.0</td></tr> <tr><td>WBA</td><td>1.0</td></tr> <tr><td>UMTS</td><td>1.1</td></tr> <tr><td>LSTI</td><td>1.1</td></tr> <tr><td>GSMA</td><td>1.5</td></tr> <tr><td>CCF</td><td>1.6</td></tr> <tr><td>CDG</td><td>1.8</td></tr> </tbody> </table>	Provider	PODI	WIMAX	0.6	OPA	0.8	NGMN	1.0	WBA	1.0	UMTS	1.1	LSTI	1.1	GSMA	1.5	CCF	1.6	CDG	1.8
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WiMAX Technology and Standard

Table 18: WiMAX Technology and Standard

E4: WiMAX Technology and Standard (I)	I1: WiMAX Technology and Standard (II)																																								
<p>a) "WiMAX" b) "TDD OR FDD" c) "IEEE AND 802.16" d) "ecosystem AND mobile AND broadband" e) "forum"</p> <p style="text-align: center;">PODI(E4, All, E)</p> <table border="1"> <thead> <tr> <th>Technology</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>CDG</td><td>0.5</td></tr> <tr><td>GSMA</td><td>0.8</td></tr> <tr><td>WBA</td><td>0.8</td></tr> <tr><td>NGMN</td><td>1.0</td></tr> <tr><td>CCF</td><td>1.1</td></tr> <tr><td>LSTI</td><td>1.2</td></tr> <tr><td>OPA</td><td>1.3</td></tr> <tr><td>WiMAX</td><td>1.7</td></tr> <tr><td>UMTS</td><td>1.8</td></tr> </tbody> </table>	Technology	PODI	CDG	0.5	GSMA	0.8	WBA	0.8	NGMN	1.0	CCF	1.1	LSTI	1.2	OPA	1.3	WiMAX	1.7	UMTS	1.8	<p>a) "OFDMA OR 'Orthogonal Frequency Division Multiple Access'" b) "IEEE AND 802.16" c) WiMAX c) "'base station' OR 'base-station'" e) "TDD OR FDD"</p> <p style="text-align: center;">PODI(I1, All, I)</p> <table border="1"> <thead> <tr> <th>Technology</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>GSMA</td><td>0.2</td></tr> <tr><td>CDG</td><td>0.4</td></tr> <tr><td>CCF</td><td>0.5</td></tr> <tr><td>UMTS</td><td>0.5</td></tr> <tr><td>WBA</td><td>0.5</td></tr> <tr><td>LSTI</td><td>1.1</td></tr> <tr><td>NGMN</td><td>1.2</td></tr> <tr><td>OPA</td><td>3.4</td></tr> <tr><td>WiMAX</td><td>5.8</td></tr> </tbody> </table>	Technology	PODI	GSMA	0.2	CDG	0.4	CCF	0.5	UMTS	0.5	WBA	0.5	LSTI	1.1	NGMN	1.2	OPA	3.4	WiMAX	5.8
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The WiMAX Forum is a non-profit organization that lists about 500 companies with the stated goal of promoting the WiMAX standard, which was developed by the IEEE and also known as 802.16. TDD and FDD are variants of the technology. The WiMAX Forum acts as a keystone. The keywords identified in Table 18 characterize the members' support for the forum, technology and standards.

Hardware

Table 19: Hardware

E5: Hardware (I)	F4: Hardware (II)																																								
<p>a) "microprocessor OR processor OR microcontroller OR DSP OR 'RF subsystem' OR 'power management' OR chips OR chipsets OR sensor"</p> <p>b) "semiconductor"</p> <p>c) "design"</p> <p>d) "packaging"</p> <p>PODI(E5, All, E)</p> <table border="1"> <thead> <tr> <th>Technology</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>WBA</td><td>0.2</td></tr> <tr><td>CDG</td><td>0.6</td></tr> <tr><td>GSM</td><td>0.7</td></tr> <tr><td>CCF</td><td>1.1</td></tr> <tr><td>UMTS</td><td>1.1</td></tr> <tr><td>NGMN</td><td>1.3</td></tr> <tr><td>LSTI</td><td>1.4</td></tr> <tr><td>OPA</td><td>1.6</td></tr> <tr><td>WiMAX</td><td>1.6</td></tr> </tbody> </table>	Technology	PODI	WBA	0.2	CDG	0.6	GSM	0.7	CCF	1.1	UMTS	1.1	NGMN	1.3	LSTI	1.4	OPA	1.6	WiMAX	1.6	<p>a) "signal AND processing"</p> <p>b) "microprocessor OR processor OR microcontroller OR DSP OR 'RF subsystem' OR 'power management' OR chips OR chipsets OR sensor"</p> <p>c) "multi-standard"</p> <p>d) "'base station' OR 'base-station'"</p> <p>PODI(F4, All, F)</p> <table border="1"> <thead> <tr> <th>Technology</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>WBA</td><td>0.2</td></tr> <tr><td>GSM</td><td>0.4</td></tr> <tr><td>CCF</td><td>0.7</td></tr> <tr><td>UMTS</td><td>1.1</td></tr> <tr><td>WiMAX</td><td>1.8</td></tr> <tr><td>LSTI</td><td>2.8</td></tr> <tr><td>CDG</td><td>4.6</td></tr> <tr><td>OPA</td><td>5.2</td></tr> <tr><td>NGMN</td><td>6.0</td></tr> </tbody> </table>	Technology	PODI	WBA	0.2	GSM	0.4	CCF	0.7	UMTS	1.1	WiMAX	1.8	LSTI	2.8	CDG	4.6	OPA	5.2	NGMN	6.0
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G6: Hardware (III)	I2: Hardware (IV)																																								
<p>a) "microprocessor OR processor OR microcontroller OR DSP OR 'RF subsystem' OR 'power management' OR chips OR chipsets OR sensor"</p> <p>b) "design"</p> <p>c) "(product OR process) AND (modularity OR modular OR module)"</p> <p>d) "system AND integration"</p> <p>PODI(G6, All, G)</p> <table border="1"> <thead> <tr> <th>Technology</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>WBA</td><td>0.3</td></tr> <tr><td>CDG</td><td>0.6</td></tr> <tr><td>GSM</td><td>0.7</td></tr> <tr><td>CCF</td><td>0.9</td></tr> <tr><td>UMTS</td><td>1.0</td></tr> <tr><td>NGMN</td><td>1.1</td></tr> <tr><td>LSTI</td><td>1.3</td></tr> <tr><td>WiMAX</td><td>1.7</td></tr> <tr><td>OPA</td><td>1.8</td></tr> </tbody> </table>	Technology	PODI	WBA	0.3	CDG	0.6	GSM	0.7	CCF	0.9	UMTS	1.0	NGMN	1.1	LSTI	1.3	WiMAX	1.7	OPA	1.8	<p>a) "microprocessor OR processor OR microcontroller OR DSP OR 'RF subsystem' OR 'power management' OR chips OR chipsets OR sensor"</p> <p>b) "semiconductor"</p> <p>c) "design"</p> <p>c) "signal AND processing"</p> <p>PODI(I2, All, I)</p> <table border="1"> <thead> <tr> <th>Technology</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>WBA</td><td>0.2</td></tr> <tr><td>CDG</td><td>0.6</td></tr> <tr><td>GSM</td><td>0.7</td></tr> <tr><td>CCF</td><td>0.9</td></tr> <tr><td>UMTS</td><td>1.2</td></tr> <tr><td>NGMN</td><td>1.6</td></tr> <tr><td>LSTI</td><td>1.6</td></tr> <tr><td>WiMAX</td><td>1.8</td></tr> <tr><td>OPA</td><td>2.5</td></tr> </tbody> </table>	Technology	PODI	WBA	0.2	CDG	0.6	GSM	0.7	CCF	0.9	UMTS	1.2	NGMN	1.6	LSTI	1.6	WiMAX	1.8	OPA	2.5
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The keywords in Table 19 represent the involvement of the mobile communication industry's infrastructure providers and device manufacturers in

the design, packaging of semiconductors, integrated circuits, radio frequency (RF) and power management subsystems. The product or the process modularity is one indicator of efficiency and flexibility which are required in satisfying infrastructure provider or device manufacturer's needs for their cost reduction and flexibility. Some of the companies for which these factors are relevant are also involved in hardware for base stations – a term widely used by the wireless industry to denote the portion of the wireless network responsible for the communication over the air with the mobile user equipment.

3GPP Standard and LTE Technology

The Long Term Evolution (LTE) has become the next generation (4th generation or 4G), the convergence technology to which the current technologies will evolve to eventually, based on the involvement of the infrastructure providers and network operators worldwide. The major changes are at the “radio access” part of the network, which defines the connection over the air between the user equipment (the mobile) and the radio base station. The Multiple In Multiple Out (MIMO) or smart antenna allow for increased data rates between the base station and the mobile unit. The TDD and FDD are variants of the technology for over the air transmissions. The modularity, performance, and the cost effectiveness could be associated with the fact that the network architecture has become simpler, based on open standards, an all IP (Internet Protocol) network. The keywords identified in Table 20 characterize the members' support for the LTE technology and standards.

Table 20: 3GPP Standard and LTE Technology

E6: 3GPP Standard and LTE Technology (I)	F8: 3GPP Standard and LTE Technology (II)																																								
<p>a) 'Radio Access' b) "LTE OR 'Long Term Evolution' OR eUTRAN" c) "3GPP" d) "IMS OR 'IP Multimedia Subsystem" e) "(product OR process OR service) AND (evolution OR evolve)"</p> <p style="text-align: center;">PODI(E6, All, E)</p> <table border="1"> <thead> <tr> <th>Technology</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>WBA</td><td>0.4</td></tr> <tr><td>OPA</td><td>0.7</td></tr> <tr><td>CDG</td><td>1.0</td></tr> <tr><td>WiMAX</td><td>1.3</td></tr> <tr><td>GSM</td><td>1.4</td></tr> <tr><td>CCF</td><td>1.6</td></tr> <tr><td>UMTS</td><td>1.9</td></tr> <tr><td>NGMN</td><td>2.1</td></tr> <tr><td>LSTI</td><td>2.3</td></tr> </tbody> </table>	Technology	PODI	WBA	0.4	OPA	0.7	CDG	1.0	WiMAX	1.3	GSM	1.4	CCF	1.6	UMTS	1.9	NGMN	2.1	LSTI	2.3	<p>a) "3GPP" b) "MIMO OR 'smart antenna" c) "LTE OR 'Long Term Evolution' OR eUTRAN" d) "TDD OR FDD"</p> <p style="text-align: center;">PODI(F8, All, F)</p> <table border="1"> <thead> <tr> <th>Technology</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>WBA</td><td>0.1</td></tr> <tr><td>GSM</td><td>0.3</td></tr> <tr><td>CDG</td><td>0.9</td></tr> <tr><td>NGMN</td><td>0.9</td></tr> <tr><td>UMTS</td><td>1.0</td></tr> <tr><td>WiMAX</td><td>1.0</td></tr> <tr><td>CCF</td><td>1.2</td></tr> <tr><td>OPA</td><td>4.1</td></tr> <tr><td>LSTI</td><td>6.7</td></tr> </tbody> </table>	Technology	PODI	WBA	0.1	GSM	0.3	CDG	0.9	NGMN	0.9	UMTS	1.0	WiMAX	1.0	CCF	1.2	OPA	4.1	LSTI	6.7
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<p>a) 'Radio Access' b) "LTE OR 'Long Term Evolution' OR eUTRAN" c) "3GPP" d) "IMS OR 'IP Multimedia Subsystem" e) "(product OR process OR service) AND (evolution OR evolve)"</p> <p style="text-align: center;">PODI(H2, All, H)</p> <table border="1"> <thead> <tr> <th>Technology</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>UMTS</td><td>0.6</td></tr> <tr><td>CCF</td><td>0.7</td></tr> <tr><td>OPA</td><td>0.8</td></tr> <tr><td>GSM</td><td>0.9</td></tr> <tr><td>CDG</td><td>0.9</td></tr> <tr><td>WBA</td><td>1.0</td></tr> <tr><td>NGMN</td><td>1.1</td></tr> <tr><td>WiMAX</td><td>1.2</td></tr> <tr><td>LSTI</td><td>1.8</td></tr> </tbody> </table>	Technology	PODI	UMTS	0.6	CCF	0.7	OPA	0.8	GSM	0.9	CDG	0.9	WBA	1.0	NGMN	1.1	WiMAX	1.2	LSTI	1.8	<p>a) "LTE OR 'Long Term Evolution' OR eUTRAN" b) "3GPP" c) "MIMO OR 'smart antenna"</p> <p style="text-align: center;">PODI(I7, All, I)</p> <table border="1"> <thead> <tr> <th>Technology</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>WBA</td><td>0.1</td></tr> <tr><td>GSM</td><td>0.6</td></tr> <tr><td>CDG</td><td>0.7</td></tr> <tr><td>UMTS</td><td>1.3</td></tr> <tr><td>WiMAX</td><td>1.5</td></tr> <tr><td>CCF</td><td>1.7</td></tr> <tr><td>OPA</td><td>1.7</td></tr> <tr><td>NGMN</td><td>3.4</td></tr> <tr><td>LSTI</td><td>3.6</td></tr> </tbody> </table>	Technology	PODI	WBA	0.1	GSM	0.6	CDG	0.7	UMTS	1.3	WiMAX	1.5	CCF	1.7	OPA	1.7	NGMN	3.4	LSTI	3.6
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Revenue Management Solutions

Table 21: Revenue Management Solutions

E7: Revenue Management Solutions (I)	F3: Revenue Management Solutions (II)																																								
<p>a) "solution AND (OSS OR 'Operation Support System')"</p> <p>b) "BSS OR 'Business Support System'"</p> <p>c) "solution AND (outsourcing OR delivery)"</p> <p>d) "billing"</p> <p>e) "provisioning"</p> <p style="text-align: center;">PODI(E7, All, E)</p> <table border="1"> <thead> <tr> <th>Technology</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>CCF</td><td>0.4</td></tr> <tr><td>OPA</td><td>0.5</td></tr> <tr><td>NGMN</td><td>0.6</td></tr> <tr><td>WiMAX</td><td>0.6</td></tr> <tr><td>LSTI</td><td>0.7</td></tr> <tr><td>UMTS</td><td>0.8</td></tr> <tr><td>WBA</td><td>0.9</td></tr> <tr><td>CDG</td><td>0.9</td></tr> <tr><td>GSMA</td><td>2.3</td></tr> </tbody> </table>	Technology	PODI	CCF	0.4	OPA	0.5	NGMN	0.6	WiMAX	0.6	LSTI	0.7	UMTS	0.8	WBA	0.9	CDG	0.9	GSMA	2.3	<p>a) "BSS OR 'Business Support System'"</p> <p>b) "solution AND (OSS OR 'Operation Support System')"</p> <p>c) "activation AND mediation AND service"</p> <p>d) "'cost of ownership' OR 'optimise infrastructure' OR 'optimize infrastructure'"</p> <p style="text-align: center;">PODI(F3, All, F)</p> <table border="1"> <thead> <tr> <th>Technology</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.2</td></tr> <tr><td>WBA</td><td>0.3</td></tr> <tr><td>CCF</td><td>0.5</td></tr> <tr><td>WiMAX</td><td>1.0</td></tr> <tr><td>LSTI</td><td>1.2</td></tr> <tr><td>UMTS</td><td>1.5</td></tr> <tr><td>GSMA</td><td>1.9</td></tr> <tr><td>NGMN</td><td>3.4</td></tr> <tr><td>CDG</td><td>5.9</td></tr> </tbody> </table>	Technology	PODI	OPA	0.2	WBA	0.3	CCF	0.5	WiMAX	1.0	LSTI	1.2	UMTS	1.5	GSMA	1.9	NGMN	3.4	CDG	5.9
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The "Revenue Management Solutions" factors are specific to service and billing providers²⁴. Service and billing providers provide software systems necessary for provisioning, billing, and customer service. These backend systems enable the operators to monetize the products and services they offer. These solutions provide provisioning automation, revenue assurance, cost management, billing,

²⁴ <http://www.ossbssworld.com/>

and subscriber management. These factors indicated that the ability to seamlessly provision and price new, bundled services is important. The providers of Operations and Business Support Systems offer solutions to the network operators to improve the operational efficiency and control. These business models are represented by the keywords indicated in Table 21.

Security Solutions

The providers of security solutions offer security protection at the corporate and consumer level against the threat of mobile viruses, malware, inappropriate content, unsolicited communications and spam at a corporate and consumer level; the digital signature, authentication and authority are part of the language used in these solutions. These keywords are captured in the factors shown in Table 22.

Table 22: Security Solutions

<p>E8: Security Solutions (I)</p> <p>a) "(protect OR protecting OR promote) AND (consumers OR users)" b) "(security OR 'customer protection' OR protection) AND (virus OR malware OR 'inappropriate content' OR spam OR phishing)" c) "authentication OR security OR signature" d) "authority"</p> <p>PODI(E8, All, E)</p> <table border="1"> <thead> <tr> <th>Solution</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>CCF</td><td>0.7</td></tr> <tr><td>NGMN</td><td>0.8</td></tr> <tr><td>CDG</td><td>0.8</td></tr> <tr><td>LSTI</td><td>0.9</td></tr> <tr><td>WBA</td><td>1.1</td></tr> <tr><td>UMTS</td><td>1.1</td></tr> <tr><td>WiMAX</td><td>1.1</td></tr> <tr><td>GSMA</td><td>1.2</td></tr> <tr><td>OPA</td><td>1.3</td></tr> </tbody> </table>	Solution	PODI	CCF	0.7	NGMN	0.8	CDG	0.8	LSTI	0.9	WBA	1.1	UMTS	1.1	WiMAX	1.1	GSMA	1.2	OPA	1.3	<p>F5: Security Solutions (II)</p> <p>a) "(protect OR protecting OR promote) AND (consumers OR users)" b) "reputation OR competence" c) "(security OR 'customer protection' OR protection) AND (virus OR malware OR 'inappropriate content' OR spam OR phishing)" e) "conformity OR compliance"</p> <p>PODI(F5, All, F)</p> <table border="1"> <thead> <tr> <th>Solution</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.6</td></tr> <tr><td>NGMN</td><td>0.8</td></tr> <tr><td>WiMAX</td><td>0.9</td></tr> <tr><td>WBA</td><td>1.0</td></tr> <tr><td>CCF</td><td>1.1</td></tr> <tr><td>CDG</td><td>1.2</td></tr> <tr><td>UMTS</td><td>1.3</td></tr> <tr><td>GSMA</td><td>1.4</td></tr> <tr><td>LSTI</td><td>1.4</td></tr> </tbody> </table>	Solution	PODI	OPA	0.6	NGMN	0.8	WiMAX	0.9	WBA	1.0	CCF	1.1	CDG	1.2	UMTS	1.3	GSMA	1.4	LSTI	1.4
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<p>G8: Security Solutions (III)</p> <p>a) "(protect OR protecting OR promote) AND (consumers OR users)" b) "conformity OR compliance" c) "authentication OR security OR signature"</p> <p>PODI(G8, All, G)</p> <table border="1"> <thead> <tr> <th>Solution</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>CDG</td><td>0.4</td></tr> <tr><td>CCF</td><td>0.9</td></tr> <tr><td>UMTS</td><td>0.9</td></tr> <tr><td>OPA</td><td>0.9</td></tr> <tr><td>NGMN</td><td>1.0</td></tr> <tr><td>LSTI</td><td>1.0</td></tr> <tr><td>GSMA</td><td>1.1</td></tr> <tr><td>WBA</td><td>1.2</td></tr> <tr><td>WiMAX</td><td>1.3</td></tr> </tbody> </table>	Solution	PODI	CDG	0.4	CCF	0.9	UMTS	0.9	OPA	0.9	NGMN	1.0	LSTI	1.0	GSMA	1.1	WBA	1.2	WiMAX	1.3	<p>H5: Security Solutions (IV)</p> <p>a) "(protect OR protecting OR promote) AND (consumers OR users)" b) "reputation OR competence" c) "(security OR 'customer protection' OR protection) AND (virus OR malware OR 'inappropriate content' OR spam OR phishing)" d) "router OR gateway" e) "conformity OR compliance"</p> <p>PODI(H5, All, H)</p> <table border="1"> <thead> <tr> <th>Solution</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>NGMN</td><td>0.5</td></tr> <tr><td>LSTI</td><td>0.5</td></tr> <tr><td>CCF</td><td>0.5</td></tr> <tr><td>OPA</td><td>0.6</td></tr> <tr><td>CDG</td><td>0.7</td></tr> <tr><td>WiMAX</td><td>0.8</td></tr> <tr><td>UMTS</td><td>0.8</td></tr> <tr><td>WBA</td><td>1.1</td></tr> <tr><td>GSMA</td><td>1.5</td></tr> </tbody> </table>	Solution	PODI	NGMN	0.5	LSTI	0.5	CCF	0.5	OPA	0.6	CDG	0.7	WiMAX	0.8	UMTS	0.8	WBA	1.1	GSMA	1.5
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Interoperability Solutions

Table 23: Interoperability Solutions

E9: Interoperability Solutions (I)	F6: Interoperability Solutions (II)																																								
<p>a) "(SMS OR MMS) AND services" b) "VAS OR 'Value Added Services'" c) "roaming OR NRTRDE" d) "network AND operator"</p> <p style="text-align: center;">PODI(E9, All, E)</p> <table border="1"> <thead> <tr> <th>Solution</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.2</td></tr> <tr><td>WIMAX</td><td>0.4</td></tr> <tr><td>CCF</td><td>0.5</td></tr> <tr><td>NGMN</td><td>0.7</td></tr> <tr><td>LSTI</td><td>0.9</td></tr> <tr><td>CDG</td><td>1.1</td></tr> <tr><td>UMTS</td><td>1.4</td></tr> <tr><td>WBA</td><td>1.9</td></tr> <tr><td>GSMA</td><td>2.0</td></tr> </tbody> </table>	Solution	PODI	OPA	0.2	WIMAX	0.4	CCF	0.5	NGMN	0.7	LSTI	0.9	CDG	1.1	UMTS	1.4	WBA	1.9	GSMA	2.0	<p>a) "(SMS OR MMS) AND services" b) "roaming OR NRTRDE" c) "mobile AND messaging AND services" d) "VAS OR 'Value Added Services'" e) "GSM"</p> <p style="text-align: center;">PODI(F6, All, F)</p> <table border="1"> <thead> <tr> <th>Solution</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.3</td></tr> <tr><td>NGMN</td><td>0.5</td></tr> <tr><td>WIMAX</td><td>0.5</td></tr> <tr><td>CDG</td><td>0.7</td></tr> <tr><td>LSTI</td><td>0.7</td></tr> <tr><td>CCF</td><td>1.0</td></tr> <tr><td>WBA</td><td>1.8</td></tr> <tr><td>GSMA</td><td>2.2</td></tr> <tr><td>UMTS</td><td>2.2</td></tr> </tbody> </table>	Solution	PODI	OPA	0.3	NGMN	0.5	WIMAX	0.5	CDG	0.7	LSTI	0.7	CCF	1.0	WBA	1.8	GSMA	2.2	UMTS	2.2
Solution	PODI																																								
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G5: Interoperability Solutions (III)	H7: Interoperability Solutions (IV)																																								
<p>a) "roaming OR NRTRDE" b) "solutions AND (roaming OR VAS OR 'Customer Care')" c) "network AND operator" d) "(SMS OR MMS) AND services"</p> <p style="text-align: center;">PODI(G5, All, G)</p> <table border="1"> <thead> <tr> <th>Solution</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.2</td></tr> <tr><td>CDG</td><td>0.4</td></tr> <tr><td>WIMAX</td><td>0.5</td></tr> <tr><td>CCF</td><td>0.6</td></tr> <tr><td>NGMN</td><td>0.7</td></tr> <tr><td>LSTI</td><td>0.9</td></tr> <tr><td>WBA</td><td>1.8</td></tr> <tr><td>GSMA</td><td>1.8</td></tr> <tr><td>UMTS</td><td>2.1</td></tr> </tbody> </table>	Solution	PODI	OPA	0.2	CDG	0.4	WIMAX	0.5	CCF	0.6	NGMN	0.7	LSTI	0.9	WBA	1.8	GSMA	1.8	UMTS	2.1	<p>a) "(SMS OR MMS) AND services" b) "solutions AND ('SIM card' OR 'smart card')" c) "solutions AND (roaming OR VAS OR 'Customer Care')" d) "service AND mobile AND (banking OR payment OR money OR financial)" e) "roaming OR NRTRDE"</p> <p style="text-align: center;">PODI(H7, All, H)</p> <table border="1"> <thead> <tr> <th>Solution</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.1</td></tr> <tr><td>NGMN</td><td>0.4</td></tr> <tr><td>WIMAX</td><td>0.4</td></tr> <tr><td>CCF</td><td>0.5</td></tr> <tr><td>LSTI</td><td>0.5</td></tr> <tr><td>CDG</td><td>1.3</td></tr> <tr><td>UMTS</td><td>1.6</td></tr> <tr><td>WBA</td><td>2.1</td></tr> <tr><td>GSMA</td><td>2.9</td></tr> </tbody> </table>	Solution	PODI	OPA	0.1	NGMN	0.4	WIMAX	0.4	CCF	0.5	LSTI	0.5	CDG	1.3	UMTS	1.6	WBA	2.1	GSMA	2.9
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The text messaging (SMS) and multimedia messaging (MMS) services require interoperability solutions when moving from one operator to the other or from one technology to another (e.g. CDMA and GSM). These services also allow the message conversion to and from various formats. These solutions are designed to enable mobile network operators to make more profits out of messaging. For the mobile operators interested to manage large-scale Value Added Services (VAS) applications based on SMS, MMS, WAP and Voice, the providers offer complete solutions. The application providers help mobile operators and service providers to reduce customer care costs and increase revenues from advanced data services such as over the air configuration of terminals, service agreement updates, administration tools, etc. The Near Real Time Roaming Data Exchange (NRTRDE) is a platform for roaming management that provides immediate access to the critical information needed to combat roaming fraud; NRTRDE was introduced by one of the working groups in the GSM Association. These interoperability indicators are captured by the factors shown in Table 23.

Reputation

Table 24: Reputation

E10: Reputation (I)	G7: Reputation (II)																																								
a) "reputation OR competence" b) "agreement" c) "governance OR govern" d) "regulator OR regulate OR supervise OR regulation OR regulatory"	a) "reputation OR competence" b) "governance OR govern" c) "agreement" d) "regulator OR regulate OR supervise OR regulation OR regulatory"																																								
<p style="text-align: center;">PODI(E10, All, E)</p> <table border="1"> <thead> <tr> <th>Entity</th> <th>PODI(E10, All, E)</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.5</td></tr> <tr><td>CCF</td><td>0.7</td></tr> <tr><td>GSMA</td><td>0.9</td></tr> <tr><td>CDG</td><td>0.9</td></tr> <tr><td>WiMAX</td><td>1.0</td></tr> <tr><td>NGMN</td><td>1.0</td></tr> <tr><td>LSTI</td><td>1.2</td></tr> <tr><td>WBA</td><td>1.3</td></tr> <tr><td>UMTS</td><td>2.0</td></tr> </tbody> </table>	Entity	PODI(E10, All, E)	OPA	0.5	CCF	0.7	GSMA	0.9	CDG	0.9	WiMAX	1.0	NGMN	1.0	LSTI	1.2	WBA	1.3	UMTS	2.0	<p style="text-align: center;">PODI(G7, All, G)</p> <table border="1"> <thead> <tr> <th>Entity</th> <th>PODI(G7, All, G)</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.6</td></tr> <tr><td>CDG</td><td>0.7</td></tr> <tr><td>CCF</td><td>0.9</td></tr> <tr><td>WiMAX</td><td>1.0</td></tr> <tr><td>NGMN</td><td>1.0</td></tr> <tr><td>GSMA</td><td>1.0</td></tr> <tr><td>WBA</td><td>1.1</td></tr> <tr><td>LSTI</td><td>1.1</td></tr> <tr><td>UMTS</td><td>1.5</td></tr> </tbody> </table>	Entity	PODI(G7, All, G)	OPA	0.6	CDG	0.7	CCF	0.9	WiMAX	1.0	NGMN	1.0	GSMA	1.0	WBA	1.1	LSTI	1.1	UMTS	1.5
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Sociological studies on market competition (Podolny, 2005) indicate that under conditions of market uncertainty the reputation and the status of a firm play an important role in its success. Among the main players in the mobile communication industry the application developers and content providers face the highest levels of rivalry (Teo, 2001). The reputation indicators are captured by the "Reputation" factor as shown in Table 24.

Research

Table 25: Research

E11: Research (I)	G9: Research (II)																																								
<p>a) "(university OR universities) AND research"</p> <p>b) "research OR innovation OR 'research and development'"</p> <p>c) "science AND technology"</p> <p style="text-align: center;">PODI(E11, All, E)</p> <table border="1"> <thead> <tr> <th>Category</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.6</td></tr> <tr><td>CDG</td><td>0.7</td></tr> <tr><td>WBA</td><td>1.0</td></tr> <tr><td>GSMA</td><td>1.0</td></tr> <tr><td>CCF</td><td>1.1</td></tr> <tr><td>WiMAX</td><td>1.2</td></tr> <tr><td>LSTI</td><td>1.4</td></tr> <tr><td>NGMN</td><td>1.7</td></tr> <tr><td>UMTS</td><td>1.8</td></tr> </tbody> </table>	Category	PODI	OPA	0.6	CDG	0.7	WBA	1.0	GSMA	1.0	CCF	1.1	WiMAX	1.2	LSTI	1.4	NGMN	1.7	UMTS	1.8	<p>a) "(university OR universities) AND research"</p> <p>b) "research OR innovation OR 'research and development'"</p> <p>c) "science AND technology"</p> <p>d) "technology AND development"</p> <p style="text-align: center;">PODI(G9, All, G)</p> <table border="1"> <thead> <tr> <th>Category</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>CDG</td><td>0.4</td></tr> <tr><td>WBA</td><td>0.8</td></tr> <tr><td>GSMA</td><td>1.0</td></tr> <tr><td>OPA</td><td>1.0</td></tr> <tr><td>CCF</td><td>1.1</td></tr> <tr><td>NGMN</td><td>1.5</td></tr> <tr><td>LSTI</td><td>1.6</td></tr> <tr><td>WiMAX</td><td>1.6</td></tr> <tr><td>UMTS</td><td>1.6</td></tr> </tbody> </table>	Category	PODI	CDG	0.4	WBA	0.8	GSMA	1.0	OPA	1.0	CCF	1.1	NGMN	1.5	LSTI	1.6	WiMAX	1.6	UMTS	1.6
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<p>a) "research OR innovation OR 'research and development'"</p> <p>b) "(university OR universities) AND research"</p> <p>c) "science AND technology"</p> <p>d) "research AND testing"</p>	<p style="text-align: center;">PODI(I8, All, I)</p> <table border="1"> <thead> <tr> <th>Category</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>CDG</td><td>0.7</td></tr> <tr><td>WBA</td><td>0.7</td></tr> <tr><td>GSMA</td><td>0.9</td></tr> <tr><td>OPA</td><td>1.2</td></tr> <tr><td>WiMAX</td><td>1.4</td></tr> <tr><td>CCF</td><td>1.5</td></tr> <tr><td>LSTI</td><td>1.9</td></tr> <tr><td>NGMN</td><td>2.1</td></tr> <tr><td>UMTS</td><td>2.1</td></tr> </tbody> </table>	Category	PODI	CDG	0.7	WBA	0.7	GSMA	0.9	OPA	1.2	WiMAX	1.4	CCF	1.5	LSTI	1.9	NGMN	2.1	UMTS	2.1																				
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The keywords in Table 25 identify research and innovation as a characteristic of the technology organizations and universities with ties in the mobile communication industry. The factors indicate that organizations are involved in the research and development of the new wireless technologies.

3GPP Standard and 3G Technologies Evolution

Table 26: 3GPP Standard and 3G Technologies Evolution

The 3GPP 3G standards cover the technology evolution from GSM, GPRS to UMTS/WCDMA over the last two decades. The organizations for which the component is relevant could indicate continuous involvement with these technologies as indicated in Table 26.

Fraud Detection

Fraud monitoring and detection are some of the solutions offered by firms involved in the testing and improving of the communication quality. The web pages of the organizations that this study analyzed also indicates that for the companies involved in roaming, the exchange of information related to user's access to other networks require fraud monitoring and analysis. Factor F1 also includes a keyword identifying the GSM Association. This fact confirms that these solutions are provided to the operators to enable the operators monetize

the services they offer. Table 27 shows the keywords identified for this component.

Table 27: Fraud Detection

F1: Fraud Detection (I)	H1: Fraud Detection (II)																																								
<p>a) "(analyze OR monitor OR test) AND fraud"</p> <p>b) "fraud AND (control OR detection)"</p> <p>c) "analyze AND revenue AND (loss OR risk)"</p> <p>d) "assurance AND (customer OR service)"</p> <p style="text-align: center;">PODI(F1, All, F)</p> <table border="1"> <thead> <tr> <th>Keyword</th> <th>PODI(F1, All, F)</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.3</td></tr> <tr><td>LSTI</td><td>0.5</td></tr> <tr><td>WiMAX</td><td>0.6</td></tr> <tr><td>NGMN</td><td>0.8</td></tr> <tr><td>CCF</td><td>0.9</td></tr> <tr><td>UMTS</td><td>1.4</td></tr> <tr><td>CDG</td><td>1.4</td></tr> <tr><td>WBA</td><td>2.0</td></tr> <tr><td>GSMA</td><td>2.8</td></tr> </tbody> </table>	Keyword	PODI(F1, All, F)	OPA	0.3	LSTI	0.5	WiMAX	0.6	NGMN	0.8	CCF	0.9	UMTS	1.4	CDG	1.4	WBA	2.0	GSMA	2.8	<p>a) "analyze AND revenue AND (loss OR risk)"</p> <p>b) "fraud AND (control OR detection)"</p> <p>c) "(analyze OR monitor OR test) AND fraud"</p> <p>d) "billing"</p> <p>e) "assurance AND (customer OR service)"</p> <p>f) "GSMA OR 'GSM Association' OR gsmworld"</p> <p style="text-align: center;">PODI(H1, All, H)</p> <table border="1"> <thead> <tr> <th>Keyword</th> <th>PODI(H1, All, H)</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.0</td></tr> <tr><td>NGMN</td><td>0.2</td></tr> <tr><td>WiMAX</td><td>0.3</td></tr> <tr><td>CCF</td><td>0.4</td></tr> <tr><td>UMTS</td><td>0.5</td></tr> <tr><td>CDG</td><td>0.5</td></tr> <tr><td>LSTI</td><td>0.7</td></tr> <tr><td>WBA</td><td>0.9</td></tr> <tr><td>GSMA</td><td>5.5</td></tr> </tbody> </table>	Keyword	PODI(H1, All, H)	OPA	0.0	NGMN	0.2	WiMAX	0.3	CCF	0.4	UMTS	0.5	CDG	0.5	LSTI	0.7	WBA	0.9	GSMA	5.5
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Business Opportunity Solutions

Table 28: Business Opportunity Solutions

F2: Business Opportunity Solutions (I)	G2: Business Opportunity Solutions (II)																																								
<p>a) "new AND (market OR industry)" b) "solution AND (outsourcing OR delivery)" c) "strategy AND development" d) "network AND operator" e) "end-to-end AND communication AND solutions"</p> <p style="text-align: center;">PODI(F2, All, F)</p> <table border="1"> <thead> <tr> <th>Category</th> <th>PODI(F2, All, F)</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>1.1</td></tr> <tr><td>CCF</td><td>1.1</td></tr> <tr><td>WIMAX</td><td>1.3</td></tr> <tr><td>GSMA</td><td>1.3</td></tr> <tr><td>WBA</td><td>1.4</td></tr> <tr><td>LSTI</td><td>2.2</td></tr> <tr><td>UMTS</td><td>2.6</td></tr> <tr><td>NGMN</td><td>4.3</td></tr> <tr><td>CDG</td><td>4.5</td></tr> </tbody> </table>	Category	PODI(F2, All, F)	OPA	1.1	CCF	1.1	WIMAX	1.3	GSMA	1.3	WBA	1.4	LSTI	2.2	UMTS	2.6	NGMN	4.3	CDG	4.5	<p>a) "solution AND provider" b) "'end-to-end' AND communication AND solutions" c) "solution AND (outsourcing OR delivery)" d) "new AND (market OR industry)" e) "cost AND (reduce OR reduction OR saving OR effective)"</p> <p style="text-align: center;">PODI(G2, All, G)</p> <table border="1"> <thead> <tr> <th>Category</th> <th>PODI(G2, All, G)</th> </tr> </thead> <tbody> <tr><td>CCF</td><td>0.8</td></tr> <tr><td>OPA</td><td>0.8</td></tr> <tr><td>WBA</td><td>0.8</td></tr> <tr><td>LSTI</td><td>1.0</td></tr> <tr><td>NGMN</td><td>1.2</td></tr> <tr><td>UMTS</td><td>1.2</td></tr> <tr><td>GSMA</td><td>1.3</td></tr> <tr><td>WiMAX</td><td>1.3</td></tr> <tr><td>CDG</td><td>2.4</td></tr> </tbody> </table>	Category	PODI(G2, All, G)	CCF	0.8	OPA	0.8	WBA	0.8	LSTI	1.0	NGMN	1.2	UMTS	1.2	GSMA	1.3	WiMAX	1.3	CDG	2.4
Category	PODI(F2, All, F)																																								
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The business oriented solutions are generally providing strategies to the network operators on how to access new markets or industries. The keywords identified in Table 28 suggest that these solutions are aligned with the new market dynamics and business models, and are oriented towards cost effectiveness.

Licenses and Regulation

Some of the application providers license their software to semiconductor companies, network operators, and mobile terminal manufacturers. Others provide a trading platform for content licensing and distribution. Licensing is also related to network operators for operating telecommunication services in a market that is regulated by an authority which has the power to promote

competition through its regulations. The keywords shown in Table 29 were analyzed for a number of organizations from the sample and suggest that the mobile communication companies may have just acquired a license for operations and that their new entry in the market promotes competition which ultimately benefits the consumers.

Table 29: Licenses and Regulation

F10: Licenses and Regulation (I)	H4: Licenses and Regulation (II)																																								
<p>a) "(issue OR administer) AND (license OR licensing)"</p> <p>b) "market AND (regulation OR oversight)"</p> <p>c) "(enable OR enabling OR promote OR promoting) AND competition"</p> <p>d) "authority"</p> <p style="text-align: center;">PODI(F10, All, F)</p> <table border="1"> <thead> <tr> <th>Organization</th> <th>PODI(F10, All, F)</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.2</td></tr> <tr><td>WBA</td><td>0.6</td></tr> <tr><td>NGMN</td><td>0.9</td></tr> <tr><td>WiMAX</td><td>0.9</td></tr> <tr><td>GSMA</td><td>0.9</td></tr> <tr><td>CCF</td><td>1.4</td></tr> <tr><td>CDG</td><td>1.4</td></tr> <tr><td>LSTI</td><td>1.7</td></tr> <tr><td>UMTS</td><td>3.2</td></tr> </tbody> </table>	Organization	PODI(F10, All, F)	OPA	0.2	WBA	0.6	NGMN	0.9	WiMAX	0.9	GSMA	0.9	CCF	1.4	CDG	1.4	LSTI	1.7	UMTS	3.2	<p>a) "regulator OR regulate OR supervise OR regulation OR regulatory"</p> <p>b) "market AND (regulation OR oversight)"</p> <p>c) "guidelines OR rules OR regulation"</p> <p>d) "(issue OR administer) AND (license OR licensing)"</p> <p style="text-align: center;">PODI(H4, All, H)</p> <table border="1"> <thead> <tr> <th>Organization</th> <th>PODI(H4, All, H)</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.2</td></tr> <tr><td>LSTI</td><td>0.5</td></tr> <tr><td>CDG</td><td>0.6</td></tr> <tr><td>GSMA</td><td>0.7</td></tr> <tr><td>NGMN</td><td>1.0</td></tr> <tr><td>WiMAX</td><td>1.0</td></tr> <tr><td>WBA</td><td>1.6</td></tr> <tr><td>UMTS</td><td>4.1</td></tr> <tr><td>CCF</td><td>8.5</td></tr> </tbody> </table>	Organization	PODI(H4, All, H)	OPA	0.2	LSTI	0.5	CDG	0.6	GSMA	0.7	NGMN	1.0	WiMAX	1.0	WBA	1.6	UMTS	4.1	CCF	8.5
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Conformance and Certification

Table 30: Conformance and Certification

F11: Conformance and Certification (I)	G4: WiMAX Certification																																								
<p>a) "conformance" b) "test AND equipment AND manufacturer" c) "validate AND technology" d) "certified OR certification" e) "interoperability"</p> <p style="text-align: center;">PODI(F11, All, F)</p> <table border="1"> <thead> <tr> <th>Standard</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>GSM</td><td>0.5</td></tr> <tr><td>NGMN</td><td>0.6</td></tr> <tr><td>CDG</td><td>0.7</td></tr> <tr><td>UMTS</td><td>0.7</td></tr> <tr><td>WiMAX</td><td>1.5</td></tr> <tr><td>WBA</td><td>1.5</td></tr> <tr><td>LSTI</td><td>1.8</td></tr> <tr><td>OPA</td><td>2.3</td></tr> <tr><td>CCF</td><td>2.7</td></tr> </tbody> </table>	Standard	PODI	GSM	0.5	NGMN	0.6	CDG	0.7	UMTS	0.7	WiMAX	1.5	WBA	1.5	LSTI	1.8	OPA	2.3	CCF	2.7	<p>a) "'base station' OR 'base-station'" b) "WiMAX" c) "forum" d) "management AND spectrum" e) "certified OR certification"</p> <p style="text-align: center;">PODI(G4, All, G)</p> <table border="1"> <thead> <tr> <th>Standard</th> <th>PODI</th> </tr> </thead> <tbody> <tr><td>GSM</td><td>0.5</td></tr> <tr><td>UMTS</td><td>0.9</td></tr> <tr><td>WBA</td><td>0.9</td></tr> <tr><td>CCF</td><td>0.9</td></tr> <tr><td>LSTI</td><td>1.1</td></tr> <tr><td>NGMN</td><td>1.1</td></tr> <tr><td>CDG</td><td>1.8</td></tr> <tr><td>WiMAX</td><td>2.3</td></tr> <tr><td>OPA</td><td>3.2</td></tr> </tbody> </table>	Standard	PODI	GSM	0.5	UMTS	0.9	WBA	0.9	CCF	0.9	LSTI	1.1	NGMN	1.1	CDG	1.8	WiMAX	2.3	OPA	3.2
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Network operators use products from infrastructure providers and device manufacturers that passed the conformance and certification tests. The conformity to standards and specification is validated by the certification service providers. Besides safety, interference and performance, one of the reasons for certification is interoperability which ensures that similar products from different providers are inter-changeable and integrate seamlessly with other parts of the network. Table 30 presents the keywords that are representative for conformance and certification. The G4 factor defines one of the main

characteristics of the WiMAX Forum – its focus on certification. A study of the WiMAX Forum confirms that the certification services for the base stations are widely used by its members.

CDMA Technology and Standards

Table 31: CDMA Technology and Standards

The code division multiple access (CDMA) is a wireless technology used in the *cdmaOne* and *CDMA2000* mobile phone family of standards (which are often referred to as simply CDMA). The 1xRTT and EV-DO are part of the CDMA2000 family of standards and were developed by the "3rd Generation Partnership Project 2" (3GPP2). Therefore factor I6 is relevant for organizations with business models and offerings based on CDMA technologies and 3GPP2 standard.

Consortia Brand Names

Table 32: Consortia Brand Names

WiMAX Forum (I1)	GSMA Association (H1)																																								
<p>a) "OFDMA OR 'Orthogonal Frequency Division Multiple Access'" b) "IEEE AND 802.16" c) WiMAX c) "'base station' OR 'base-station'" e) "TDD OR FDD"</p> <p>PODI(I1, All, I)</p> <table border="1"> <thead> <tr> <th>Consortia</th> <th>PODI(I1, All, I)</th> </tr> </thead> <tbody> <tr><td>GSMA</td><td>0.2</td></tr> <tr><td>CDG</td><td>0.4</td></tr> <tr><td>CCF</td><td>0.5</td></tr> <tr><td>UMTS</td><td>0.5</td></tr> <tr><td>WBA</td><td>0.5</td></tr> <tr><td>LSTI</td><td>1.1</td></tr> <tr><td>NGMN</td><td>1.2</td></tr> <tr><td>OPA</td><td>3.4</td></tr> <tr><td>WiMAX</td><td>5.8</td></tr> </tbody> </table>	Consortia	PODI(I1, All, I)	GSMA	0.2	CDG	0.4	CCF	0.5	UMTS	0.5	WBA	0.5	LSTI	1.1	NGMN	1.2	OPA	3.4	WiMAX	5.8	<p>a) "analyze AND revenue AND (loss OR risk)" b) "fraud AND (control OR detection)" c) "(analyze OR monitor OR test) AND fraud" d) "billing" e) "assurance AND (customer OR service)" f) "GSMA OR 'GSM Association' OR gsmworld"</p> <p>PODI(H1, All, H)</p> <table border="1"> <thead> <tr> <th>Consortia</th> <th>PODI(H1, All, H)</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.0</td></tr> <tr><td>NGMN</td><td>0.2</td></tr> <tr><td>WiMAX</td><td>0.3</td></tr> <tr><td>CCF</td><td>0.4</td></tr> <tr><td>UMTS</td><td>0.5</td></tr> <tr><td>CDG</td><td>0.5</td></tr> <tr><td>LSTI</td><td>0.7</td></tr> <tr><td>WBA</td><td>0.9</td></tr> <tr><td>GSMA</td><td>5.5</td></tr> </tbody> </table>	Consortia	PODI(H1, All, H)	OPA	0.0	NGMN	0.2	WiMAX	0.3	CCF	0.4	UMTS	0.5	CDG	0.5	LSTI	0.7	WBA	0.9	GSMA	5.5
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<p>a) "'UMTS Forum' OR (UMT AND Forum)" b) "HSPA OR 'High Speed Packet Access'" c) "UMTS"</p> <p>PODI(I4, All, I)</p> <table border="1"> <thead> <tr> <th>Consortia</th> <th>PODI(I4, All, I)</th> </tr> </thead> <tbody> <tr><td>WBA</td><td>0.5</td></tr> <tr><td>OPA</td><td>0.6</td></tr> <tr><td>WiMAX</td><td>0.7</td></tr> <tr><td>GSMA</td><td>1.1</td></tr> <tr><td>CDG</td><td>1.1</td></tr> <tr><td>CCF</td><td>1.7</td></tr> <tr><td>NGMN</td><td>2.3</td></tr> <tr><td>LSTI</td><td>2.3</td></tr> <tr><td>UMTS</td><td>4.5</td></tr> </tbody> </table>	Consortia	PODI(I4, All, I)	WBA	0.5	OPA	0.6	WiMAX	0.7	GSMA	1.1	CDG	1.1	CCF	1.7	NGMN	2.3	LSTI	2.3	UMTS	4.5	<p>a) "'Wireless Broadband Alliance' OR wballiance" b) "'collaboration opportunities'" c) "'business ecosystem' OR 'business ecosystem'"</p> <p>PODI(I5, All, I)</p> <table border="1"> <thead> <tr> <th>Consortia</th> <th>PODI(I5, All, I)</th> </tr> </thead> <tbody> <tr><td>OPA</td><td>0.0</td></tr> <tr><td>CDG</td><td>0.1</td></tr> <tr><td>CCF</td><td>0.1</td></tr> <tr><td>NGMN</td><td>0.1</td></tr> <tr><td>UMTS</td><td>0.1</td></tr> <tr><td>LSTI</td><td>0.2</td></tr> <tr><td>WiMAX</td><td>0.2</td></tr> <tr><td>GSMA</td><td>0.2</td></tr> <tr><td>WBA</td><td>221.9</td></tr> </tbody> </table>	Consortia	PODI(I5, All, I)	OPA	0.0	CDG	0.1	CCF	0.1	NGMN	0.1	UMTS	0.1	LSTI	0.2	WiMAX	0.2	GSMA	0.2	WBA	221.9
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The majority of organizations' websites studied indicate the membership to industry consortia. The presence of a consortia' logo or name on an organization webpage is an indication of membership to the association. It also indicates an interest in the technologies, standards or the collaboration supported by the association. The factors and keywords identified in Table 32 show some of the consortia' names (WiMAX Forum, GSMA Association, UMTS Forum and Wireless Broadband Alliance) and some the constructs relevant to their members. GSMA is associated mostly with constructs of fraud control, UMTS Forum is associated mostly with its technology, Wireless Broadband Alliance members regard themselves as members of an ecosystem, and WiMAX Forum shows focus on the base stations. CDG and CCF show a strong focus on the CDMA standards and technologies.

4.6 Points of Difference for Consortia

The *points-of-difference* (POD) for each consortium is defined by the groups of salient uncorrelated constructs identified from the Consortia PODI List. The *Consortia PODI List* provides a ranked list of POD Indexes for all the factors in each consortium. The *POD Index (factor, consortium, sample)* is used to indicate the numerical importance for each factor, consortium and sample as defined in Section 3.11 .

WiMAX Forum

The PODI Indexes for the identified factors in each sample group are presented in Figure 10.

Figure 10: WiMAX Forum POD Index Chart

The WiMAX Forum salient constructs, with their comprising factors from each sample, and their POD Index are shown in Table 33.

Table 33: WiMAX Forum Salient Constructs

WiMAX Forum Salient Constructs	Factors	POD Index
WiMAX Technology and Standards	I1, E4	5.81, 1.74
Certification	G4, F11	2.34, 1.77
Hardware	I2, G6, E5, F4	1.76, 1.69, 1.58, 1.47
Testing Solutions	I13	1.60

Grouping the salient constructs has to comply with the results from factor analysis in each sample group, in order to avoid any correlation between keywords. Based on the solutions indicated in Table 10, Table 11, Table 12, Table 13 and Table 14 the following salient construct groups, or POD, were identified for WiMAX Forum, and are shown in Table 34:

Table 34: WiMAX Forum POD

WiMAX Forum POD	POD Index
WiMAX Technology and Standards (E4)	1.74
Hardware (E5)	1.58
Certification (F11)	1.77
Hardware (F4)	1.47
Certification (G4)	2.34
Hardware (G6)	1.69
WiMAX Technology and Standards (I1)	5.81
Hardware (I2)	1.76
Testing Solutions (I13)	1.60

GSM Association (GSMA)

The POD Indexes for the identified factors in each sample group are presented for in Figure 11.

Figure 11: GSM Association POD Index Chart

The GSM Association salient constructs, with their comprising factors from each sample, and their POD Index are shown in Table 35.

Table 35: GSMA Salient Constructs

GSMA Salient Constructs	Factors	POD Index
Fraud Detection	H1, I11, F1	5.47, 2.92, 2.83
Interoperability Solutions	H7, I12, F6, E9, G5	2.97, 2.36, 2.18, 2.0, 1.85
Mobile Services	H6	2.49
Revenue Management Solutions	I9, E7, F3	2.47, 2.27, 1.88
Fee Based Business Solutions	G3	1.46

Grouping the salient constructs has to comply with the results from factor analysis in each sample group, in order to avoid any correlation between keywords. Based on the solutions indicated in Table 10, Table 11, Table 12, Table 13 and Table 14 the following salient construct groups, or POD, were identified for GSMA and are shown in Table 36.

Table 36: GSMA POD

GSMA POD	POD Index
Revenue Management Solutions (E7)	2.27
Interoperability Solutions (E9)	2.00
Fraud Detection (F1)	2.83
Interoperability Solutions (F6)	2.18
Revenue Management Solutions (F3)	1.88
Interoperability Solutions (G5)	1.85
Fee Based Business Solutions (G3)	1.46
Fraud Detection (H1)	5.47
Interoperability Solutions (H7)	2.97
Mobile Services (H6)	2.49
Fraud Detection (I11)	2.92
Revenue Management Solutions (I9)	2.47
Interoperability Solutions (I12)	2.36

CDMA Development Group (CDG)

The POD Indexes for the identified factors in each sample group are presented in Figure 12.

Figure 12: CDG POD Index Chart

The CDG salient constructs, with their comprising factors from each sample, and their POD Index are shown in Table 37.

Table 37: CDG Salient Constructs

CDG Salient Constructs	Factors	POD Index
Revenue Management Solutions	F3	6.10
Hardware	F4	5.05
Business Opportunity Solutions	F2, G2	4.99, 3.53
CDMA Technology and Standards	I6	4.43
Fee Based Business Solutions	I10	1.78
WiMAX Certification	G4	1.88
Interoperability Solutions	I12	1.60

Grouping the salient constructs has to comply with the results from factor analysis in each sample group, in order to avoid any correlation between keywords. Based on the solutions indicated in Table 10, Table 11, Table 12, Table 13 and Table 14 the following salient construct groups, or POD, were identified for CDG and are shown in Table 38.

Table 38: CDG POD

CDG POD	POD Index
Revenue Management Solutions (F3)	6.10
Hardware (F4)	5.05
Business Opportunity Solutions (F2)	4.99
Business Opportunity Solutions (G2)	3.53
WiMAX Certification (G4)	1.88
CDMA Technology and Standards (I6)	4.43
Fee Based Business Solutions (I10)	1.78
Interoperability Solutions (I12)	1.60

Next Generation Mobile Networks Alliance (NGMN)

The POD Indexes for the identified factors in each sample group are presented in Figure 13.

Figure 13: NGMN Alliance POD Index Chart

The NGMN Alliance salient constructs, with their comprising factors from each sample, and their POD Index are shown in Table 39.

Table 39: NGMN Salient Constructs

NGMN Salient Constructs	Factors	POD Index
Hardware	F4, I2	6.00, 1,57
Business Opportunity Solutions	F2	4.28
Revenue Management Solutions	F3	3.43
3GPP Standards and LTE Technology	I7, E6	3.41, 2.13
Mobile Services	G1, E1	2.50, 1.71
UMTS	I4	2.27
Research	I8, E11, G9	2.06, 1.71, 1.54
Testing Solutions	I13, G10, E2	1.83, 1.73, 1.54

Grouping the salient constructs has to comply with the results from factor analyses in each sample group, in order to avoid any correlation between keywords. Based on the solutions indicated in Table 10, Table 11, Table 12, Table 13 and Table 14 the following salient construct groups, or POD, were identified for NGMN and are shown in Table 40.

Table 40: NGMN POD

NGMN POD	POD Index
3GPP Standards and LTE Technology (E6)	2.13
Mobile Services (E1)	1.77
Research (E11)	1.71
Testing Solutions (E2)	1.54
Hardware (F4)	6.00
Business Opportunity Solutions (F2)	4.28
Revenue Management Solutions (F3)	3.43
Mobile Services (G1)	2.50
Testing Solutions (G10)	1.73
Research (G9)	1.54
3GPP Standards and LTE Technology (I7)	3.41
UMTS (I4)	2.27
Research (I8)	2.06
Hardware (I2)	1.57

CDMA Certification Forum (CCF)

The POD Indexes for the identified factors in each sample group are presented in Figure 14.

Figure 14: CCF POD Index Chart

The CCF salient constructs, with their comprising factors from each sample, and their POD Index are shown in Table 41.

Table 41: CCF Salient Constructs

CCF Salient Constructs	Factors	POD Index
Licenses and Regulation	H4	8.53
CDMA Standards and Technology	I6	4.66
Conformance and Certification	F11, I3	2.65, 1.99
Testing Solutions	F9, E2, G10, I13	2.65, 2.48, 2.10, 2.75
Fee Based Business Solutions	F7, I10	2.17, 1.55
3GPP and LTE Technology	I7, E6	1.69, 1.64
UMTS	I4	1.67
Research	I8	1.52

Grouping the salient constructs has to comply with the results from factor analysis in each sample group, in order to avoid any correlation between keywords. Based on the solutions indicated in Table 10, Table 11, Table 12, Table 13 and Table 14 the following salient construct groups, or POD, were identified for CCF and are shown in Table 42.

Table 42: CCF POD

CCF POD	POD Index
Testing Solutions (E3)	2.48
3GPP and LTE Technology (E6)	1.64
CDMA Standards and Technology I(6)	4.66
Conformance and Certification (I3)	1.99
3GPP and LTE Technology (I7)	1.69
UMTS (I4)	1.67
Fee Based Business Solutions (I10)	1.55
Research (I8)	1.52

LSTI Forum

The POD Indexes for the identified factors in each sample group are presented in Figure 15.

Figure 15: LSTI Forum POD Index Chart

The LSTI salient constructs, with their comprising factors from each sample, and their POD Index are shown in Table 43.

Table 43: LSTI Forum Salient Constructs

LSTI Salient Constructs	Factors	POD Index
3GPP Standards and LTE Technology	F8, I7, E6, H2	6.72, 3.57, 2.27, 1.84
Hardware	F4, I2	2.74, 1.63
Mobile Services	E1, G1	2.72, 2.52
Testing	I13, E2, G10, F9	2.51, 2.38, 1.96, 1.56
UMTS	I4	2.29
Business Opportunity Solutions	F2	2.19
Research	I8, G9	1.94, 1.55
Conformance and Certification	F11, I3	1.79, 1.50
Licenses and Regulation	F10	1.70

Grouping the salient constructs has to comply with the results from factor analysis in each sample group, in order to avoid any correlation between keywords. Based on the solutions indicated in Table 10, Table 11, Table 12, Table 13 and Table 14 the following salient construct groups, or POD, were identified for LSTI Forum and are shown in Table 44.

Table 44: LSTI Forum POD

LSTI POD	POD Index
3GPP Standards and LTE Technology (F8)	6.72
Licenses and Regulation (F10)	1.70
3GPP Standards and LTE Technology (F8)	6.72
Testing (F9)	1.56
3GPP Standards and LTE Technology (I7)	3.57
UMTS (I4)	2.29
Research (I8)	1.94
Hardware (I2)	1.63
Conformance and Certification (I3)	1.50
Business Opportunity Solutions (F2)	2.19
Licenses and Regulation (F10)	1.70
Testing (F9)	1.56
Mobile Services (E1)	2.72
Testing (E2)	2.38
3GPP Standards and LTE Technology (E6)	2.27
Mobile Services (G1)	2.52
Testing (G10)	1.96
Research (G9)	1.55

UMTS Forum

The POD Indexes for the identified factors in each sample group are presented in Figure 16.

Figure 16: UMTS Forum POD Index Chart

The UMTS Forum salient constructs, with their comprising factors from each sample, and their POD Index are shown in Table 45.

Table 45: UMTS Forum Salient Constructs

UMTS Salient Constructs	Factors	POD Index
UMTS	I4	4.50
Licenses and Regulation	H4, F10, I15	4.08, 3.19, 2.64
Mobile Services	G1, E1	3.43, 2.97
Business Opportunity Solutions	F2	2.60
Interoperability Solutions	F6, G5, I12, H7	2.25, 2.06, 1.78, 1.63
Research	I8, E11, G9	2.10, 1.77, 1.58
Monitoring Solutions	F9	2.04
Reputation	E10, G7	2.00, 1.48
3GPP Standard and LTE Technology	E6	1.90
WiMAX Technology and Standard	E4	1.80
3GPP Standard and 3G Technologies Evolution	E12	1.59

Grouping the salient constructs has to comply with the results from factor analyses in each sample group, in order to avoid any correlation between keywords. Based on the solutions indicated in Table 10, Table 11, Table 12, Table 13 and Table 14 the following salient constructs groups, or POD, were identified for UMTS Forum and are shown in Table 46.

Table 46: UMTS Forum POD

UMTS POD	POD Index
Mobile Services (E1)	2.97
Reputation (E10)	2.00
3GPP Standard and LTE Technology (E6)	1.90
WiMAX Technology and Standard (E4)	1.80
Research (E11)	1.77
3GPP Standard and 3G Technologies Evolution (E12)	1.59
Licenses and Regulation (F10)	3.19
Business Opportunity Solutions (F2)	2.60
Interoperability Solutions (F6)	2.25
Monitoring Solutions (F9)	2.04
Mobile Services (G1)	3.43
Interoperability Solutions (G5)	2.06
Research (G9)	1.58
Licenses and Regulation (H4)	4.08
Interoperability Solutions (H7)	1.63
UMTS (I4)	4.50
Licenses and Regulation (I15)	2.64
Research (I8)	2.10
3GPP Standard and 3G Technologies Evolution (I12)	1.59

Wireless Broadband Alliance (WBA)

The POD Indexes for the identified factors in each sample group are presented in Figure 17.

Figure 17: WBA POD Index Chart

The WBA salient constructs, with their comprising factors from each sample, and their POD Index are shown in Table 47.

Table 47: WBA Salient Construct

WBA Salient Constructs	Factors	POD Index
Wireless Broadband Alliance	I5	221.9
Interoperability Solutions	H7, I12, E9, F6, G5	2.09, 2.03, 1.87, 1.84, 1.79
Fraud Detection	F1	2.04
Fee Based Business Solutions	E3, G3	1.97, 1.59
Licenses and Regulation	H4	1.63
Conformance and Certification	F11	1.51

Grouping the salient constructs has to comply with the results from factor analyses in each sample group, in order to avoid any correlation between keywords. Based on the solutions indicated in Table 10, Table 11, Table 12, Table 13 and Table 14 the following salient construct groups, or POD, were identified for WBA and are shown in Table 48.

Table 48: WBA POD

WBA POD	POD Index
Wireless Broadband Alliance (I5)	221.9
Interoperability Solutions (I12)	2.03
Interoperability Solutions (H7)	2.09
Licenses and Regulation (H4)	1.63
Fraud Detection (F1)	2.04
Interoperability Solutions (F6)	1.84
Fraud Detection (F1)	2.04
Conformance and Certification (F11)	1.51
Fee Based Business Solutions (E3)	1.97
Interoperability Solutions (E9)	1.87
Interoperability Solutions (G5)	1.79
Fee Based Business Solutions (G3)	1.59

Open Patent Alliance (OPA)

The POD Indexes for the identified factors in each sample group are presented in Figure 18.

Figure 18: OPA POD Index Chart

The OPA salient constructs, with their comprising factors from each sample, and their POD Index are shown in Table 49.

Table 49: OPA Salient Constructs

OPA Salient Constructs	Factors	POD Index
Hardware	F4, I2, G6, E5	5.16, 2.47, 1.79, 1.58
3GPP Standard and LTE Technology	F8, I7	4.09, 1.70
WiMAX Technology and Standard	I1	3.39
WiMAX Certification	G4	3.21
Conformance and Certification	F11	2.34

Grouping the salient constructs has to comply with the results from factor analysis in each sample group, in order to avoid any correlation between keywords. Based on the solutions indicated in Table 10, Table 11, Table 12, Table 13 and Table 14 the following salient construct groups, or POD, were identified for OPA and are shown in Table 50.

Table 50: OPA POD

OPA POD	POD Index
Hardware (F4)	5.16
Conformance and Certification (F11)	2.34
WiMAX Technology and Standard (I1)	3.39
Hardware (I2)	2.47
3GPP Standard and LTE Technology	1.70
WiMAX Certification (G4)	3.21
Hardware (G6)	1.79

4.7 Multiple Memberships

An analysis of single and multiple memberships for organizations in sample Group I using the technology factors could provide additional insights on the technology adoption. The POD Index ranking of organizations based on either the single or double membership was performed for the following factors:

- I6: CDMA Technology and 3GPP2 Standards
- I1: WiMAX Technology and IEEE 802.11 Standards
- I7: LTE Technology and 3GPP Standards

The *PODI (I6, All, I)* index for groups of organizations that are members of one or two consortia is shown in Figure 19.

Figure 19: Distribution of CDMA Technology and Standards

The *PODI (I1, All, I)* index for groups of organizations that are members of one or two consortia is shown in Figure 20.

Figure 20: Distribution of WiMAX Technology and Standards

The *PODI (I7, All, I)* index for groups of organizations that are members of one or two consortia is shown in Figure 21.

Figure 21: Distribution of LTE Technology and Standards

4.8 Construct Groups Visualization

A graphical representation of the construct groups identified for each consortium in each sample group is provided in Figure 22, Figure 23, Figure 24, Figure 25 and Figure 26. The visualization could help with the interpretation of constructs and the impact the shared membership have on these constructs by bringing

Figure 23: Sample Group F: Construct Groups Visualization

Figure 24: Sample Group G: Construct Groups Visualization

Figure 25: Sample Group H: Construct Groups Visualization

Figure 26: Sample Group I: Construct Groups Visualization

5. Discussion of Results

This chapter discusses the results of the research. It is divided into eight sections. Section 5.1 provides a discussion on the points of difference in wireless industry consortia. Section 5.2 identifies membership motivation. Section 5.3 provides a view on the development phases of consortia. Section 5.4 identifies the characteristics of technological evolution. Section 5.5 provides evidence of technological adoption. Section 5.6 identifies the emerging role of backend systems. Section 5.7 discusses the insights acquired from the research results. Section 5.8 provides recommendations for organizations that operate as keystones.

5.1 Points of Difference

The points-of-difference (POD) for each consortia are defined by the groups of salient constructs identified in *Section 4.6 Points of Difference*.

This section provides a comparison between the POD identified in this research and the consortia's objectives obtained from the web pages of the associations, forums and alliances studied.

WiMAX Forum

Table 51: Mapped Objectives for WiMAX Forum

WiMAX Forum POD	WiMAX Forum Objectives
<p>WiMAX Technology and Standards Conformance and Certification Hardware (see Table 34 for details)</p>	<p>“The WiMAX Forum is the worldwide consortium focused on global adoption of WiMAX and chartered to establish certification processes that achieve interoperability, publish technical specifications based on recognized standards, promote the technology and pursue a favourable regulatory environment”²⁵</p>
<p>Discussion:</p> <p>The certification of the hardware products for base stations are intended to validate the cross-vendor interoperability at the lower layers of the communication stack in the wireless network – the access network, and it is based on the IEEE 801.16 standard and WiMAX technology. In summary, the POD are an indication of:</p> <ul style="list-style-type: none"> • <i>Certification for standard compliance and interoperability at the access level of the network</i> <p>Conclusion:</p> <p>There is a good mapping between the points-of-difference identified and the forum’s objectives</p>	

²⁵ <http://www.wimaxforum.org/about/vision-and-mission>, last checked July 14, 2010

GSM Association

Table 52: Mapped Objectives for GSMA

GSMA POD	GSMA Objectives
Interoperability Solutions Fraud Detection Revenue Management Solutions Mobile Services Fee Based Business Solutions (See Table 36 for details)	“The GSMA’s mission is to create value for operators and the mobile industry in the provision of services for the benefit of end users” ²⁶ .
<p>Discussion:</p> <p>The majority of the GSM Association members are mobile operators and this is reflected on the focus on services and applications for end-users. In summary, the POD show that:</p> <ul style="list-style-type: none"> • <i>Interoperability is focused on the reliability of the user information exchanged between the service providers when mobile users roam between different networks</i> • <i>There is a strong focus on operational optimization, mobile applications and services</i> <p>Conclusion:</p> <p>GSMA objectives are vague and general. The identified POD have a definitional role, they provide suggestions for the group’s objectives meaning, and identify how the group brings value to its members.</p>	

²⁶ <http://www.gsmworld.com/about-us/vision.htm>, last checked July 23, 2010

CDMA Development Group

Table 53: Mapped Objectives for CDG

CDG POD	CDG Objectives
Revenue Management Solutions Hardware Business Opportunity Solutions WiMAX Certification CDMA Technology and Standards Fee Based Business Solutions Interoperability Solutions (see Table 38 for more details)	CDG is an “international consortium of companies which jointly define the technical requirements for the evolution of CDMA2000 and complementary 4G systems and interoperability with other emerging wireless technologies to expand the availability of wireless products and services to consumers and businesses worldwide” ²⁷ .
<p>Discussion:</p> <p>The CDMA Development Group was established in 1993 and matches the timeline for the CDMA technologies. The CDMA technology fits between GSM and WiMAX technologies in the timeline of the wireless technologies evolution. This research showed that the newer technologies like WiMAX have a strong focus on the hardware aspect of the technology while the older technologies, like GSM, are more focused on the network operational side. In summary, the POD show that:</p> <ul style="list-style-type: none"> • <i>As a midpoint in the evolution of wireless technologies the members of the CDG indicate a focus on both hardware – more typical of the newer technologies, and the network operations – more typical of the older technologies</i> <p>Conclusion:</p> <p>CDG objectives are vague and general. The identified POD have a definitional role, they provide suggestions for the group’s objectives meaning, and identify how the group brings value to its members.</p>	

²⁷ <http://www.cdg.org/about/index.asp>, last access July 23, 2010

LSTI Forum

Table 54: Mapped Objectives for LSTI Forum

LSTI POD	LSTI Objectives
3GPP Standards and LTE Technology UMTS Research Hardware Conformance and Certification (see Table 44 for more details)	The LSTI Forum objective is to “develop an open industry ecosystem by involving all stakeholder (manufacturers, regulators, operators, research community, application developers) in the process; early cooperation to reduce risks; early proof of concept and interoperability tests of equipment between vendors; support of 3GPP LTE/SAE standardization” ²⁸
<p>Discussion:</p> <p>With no commercial deployment at this time²⁹ the area of focus for the member organizations are in standards, research, and testing. As indicated in Appendix D: Membership Distribution, the LSTI Forum membership is shared with other consortia, more significantly with GSM Association and WiMAX Forum. The mobile services components identified in our results are a measure of the shared membership and it suggests that a large proportion of the participants are incumbents involved in other mobile communication technologies. In summary, the POD show that:</p> <ul style="list-style-type: none"> • <i>The involvement in the newest mobile communication technologies has its strongest constructs in standards, research, development and testing</i> <p>Conclusion:</p> <p>LSTI Forum objectives are vague and general. The identified POD have a definitional role, they provide suggestions for the forum’s objectives meaning, and identify how the forum brings value to its members.</p>	

²⁸ <http://www.lstiforum.org/about/intro.html>, last accessed July 23, 2010

²⁹ July 2010

NGMN Alliance

Table 55: Mapped Objectives for NGMN Alliance

NGMN POD	NGMN Objectives
3GPP Standards and LTE Technology UMTS Research Hardware Mobile Services Testing Solutions (see Table 40 for more details)	“NGMN intends to complement and support the work within standardisation bodies by providing a coherent view of what the operator community is going to require in the decade beyond 2010” ³⁰
<p>Discussion:</p> <p>With no commercial deployment at this time³¹ the area of focus for the member organizations are in standards, research, and testing.</p> <p>As indicated in Appendix D: Membership Distribution, similar to the LSTI Forum, the NGMN Alliance membership is shared with other consortia, more significantly with GSM Association and WiMAX Forum. The mobile services components identified in our results are a measure of the shared membership and it suggests that a large proportion of the participants are incumbents involved in other mobile communication technologies. In summary, the POD show that:</p> <ul style="list-style-type: none"> • <i>The involvement in the newest mobile communication technologies has its strongest constructs in standards, research, development and testing</i> <p>Conclusion:</p> <p>NGMN Alliance objectives are vague and general. The identified POD have a definitional role, they provide suggestions for the alliance’s objectives meaning, and identify how the alliance brings value to its members.</p>	

³⁰ <http://www.ngmn.org/aboutus.html>, last accessed July 12, 2010

³¹ July 2010

CDMA Certification Forum

Table 56: Mapped Objectives for CCF

CCF POD	CCF Objectives
CDMA Standards and Technology Conformance and Certification 3GPP and LTE Technology UMTS Fee Based Business Solutions Research Testing Solutions (see Table 42 for more details)	"CDMA Certification Forum is a partnership between CDMA operators and CDMA device vendors to establish and maintain a core global device certification process that helps improve quality through consistent interoperability, conformance and performance testing across the globe." ³²
<p>Discussion:</p> <p>The CDMA Certification Group was established in 2004, a decade later after the establishment of the CDMA Development Group, in order to establish a global CDMA certification process. The CCF shows strong support for the CDMA Standards and Technology construct and a relative medium support for the Conformance and Certification construct. The relative weak support for a wide range of other constructs, some of them specific to 3GPP technologies, is explained by the shared membership of operators and device manufacturers to other consortia, as shown in Appendix D: Membership Distribution. In summary, the POD show that:</p> <ul style="list-style-type: none"> • <i>The main focus is on standards and certification</i> <p>Conclusion:</p> <p>There is a good mapping between the points-of-difference identified and the forum objectives.</p>	

³² http://www.globalccf.org/about_us.php, last accessed July 12, 2010

UMTS Forum

Table 57: Mapped Objectives for UMTS

UMTS POD	UMTS Objectives
UMTS Licenses and Regulation Research 3GPP Standard and 3G Technologies 3GPP Standard and LTE Technology WiMAX Standard and Technology Interoperability Solutions Mobile Services (see Table 46 for more details)	UMTS Forum objective is to support its members with a range of studies and reports on markets trends, mobile services and applications, key growth markets, and with advice on 3GPP and LTE licensing and regulation, global spectrum arrangements, "LTE ecosystem", and contributions to international standards ³³ .
<p>Discussion:</p> <p>The UMTS technology, also known as Wide Band CDMA (WCDMA), is part of the 3GPP group of standards and it fits chronologically between GSM and LTE, in a span over time of two decades. Some of UMTS Forum members in each of the analyzed groups share their membership with GSM Association, LSTI Forum and NGMN Alliance as indicated in Appendix D: Membership Distribution. This fact could explain in part the wide scope of the constructs identified. In summary, the POD show that:</p> <ul style="list-style-type: none"> • <i>The advisory role of the consortium is suggested by a wide scope of interests in research, standards, mobile services and interoperability</i> <p>Conclusion:</p> <p>UMTS Forum objectives are vague and general. The identified POD have a definitional role, they provide suggestions for the forum's objectives meaning, and identify how the forum brings value to its members.</p>	

³³ <http://www.umts-forum.org/content/view/2002/125/>, last accessed July 9, 2010

Wireless Broadband Alliance

Table 58: Mapped Objectives for WBA

WBA POD	WBA Objectives
Interoperability Solutions Fraud Detection Fee Based Business Solutions (see Table 48 for more details)	WBA objective is to “drive wireless broadband adoption globally by developing common commercial and technical frameworks for interoperability across networks, technologies and devices” ³⁴ .
<p>Discussion:</p> <p>The majority of the WBA members are mobile operators and this fact is reflected on the identified constructs. The alliance is focused on services and applications for end-users. In summary, the POD show that:</p> <ul style="list-style-type: none"> • <i>The interoperability is focused on the reliability of the user information exchanged between the service providers when mobile users roam between different networks</i> <p>Conclusion:</p> <p>The WBA objectives are vague and general. The identified POD have a definitional role, they provide suggestions for the alliance’s objectives meaning, and identify how the alliance brings value to its members.</p>	

³⁴ <http://www.wballiance.net/history.html>, last accessed July 12, 2010

Open Patent Alliance

Table 59: Mapped Objectives for OPA

OPA POD	OPA Objectives
WiMAX Technology and Standards Conformance and Certification Hardware 3GPP Standards and LTE Technology (see Table 50 for more details)	OPA objective is to “foster a global ecosystem that will help ensure the successful and broad adoption of 4G wireless [...] by creating a fair, transparent and balanced IPR licensing structure to accelerate the global adoption of WiMAX, while simultaneously fostering broader choice and lowering costs for WiMAX technology, devices and applications” ³⁵ .
<p>Discussion:</p> <p>The majority of Open Patent Alliance members are shared with WiMAX Forum. This explains the similarity in the identified constructs of the alliance. The alliance objective, to create a licensing IPR structure for WiMAX is not reflected in the identified constructs. In summary, the POD show that:</p> <ul style="list-style-type: none"> • <i>Certification for standard compliance and focus on hardware at the access level of the network</i> <p>Conclusion:</p> <p>There is a poor mapping between the points-of-difference identified and the alliance’s objectives.</p>	

³⁵ <http://openpatentalliance.com/about>, last accessed July 12, 2010

5.2 Legacy and Evolution

The analysis of the members of the wireless industry consortia, as indicated in *Section 5.1 Points of Difference*, shows that based on their establishment date and involvement with the respective technologies a map can be drawn that indicates the consortia's focus at different stages in the evolution of technologies.

Table 60: Legacy and Evolution Constructs

Technology	Standards	Consortia and year of establishment	Constructs
GSM	3GPP	GSM Association (1987)	Operational Optimization Interoperability Solutions Mobile Services (see Table 36)
CDMA	3GPP2	CDMA Development Group (1993) CDMA Certification Forum (2004)	Operational Optimization Cost Reduction for Base Stations Standards Testing Certification (see Table 38 and Table 42)
UMTS	3GPP	UMTS Forum (1996)	Research 3G and 4G Standards Interoperability Solutions Mobile Services Regulation (see Table 46)
WiMAX	IEEE 802.11	WiMAX Forum (2001) Open Patent Alliance (2008)	Standards Interoperability at Device Level Hardware Certification (see Table 34 and Table 50)
LTE	3GPP	NGMN Alliance (2006) LSTI Forum (2007)	Standards Research Test Solutions Hardware Mobile Services (see Table 40 and Table 44)

The identified constructs provide a trajectory from the legacy to newer technologies as indicated in Figure 27. This study shows that legacy technologies are characterized by a focus on optimization, services and cost reduction while the new and developing technologies are focused on standards, research, hardware, and testing. The outlier in this interpretation is the CDMA Certification Forum. The association was established ten years after the introduction of the CDMA technology. As a certification organization the focus on testing and certification at the access level of the network indicates that the access equipment is possibly still under development and has not become a commodity yet.

Figure 27: Legacy and Evolution

5.3 Technology Adoption

The analysis of organizations with multiple memberships in the wireless industry consortia can provide insights into the technology adoption. A chronological view of the wireless industry consortia, technologies and standards is presented in Figure 28.

Figure 28: Chronological View

For organizations that are members of two consortia it can be inferred that the later chronological membership is an indication of adopting the technology that is supported by the later. The following factors were identified as representative for the technologies and standards and are used as proxies for detecting the technology adoption:

- I6: CDMA Technology and 3GPP2 Standards
- I1: WiMAX Technology and IEEE 802.11 Standards
- I7: LTE Technology and 3GPP Standards

The following consortia are used as proxy for the technology and standards they support:

- GSMA: GSM Technology and 3GPP Standards
- CDG: CDMA Technology and 3GPP2 Standards
- UMTS Forum: UMTS Technology and 3GPP Standards
- WiMAX Forum: WiMAX Technology and IEEE 802.11 Standards
- LSTI and NGMN: LTE Technology and 3GPP Standards

The adoption map to CDMA and from CDMA to other technologies, based on *PODI (I6, All, I)* Index identified in Figure 19, is presented in Figure 29:

Figure 29: CDMA Adoption

The adoption map to WiMAX and from WiMAX to other technologies, based on *PODI (I1, All, I)* Index identified in Figure 20, is presented in Figure 30:

Figure 30: WiMAX Adoption

The adoption map to LTE, based on *PODI (I1, All, I)* Index identified in Figure 21, is presented in Figure 31:

Figure 31: LTE Adoption

From the technologies and standards analyzed, CDMA/3GPP2, WiMAX/IEEE and LTE/3GPP, only WiMAX does not show a strong indication of adoption from the legacy standards. This could be an indication that the introduction of WiMAX allowed new comers to enter the market. By comparison, CDMA, even though it is specified by the 3GPP2 standards, indicates strong adoption from 3GPP legacy and to 3GPP evolution standards. This study also found that the evolution of 3GPP standards from legacy technologies, such as GSM and UMTS, to the evolution technology, LTE, is strongly supported.

5.4 The Emerging Role of Backend Systems

One observation is the strong showing of constructs related to service and billing:

- Revenue Management Solutions (Table 21)
- Fee Based Business Solutions (Table 17)
- Mobile Services (Table 15)
- Interoperability Solutions (Table 23)
- Fraud Detection (Table 27)

- Business Opportunity Solutions (Table 28)
- Security Solutions (Table 22)

In the study of the convergence of the mobile ecosystem Basole (2009) highlights the relative central network position of the service and billing providers. The service and billing providers provide software systems necessary for provisioning, billing, and customer service. Basole (2009) arguments that, as technologies, content and offerings converge, the ability to seamlessly provision and price new, bundled service becomes even more important as these backend systems enable network operators, service and content providers to monetize the products and services they offer.

These points explain in part the strength of the service and billing constructs identified in this study.

5.5 Members Motivation for Participation

The participation of the industry stakeholders in standards development activities, technology trials and equipment certification to validate the cross-vendor interoperability of the radio access and core networks is often regarded as an effort to create or further the mobile ecosystem³⁶. The niches created in the industry by associations, forums or alliances take shape under the leadership of these organizations which act as keystones and network hubs. Iansiti and Levien (2004) defines them as active leaders, effective at both creating and sharing value across the system; they are the network hubs that sit

³⁶ [http //www.lstforum.org/media/press.html?lstNum=160](http://www.lstforum.org/media/press.html?lstNum=160), last accessed August 8, 2010

at the core of the collaboration network. These associations, forums and alliances have attracted membership based on several manifest characteristics. A summary of these characteristics based on the results identified in Chapter 5 and the consortia “About Us” web pages is provided in Table 61.

Table 61: Members Motivation for Participation

Consortia	Main Drivers for Participation
WiMAX Forum	<p>The forum is an exclusive WiMAX certification provider:</p> <ul style="list-style-type: none"> • The certification for standard compliance and interoperability at the access level of the network is one of the main reasons for membership
GSM Association	<p>The association is an interoperability enabler:</p> <ul style="list-style-type: none"> • In the absence of industry standards regulating the roaming data exchange between network operators the GSMA working groups have developed the NRTRDE – a method to monitor customer’s activities in the visited networks and quickly detect roaming fraud
LSTI Forum NGMN Alliance	<p>Members and the consortia are setting the LTE/SAE standards:</p> <ul style="list-style-type: none"> • The 3GPP standard and the LTE technology represent one of the strongest constructs found for the LSTI Forum and NGMN Alliance members <p>Members participate in technology trials to test for interoperability:</p> <ul style="list-style-type: none"> • The early stages of interoperability are defined by research and testing as the technology is not mature and stable enough

CDMA Certification Forum	<p>The forum is a certification provider:</p> <ul style="list-style-type: none"> • The certification testing for standard compliance allows for cross-vendor interoperability • By certifying its member's products, the association brings value to its members by guaranteeing the standards compliance and cross-vendor interoperability
UMTS Forum	<p>The forum is a consultancy provider:</p> <ul style="list-style-type: none"> • There is large number of constructs identified for this forum; this is explained in large part by its involvement with both UMTS and LTE technologies; the forum supports the interests of its members through studies and reports on markets, applications, regulation, etc.
CDMA Development Group	<p>As the evolution path of 3GPP2 was dropped in favour of 3GPP the group supports its members with the evolution from CDMA to 4G/3GPP:</p> <ul style="list-style-type: none"> • The majority of its members are operators and this fact is reflected in constructs specific to operators, such as revenue management and business opportunity solutions. • The identification of the Hardware construct could be explained by the new requirements for dual support CDMA/LTE at the base station and user device level
Wireless Broadband Alliance	<p>The association is an interoperability enabler:</p> <ul style="list-style-type: none"> • In the absence of industry standards regulating the roaming data exchange between Wi-Fi network operators the WBA developed the WRIX – a roaming specification for Wi-Fi

Open Patent Alliance	<p>The alliance's goal is to create an IPR licensing structure for WiMAX</p> <ul style="list-style-type: none"> • Most of the members are also members of WiMAX Forum • The constructs identified in this study do not indicate a focus on the IPR licensing
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5.6 Phases of Development

The characteristics identified in Table 61 suggest several phases in the development of consortia, as shown in Table 62.

Table 62: Consortia Phases of Development

Phase	Phase Name	Phase Description
1	Provide a platform for discussion among interested parties	The industry consortia enable the communication among member organizations on how to enter into an agreement to accomplish a common purpose
2	Work with members and standard bodies in setting and implementation of standards	CDMA Certification Forum works with its members to ensure the compliance to 3GPP2 standards. WiMAX Forum works with its members to promote and support the 802.16 standard developed by IEEE. UMTS Forum, LSTI Forum and NGMN Alliance work with their members to ensure that their recommendations are included in the standards by the 3GPP organization

3	Enable the interoperability of members' products	WiMAX Forum enables interoperability at the lower layers of the communication stack (e.g. technology trials for cross-vendor interoperability or certification for industry acceptance). GSM Association show a strong focus on interoperability at higher layers of the communication stack (e.g. methodologies for inter-operator roaming user data exchange)
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This study provided a cross-sectional analysis of consortia that were created at various points in time and suggests that these associations, forums and alliances evolve over time to adapt to the new technologies and business models of their members and cycle through phases 1, 2 and 3 as shown in Figure 32.

Figure 32: Consortia Evolution Cycle

5.7 Insights Gained From Research

The following insights were gained from this research:

I1: Product certification motivates organizations to join industry consortia

There is an identifiable niche for certification for standard compliance at the access level of the network as indicated by the “Conformance and Certification” construct in Table 30. WiMAX Forum has become de facto the exclusive certification organization for base stations and user equipment for compliance to the WiMAX standard³⁷. Members use “WiMAX Forum Certified” logo on their websites as a mark of compliance.

I2: Interoperability of their products motivates organizations to join industry consortia

The conformance certification of products at the access level of the wireless network is based on the standards developed by 3GPP, 3GPP2 and IEEE standard organizations and represents a mandatory requirement for cross-vendor interoperability. With the advance of global mobility the network operators have new requirements for roaming, user data exchange and fraud detection. These characteristics were identified by the “Interoperability Solutions” construct as shown in Table 23. In the absence of standards provided by the standard organizations, consortia such as GSM Association and

³⁷ <http://www.wimaxforum.org/certification/certification-overview>, last accessed July 30, 2010

Broadband Wireless Alliance have stepped in and provided platforms for interoperability such as NRTRDE³⁸ or WRIX³⁹.

I3: As technology matures the new interoperability requirements move up in the network stack

If the layered model proposed by Fransman (2002) (see *Section 2.1.3 The layered model*) is used as a backdrop for mapping the salient constructs of interoperability identified by insights I1 and I2, then it can be suggested that as the technology evolves and matures, the new requirements for product interoperability move up to the next layer in the wireless communication network stack.

I4: Organizations involved in legacy technologies are characterized by a focus on optimization, services and cost reduction; organizations involved in the new and developing technologies are focused on standards, research, hardware, and testing

The most active organizations involved in the new and developing technologies are the infrastructure providers and the device manufacturers. In time, as the technology evolves, there is a drive for cost reduction for infrastructure equipment and devices as indicated by the identified constructs in Table 60 and Figure 27. As technologies, content, and offerings converge (Basole, 2009) the ability to provide new, bundled services becomes more important.

³⁸ <http://www.gsmworld.com/newsroom/press-releases/2069.htm>, last accessed July 30, 2010

³⁹ <http://www.wballiance.net/index.html>, last accessed July 30, 2010

I5: Service and billing providers form a critical segment in the wireless industry

Traditionally, the infrastructure providers, device manufacturers, network operators, application developers and content providers were regarded as the main players in the industry. Some of the salient constructs, identified and summarized in *Section 5.4 The Emerging Role of Backend Systems*, confirm the observations in Basole (2009) that the service and billing providers occupy a central position and play a critical role in the mobile ecosystem. These backend systems enable operators to provision and price new, bundled services and products.

I6: The membership to wireless industry consortia provides an indication of technology adoption

Based on the chronological comparison between the consortia's establishment date and the technologies they support it can be inferred that membership to more than one association, forum or alliance can be used as an indicator for the adoption of the technology supported by the later membership (see *Section 5.3 Technology Adoption*).

I7: The hierarchical decomposition dissimilarity index is an indicator for factor analysis solutions

As indicated in Table 7, the initial exploratory sub-sampling resulted in eight sample groups (A, B, C, D, E, F, G, and H). The factor analysis results were retained only for groups E, F, G, and H, as these groups provided more relevant

solutions. One observation is that the retained groups are characterized by small values of the dissimilarity index. Although the intent was to create sub-samples with higher degrees of similarity this observation is no hard-set rule and more research is needed to validate this observation.

I8: Non random sampling is recommended for content analysis

The results in this study show that the content analysis using factor reduction depends significantly on the sample. This reinforces the recommendations from Eisenhardt (1989, 2007) and Patton (1990) which highlight the inappropriateness of random sampling. This approach is particularly relevant in this study as its goal was to uncover as many and diverse constructs as possible and this was possible by creating sub-samples with higher similarity.

Summary

The results of this research identified the following points of difference for the associations, forums and alliances in the consortia studied:

- Supporters of legacy technologies are characterized by a focus on optimization, services and cost reduction. This is the case for GSM Association, CDMA Development Group and in part UMTS Forum.
- Supporters of newer technologies are characterized by a focus on standards, research, hardware, and testing. This is the case for WiMAX Forum, NGMN Alliance, LSTI Forum, and in part UMTS Forum.
- Member's motivation to participate is driven by two constructs: certification and interoperability. WiMAX Forum, CDMA Certification Forum and Open

Patent Alliance are more active in certification. The interoperability is a focus area for GSM Association, CDMA Development Group, Wireless Broadband Alliance, and LSTI Forum.

- Multiple memberships combined with technology focus provide an indication of technology adoption:
 - CDMA technology supporters also support GSM, UMTS, WiMAX and LTE technologies
 - LTE technology supporters also support GSM, CDMA, UMTS and WiMAX technologies
 - WiMAX technology supporters support LTE technology only, which suggests a large number of new market entrants

5.8 Recommendations for Keystone Organizations

Based on the research insights (see *Section 5.7 Insights Gained From Research*) and the identified constructs for the wireless industry consortia (see *Section 4.5 Constructs*) the following recommendations can be inferred for non-profit organizations that play a keystone role:

Table 63: Recommendations for Keystone Organizations

1	Get involved in the early stages of technology	<ul style="list-style-type: none"> • Attract members by supporting their recommendations to the standards bodies • Work with members and standards bodies in setting and implementation of standards
2	Act as an enabler of	<ul style="list-style-type: none"> • Provide a solutions for member's cross-

	interoperability for members products and services	<p>vendor interoperability needs such as certification services (see <i>Section 5.7, I1</i>)</p> <ul style="list-style-type: none"> • Provide platforms of interoperability if no standards are available (e.g. NRTRDE and WRIX roaming platforms identified in <i>Section 5.7, I2</i>)
3	Prepare to move up the interoperability stack as technology matures	<ul style="list-style-type: none"> • As the technology matures a keystone should prepare the ground for the next interoperability needs (e.g. WiMAX Forum, which is focused on certification, launched its roaming guidelines and specifications under a new brand name, WiMAX Roaming, and a new website⁴⁰)
4	Identify the most active members at each stage in the technology evolution and support their interests	<ul style="list-style-type: none"> • In the early stages of a technology the most active members are the infrastructure equipment providers and device manufacturers. Later on, as the network operators and service providers become the most active members they depend more and more on the service and billing providers (see <i>Section 5.7, I5</i>)

⁴⁰ <http://www.wimaxroaming.org/>, last accessed August 12, 2010

6. Conclusions

This chapter is organized into three sections. The first section provides the conclusions of this research. The second section provides the limitations of this research. The third section provides opportunities for future research.

6.1 Conclusions

The objective of this research was to examine the points of difference for members of associations, forums or alliances operating in the wireless industry. An organization's membership to an association, forum or alliance was used to classify the organization as a stakeholder in the standard and technologies supported by the consortium the organization is a member of. The introduction of the POD Index, as an instrument of comparison for consortia, allowed for the identification of differences amongst the associations, forums and alliances. This approach was validated by the fact that the relatively high value for the POD Index for standards and technologies constructs identified for a consortium matches the standard and technology openly supported by that consortium, as shown by *Consortia Brand Names* construct.

The *points-of-difference* (POD) - defined as groups of constructs – was used to create a mapping of consortia's objectives to constructs identified from consortia's members. The mapping of the 9 associations, forums and alliances resulted in three types of links between constructs and objectives:

1. *Strong support*: there is a good mapping between the points-of-difference identified and the consortia's objective for WiMAX Forum, and CDMA Certification Forum.
2. *Definitional role*: the identified POD provide suggestions for what the consortia's objective means, and identify how the consortia brings value to its members. This is characteristic for consortia with vague and general objectives as shown in the case of: GSM Association, CDMA Development Group, UMTS Forum, LSTI Forum, NGMN Alliance, and Wireless Broadband Alliance.
3. *Weak support*: There is a poor mapping between the points-of-difference identified and the consortia's objective for Open Patent Alliance.

Another contribution made by this research was in identifying an opportunity on how to enhance the use of factor analysis from a technique of dimension reduction to a methodology of searching for construct diversity. In the research process the following methodology steps were identified:

1. *A priori classification*: the initial classification of organizations, based on the memberships to wireless industry consortia, helped identify which organizations support what standards and technologies. This a priori classification allows for constructs comparison between consortia.
2. *Sub-sampling*: using hierarchical decomposition, several homogenous sub-samples were identified. The non-probability sampling methodology created more similar samples on which factor analysis identified factors that would not be found otherwise in a random sample.

3. *Constructs identification*: similar factors from the sub-samples are grouped together to define a construct.
4. *Points of difference*: the salient constructs indicate the relative importance of a construct for a consortium and are used for comparisons to other consortia.

The techniques for analyzing the industries and competitors proposed by Porter (2004) provide a view from an organization's level. By comparison, this research provides an analysis of an industry by comparing the differentiating points of its consortia.

To the best of my knowledge, this is the first study that uses this methodology. The use of sub-samples created using hierarchical decomposition and multiple factor analysis provides an approach that allows the identification of as many and diverse factors as possible. The non probability sampling approach is instrumental in the mapping of the wireless industry consortia.

A key finding made by this research was the identification of constructs that are specific to legacy or newer technologies. Based on consortia's establishment date and involvement with the respective technologies it was identified that:

1. *Legacy technologies (GSM, CDMA)*: are characterized by constructs indicating a focus on optimization, services and cost reduction
2. *Evolution technologies (WiMAX, LTE)*: are characterized by constructs indicating a focus on standards, research, hardware and testing

The results from the analysis of the organizations with multiple membership to consortia helped in identifying the trajectories of technological adoption. From the technologies and standards analyzed, CDMA/3GPP2, WiMAX/IEEE and LTE/3GPP, only WiMAX does not show a strong indication of adoption from the legacy standards. This could be an indication that the introduction of WiMAX allowed more new comers to enter the market. By comparison, CDMA, even though it is specified by the 3GPP2 standards, indicates strong adoption to 3GPP evolution standards, and thus supports the idea of LTE as the convergence technology (Saini, 2009).

Another key finding is that membership to consortia is driven by two main goals: certification and interoperability. Consortia's keystone organizations step in to provide platforms for interoperability in the absence of standards.

6.2 Limitations

The research has at least three limitations:

- In general factor analysis requires that researchers have a good knowledge of the domain. A deep understanding of the wireless industry was required to conduct this research and as a result measuring the consistency is difficult.
- Factor analysis is a relatively subjective and especially so when used in conjunction with content analysis. The solutions identified in this research are based on my interpretation of the keywords and their meaning when grouped together and represent no hard-set rule for meaning.

- The points-of-difference approach used in this research uses only those constructs that are significantly stronger, at the expense of the rest.

6.3 Future Research

This research identifies four opportunities for future research:

- Measure the competition between ecosystems by identifying and comparing their differentiating points using the methodology provided in this research.
- The results from this research can be enhanced by identifying each organization type (network operator, infrastructure provider, device manufacturer, application provider, content provider, service provider, etc.). This additional information could shed more light into to which organizations are the first technology adopters and whether the salient constructs identified are more prevalent to certain types of organizations.
- Identify which organizations have multiple memberships and what is their motivation. Are the multiple memberships specific to certain types of companies?
- Enhance to mapping methodology and possibly automate it. This would allow periodic evaluations of the industry over time and shed more light into technology adoption and how the identified constructs evolve.

7. References

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7.1 Web Based Sources

Keyword Search and Analysis Tool (KSAT): <http://github.com/mwnorman/KSAT>

SPSS Statistics: <http://www.spss.com/>

CDMA Certification Forum: <http://www.globalccf.org>

CDMA Development Group: <http://www.cdg.org>

GSM Association: <http://www.gsmworld.com>

LSTI Forum: <http://www.lstiforum.org>

Next Generation Mobile Networks Alliance: <http://www.ngmn.org>

Open Patent Alliance: <http://openpatentalliance.com>

Pajek: <http://pajek.imfm.si/doku.php>

UMTS Forum: <http://www.ums-forum.org>

WiMAX Forum: <http://www.wimaxforum.org>

Wireless Broadband Alliance: <http://www.wballiance.net>

8. Appendix

Appendix A: URLs, Samples and Membership

URL	X	Y	A
http://accuris-networks.com/	1	1	1
http://authentec.com/	1	2	1
http://www.axxcelera.com/	2	1	2
http://cellatsea.com	1	2	5
http://colibria.com/	1	1	1
http://en.biigroup.com/	3	3	2
http://en.enforta.ru/	3	2	2
http://global.mitsubishielectric.com/	1	1	2
http://mobicity.ca/	3	3	1
http://openpatentalliance.com/	3	2	9
http://panasonic.net/	2	2	2
http://redknee.com/	3	2	1
http://roamsys.com	2	3	1
http://tatacommunications.com/	2	1	1
http://us.fujitsu.com/	1	1	2
http://us.zyxel.com/	1	1	2
http://w3.tue.nl	3	2	4
http://wateentel.com/	3	4	2
http://ww2.cox.com/	3	2	5
http://www.2degreesmobile.co.nz	2	3	1
http://www.7layers.com/	1	1	2
http://www.aa-tec.com	3	4	1
http://www.accenture.com/	1	1	2
http://www.accuris-networks.com/	1	1	52
http://www.acer.com/	1	2	92
http://www.acision.com/	3	2	1
http://www.acmepacket.com/	3	2	1
http://www.actix.com/	1	2	4
http://www.adaptivemobile.com/	1	3	1
http://www.adecef.com/	3	2	1
http://www.adt.com.tw/	2	2	2
http://www.advantest.co.jp/	3	4	2
http://www.aeroflex.com/	3	1	62
http://www.aeronix.com/	2	2	2
http://www.aervox.com/	2	3	1
http://www.afdtech.com/	2	3	1
http://www.agilent.com/	1	1	3
http://www.aqilisinternational.com/	3	3	1
http://www.ahciet.net	1	2	5
http://www.aheadcommunication.com	3	3	2

URL	X	Y	A
http://www.aicent.net/	2	1	52
http://www.aircell.com/	1	1	5
http://www.aircominternational.com/	2	1	4
http://www.airvana.com/	3	1	5
http://www.airwalkcom.com/	3	2	5
http://www.airwidesolutions.com	2	1	1
http://www.aksoran.kz	4	4	2
http://www.alaska-wireless.com/	3	4	1
http://www.albentia.com/	3	3	2
http://www.alcatel-lucent.com	2	1	564 23
http://www.alegro.com.ec	4	4	5
http://www.alepo.com/	2	1	2
http://www.alianza.com/	2	3	2
http://www.allround.net	2	2	1
http://www.alltel.com	3	3	1
http://www.altair-semi.com/	3	2	2
http://www.altobridge.com	3	3	1
http://www.alvarion.com/	3	3	92
http://www.amdocs.com/	1	1	2
http://www.amdtelecom.net/	3	3	1
http://www.americanroamer.com	3	3	2
http://www.amerilinkwireless.com/	3	3	1
http://www.anacom.pt	3	2	7
http://www.animatele.com/	4	4	1
http://www.anite.com/	2	1	2
http://www.anydata.com/	2	3	56
http://www.apacewave.com/	3	2	2
http://www.aptilo.com/	1	3	2
http://www.arabtel.net/	4	4	2
http://www.aradial.com/	3	3	2
http://www.arbinet.com	3	4	1
http://www.arcadyan.com/	4	4	2
http://www.archclearing.com	4	4	1
http://www.aristaenterprise.com	3	3	6
http://www.argiva.com/	1	2	2
http://www.arraycomm.com/	2	1	2
http://www.aselsan.com.tr/	2	2	2
http://www.astac.net/	3	3	1
http://www.astellia.com/	2	3	1
http://www.astri.org/	2	2	2
http://www.at4wireless.com/	1	2	2

URL	X	Y	A
http //www atdi com/	4	4	2
http //www atheeb com/	2	3	2
http //www att com/	2	2	42
http //www augereholdings com	3	3	2
http //www avea com tr/	3	4	7
http //www awardsolutions com/	3	2	2
http //www awbnetworks com/	3	3	2
http //www axesstel com/	3	2	56
http //www axisnt com/	3	2	2
http //www aylus com	3	2	1
http //www azimuthsystems com/	3	2	3
http //www babilon-t tj/	4	0	2
http //www baknetelecom com/	3	4	5
http //www basetlabs com	3	3	1
http //www batelco com/	3	4	7
http //www bayan com ph/	3	4	5
http //www beceem com/	4	2	92
http //www belgacom-ics com/	3	2	1
http //www belizetelemedia net/	2	3	5
http //www bell ca	2	2	421
http //www bellmobility ca	2	1	5
http //www bendbroadband com	1	2	1
http //www bharti com/	2	3	2
http //www billing ru	3	3	1
http //www bksv com/	2	1	6
http //www bridgewatersystems c om/	3	1	1
http //www broadcom com/	3	1	1
http //www broadhop com/	2	2	2
http //www broadpointinc com	3	3	1
http //www bsnl co in/	2	2	2
http //www bt com	3	2	2
http //www btc bw/	2	2	2
http //www btopenzone com/	3	3	8
http //www caci com	3	3	2
http //www calcomp com tw	4	4	6
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http //www cardboardfish com/	3	3	1
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http //www cbnl com/	3	2	4
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http //www cellc co za	1	3	1
http //www cellcom com/	1	1	5
http //www celloneet com/	2	1	1
http //www cellonenation com/	2	1	1

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http //www cellularone bm/	2	3	5
http //www cellularoneonline com /	2	3	1
http //www cellularone-slo com/	3	4	1
http //www celplan com/	1	2	2
http //www centennialpr com/	1	1	5
http //www ceraku com	4	4	5
http //www cerillion com/	1	1	1
http //www cetecomusa com/	2	2	2
http //www cewit org in	1	2	2
http //www cgctw com	4	3	6
http //www cherrypiq com	3	2	2
http //www chinamobile com/en/	1	1	43
http //www chinatelecom com cn/	4	4	52
http //www chinaunicom com/	2	3	2
http //www chinawill com	4	4	6
http //www cht com tw/	1	2	2
http //www chuanwei com kh/	2	2	2
http //www cieluxtelecom com/	3	4	2
http //www ciena com/	2	1	2
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http //www cinterion com	3	2	1
http //www cisco com/	1	1	923
http //www citic1616 com	2	3	51
http //www citycell com/	2	3	5
http //www clearwire com/	1	1	92
http //www clickatell com/	2	1	1
http //www cloudmark com	1	2	1
http //www cmotech com/	3	3	2
http //www coai com	2	1	7
http //www comarch com/	1	1	1
http //www comarco com/	2	3	2
http //www comcast com	1	1	2
http //www comfone com/	1	2	1
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http //www comreg ie/	1	2	7
http //www comsourceinc net/	4	2	1
http //www comstar ru/	1	2	2
http //www comsysmobile com/	1	1	2
http //www comtec eecs uni- kassel de/	1	2	4
http //www comunicazioni it	3	3	7
http //www comverse com/	1	1	7
http //www comviva com/	1	1	1

URL	X	Y	A
http://www.connections-services.com	3	3	8
http://www.convergys.com/	1	1	1
http://www.coresonic.com/	1	2	23
http://www.cornwireless.com/	3	3	1
http://www.cosmote.gr	1	1	7
http://www.cpqd.com.br/	2	1	2
http://www.cradlepoint.com	1	1	2
http://www.creospan.com/	1	2	2
http://www.crestel.in/	1	1	2
http://www.crosstel.net/	3	4	1
http://www.ctc-q.co.jp/	1	2	2
http://www.ctia.org/	1	1	56
http://www.cvalley.com/	4	4	1
http://www.cvalley.net/	3	3	1
http://www.cvidya.com	1	2	1
http://www.cyberplat.com/	2	2	1
http://www.datang.com/	1	2	1
http://www.datangmobile.cn/	2	2	4
http://www.dell.com/	1	1	2
http://www.designartnetworks.com/	2	1	2
http://www.deutsche-telekom.com	1	2	82
http://www.diffon.com	0	4	2
http://www.digicelgroup.com/	1	2	52
http://www.digitalbridgecommunications.com/	3	2	2
http://www.dlink.com/	1	1	2
http://www.dmts.biz/	2	2	1
http://www.docom9cific.com/	2	1	5
http://www.dspr.co.jp/	3	2	2
http://www.dtcwireless.com/	2	3	1
http://www.du.ae	1	3	8
http://www.eads.com/	1	1	2
http://www.eastcompeace.com/	2	2	1
http://www.ecitele.com/	1	1	2
http://www.ecrio.com/	1	1	1
http://www.edch.com/	3	3	1
http://www.ee.sgs.com	1	1	6
http://www.einsteinwireless.net/	2	3	1
http://www.eionwireless.com/	1	1	2
http://www.eircom.ie/	1	2	2
http://www.elektrobit.com/	1	1	3
http://www.elisa.fi	1	2	7
http://www.elsagdatamat.com/	2	1	1
http://www.eltekvalere.com	1	2	1
http://www.emerytelcom.com/	4	4	1
http://www.emobile.jp/en/	3	2	3
http://www.epitiro.com/	1	1	2
http://www.epivalley.com	4	4	62

URL	X	Y	A
http://www.equinix.com/	1	1	1
http://www.ericsson.com/	2	1	27
http://www.eservglobal.com/	1	1	1
http://www.etisalat.ae/	1	1	7
http://www.etisalat.com.ng	1	3	1
http://www.etiworld.com/	1	2	2
http://www.etri.re.kr/	1	2	2
http://www.ets-lindgren.com/	1	1	2
http://www.eu-anritsu.com/	1	1	42
http://www.eurescom.de/	2	1	7
http://www.eutelsat.com/	1	1	2
http://www.eyeline.mobi/	1	1	1
http://www.ezetop.com/	2	2	1
http://www.fbi.gov	1	2	2
http://www.ficora.fi	1	2	7
http://www.fido.ca/	2	2	1
http://www.flextronics.com/	1	1	1
http://www.fon.com	2	2	8
http://www.forsk.com/	1	2	2
http://www.francetelecom.com/	1	1	7
http://www.freedom4wifi.com	2	2	8
http://www.freescale.com/	1	1	3
http://www.freewirebroadband.com/	3	2	2
http://www.fujikura.co.jp/	1	1	2
http://www.fujitsu.com	1	1	43
http://www.funaiworld.com/	2	3	2
http://www.futurecard.ae/	4	4	1
http://www.g3ti.net	3	2	1
http://www.gatewaycomms.com/	1	1	1
http://www.gci.com/	2	1	51
http://www.gctsemi.com/	2	1	92
http://www.gds.com.lb/	2	3	2
http://www.gemalto.com/	2	1	1
http://www.gemtek-systems.com/	4	2	2
http://www.gencat.cat/	2	4	2
http://www.qfivemobile.com	3	1	1
http://www.qi-de.com/	1	2	1
http://www.qigafone.com/	3	3	1
http://www.qigaset.com/	2	2	2
http://www.global6.org	2	2	6
http://www.globaldenso.com/en/	2	2	2
http://www.globalservices.bt.com	1	2	1
http://www.globitel.com/	1	3	1
http://www.gloworld.com/	2	3	1
http://www.qmsu.ua/	3	1	1
http://www.gni.ch/	3	2	1
http://www.goldenwest.com/	2	2	1
http://www.google.com/	3	2	2
http://www.qorilla.com.tw/	2	2	2

URL	X	Y	A
http://www.gotransverse.com/	2	2	1
http://www.gppm.de	2	3	7
http://www.greenflyamerica.com/	3	1	1
http://www.greenpacket.com	1	2	2
http://www.grid-net.com/	3	1	2
http://www.gtlimited.com/	1	3	2
http://www.guzik.com/	3	4	2
http://www.gvsystem.com	4	4	2
http://www.haiertele.com/	3	1	6
http://www.harris.com/	2	1	2
http://www.harrisstratex.com/	2	2	2
http://www.hclinfinet.com/	2	3	2
http://www.hfclconnect.com/	1	1	2
http://www.hitachi.com/	1	3	42
http://www.hitachi-cta.com/	1	1	5
http://www.hkcs.com	1	3	8
http://www.hotspot.ne.jp	3	2	8
http://www.htc.com	2	1	52
http://www.huawei.com/	1	3	567
http://www.hutch.co.th	3	2	5
http://www.iac.com.tw/	1	1	2
http://www.ibasis.com/	1	1	1
http://www.icerasemi.com/	1	3	41
http://www.icewireless.ca/	3	2	1
http://www.idatech.com/	2	1	1
http://www.ideacellular.com/	1	2	2
http://www.idt.net/	2	2	2
http://www.iii.org.tw/	2	1	2
http://www.immix.com/	3	1	1
http://www.indosat.com/	2	3	52
http://www.indosatm2.com	3	1	82
http://www.industrie.gouv.fr/	1	3	7
http://www.infobip.com	3	3	51
http://www.infobrain.com/	3	2	1
http://www.infodirections.com/	1	4	1
http://www.infomark.co.kr/	4	1	2
http://www.informatm.com/	1	1	2
http://www.inn9th.com/	2	3	21
http://www.innowireless.co.kr/	4	2	2
http://www.in-spirit.com/	2	1	2
http://www.intecbilling.com/	1	1	1
http://www.intel.com/	1	4	921
http://www.interbro.net/	0	1	2
http://www.interdigital.com/	2	1	1
http://www.interoptechnologies.com	1	1	5
http://www.interoptechnologies.com/en/	1	2	1
http://www.intertek-etisemko.com	1	1	6
http://www.intracom-telecom.com	1	1	2

URL	X	Y	A
http://www.ipass.com	2	1	82
http://www.ipaxiom.com/	2	1	2
http://www.ipcomsa.com	3	1	5
http://www.ipfabrics.com/	1	2	2
http://www.irishbroadband.ie/	1	2	2
http://www.iriswireless.com/	2	2	1
http://www.isb.co.jp/	1	1	2
http://www.iskrate.com/	1	4	2
http://www.itisaluna.com/	3	1	5
http://www.itri.org.tw	1	2	2
http://www.its.ws/	2	2	21
http://www.iwireless.com/	2	1	1
http://www.jasperwireless.com/	1	1	1
http://www.jdsu.com	1	1	1
http://www.jhuapl.edu/	1	1	2
http://www.jinnysoftware.com/	1	2	1
http://www.jrc.co.jp/eng/	2	2	2
http://www.juniglobal.com/	2	2	2
http://www.juniper.net/	2	1	42
http://www.kabira.com/	1	1	1
http://www.kddi.com/	1	4	524
http://www.keithley.com/	4	1	2
http://www.keynote-sigos.com/	1	1	1
http://www.kineto.com/	1	1	1
http://www.kke.co.jp/	3	3	2
http://www.koc.net/	2	1	2
http://www.kpn.com/	1	4	4
http://www.kt.com/	3	1	482
http://www.kyocera-wireless.com/	1	2	56
http://www.l2one.com	3	4	1
http://www.laotel.com	4	4	5
http://www.laser.ir/	4	1	2
http://www.leapwireless.com/	3	3	5
http://www.lenovo.com/us/en/	2	2	2
http://www.lge.com	1	4	564 21
http://www.lgtelecom.com/	4	3	53
http://www.lmt.lv	3	1	7
http://www.lntinfotech.com/	1	2	2
http://www.longlines.com/	2	2	1
http://www.look.ca/	1	2	2
http://www.3	2	4	3
http://www.m800400.com/	3	1	1
http://www.mach.com/	2	3	582 1
http://www.mainstreetbb.com	1	1	2
http://www.martin-group.com/	1	1	1
http://www.marvell.com/	1	1	2
http://www.maxis.com.my	1	2	82

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http //www mblox com/	1	1	1
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http //www meucci-solutions com/	3	3	1
http //www mfone com kh/	2	1	5
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http //www mindspeed com/	1	1	2
http //www mindtree com	1	3	2
http //www minowireless com	3	4	1
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http //www mitre org/	1	3	2
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http //www mobileaccess com/	1	2	2
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http //www mobilemetrics net/	3	3	2
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http //www mobikom at/	1	3	7
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http //www mobitv com/	1	3	2
http //www modacom co kr/	3	2	2
http //www monitisegroup com/	1	2	1
http //www mosaictelecom com/	2	1	1
http //www motorola com	1	2	562
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http //www mtasolutions com	2	1	1
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http //www murata com/	1	1	2
http //www mymotorola co kr/	3	4	3
http //www myungmin com	3	4	2

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http //www nec com/	1	1	47
http //www neotel co za/	2	1	2
http //www nep net	2	2	1
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http //www nethawk fi/	1	1	2
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http //www neustar biz/	1	1	1
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http //www openrangecomm com /	3	1	2
http //www openwave com	1	1	1
http //www optel-informatik de/	3	3	1
http //www option com/	1	1	1
http //www optus com au	1	1	1
http //www orange com	1	1	1
http //www orange-wifi com	3	3	8
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http //www palm com	1	1	56
http //www panasonic net/	1	1	3
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http //www pccw com	1	1	582
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http //www picochip com/	2	1	2

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http //www pocket com/	2	1	5
http //www pointredtech com	3	1	2
http //www polystar com/	1	1	1
http //www posdata co kr/eng/	2	3	2
http //www powerwave com/	2	1	42
http //www prisma-eng com/	1	1	1
http //www proximetry com/	2	1	2
http //www proximiti com/	2	3	1
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http //www pticom com/	1	1	5
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http //www radwin com/	2	2	1
http //www rcom co in	1	1	2
http //www reach com	1	2	6
http //www reálnetworks com/	1	1	1
http //www redlinecommunication s com/	2	1	1
http //www redpinesignals com/	2	1	2
http //www redplc com/	1	2	2
http //www reliancecommunication s co in/	1	1	1
http //www reverbnetworks com/	2	2	2
http //www rim com/	1	1	42
http //www rincon com/	3	3	425
http //www ring hr	3	3	61
http //www rivada com	1	1	2
http //www roamware com/	1	1	1
http //www rogers com	2	2	5
http //www rohde-schwarz com/	1	1	1
http //www romtelecom ro/	1	1	426
http //www rsystems com/	1	2	3
http //www runcom com/	1	1	5
http //www sagem com/	1	2	2

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http //www sagemwireless com	3	3	1
http //www saitechnology com/	2	2	2
http //www samsung com	1	2	429
http //www samsungindiasoft co m/	3	2	1
http //www samsungtelecom com /	2	1	56
http //www sandvine com/	1	1	3
http //www sanjole com/	3	2	2
http //www sasktel com/	1	1	1
http //www satimo com/	3	3	2
http //www scarlet an/	2	3	2
http //www scarlet nl/	3	3	2
http //www sei co jp/	3	2	2
http //www selex-comms com/	1	1	2
http //www seowonintech co kr/	3	3	2
http //www sequans com/	2	1	29
http //www setar aw/	3	3	5
http //www setcom eu/	3	1	63
http //www sfone com vn	3	3	5
http //www sfr com	3	1	3
http //www sharp co jp/	2	2	2
http //www sharp co uk/	2	2	7
http //www siaemic it/	2	2	2
http //www sicap com/	1	2	1
http //www sierrawireless com/	2	1	562
http //www sifycorp com/	1	1	2
http //www signalion com/	2	1	3
http //www sim com	1	2	5
http //www simmetrypcs com/	1	1	1
http //www sirim-qas com my	2	2	2
http //www sktelecom com/	1	1	542
http //www skycross com	2	1	3
http //www skynetwork lk/	3	2	2
http //www skype com/	2	2	2
http //www skytel mn/	4	4	5
http //www skyterra com/	1	1	5
http //www slb com/	1	1	2
http //www smart-bz com/	3	3	5
http //www smartcall us/	3	3	1
http //www smarttrust com/	1	2	1
http //www smilecoms com/	2	3	2
http //www smithmicro com	1	1	21
http //www snet co kr	4	4	2
http //www somanetworks com/	1	1	2
http //www sonusnet com/	1	1	1
http //www sony com/	3	2	52

URL	X	Y	A
http //www sonyericsson com	1	2	41
http //www spacetime-eng com/	3	3	2
http //www sp-ausnet com au/	1	2	2
http //www spb com	2	1	1
http //www spectec com tw/	2	3	2
http //www spiceglobal com	2	1	51
http //www spidercloud com/	3	1	1
http //www spirent com/	2	1	56
http //www sprint com/	2	1	562
http //www st co kr/	1	1	2
http //www starcomms com/	3	3	5
http //www starentnetworks com	1	1	452
http //www starhome com/	1	1	3
http //www starhub com	1	1	51
http //www starsolutions com/	1	1	8
http //www stc com sa/	3	2	5
http //www stericsson com	1	1	2
http //www subexworld com/	2	2	43
http //www suntecgroup com/	2	2	1
http //www swiftng com/	2	2	1
http //www swisscom ch	3	3	2
http //www sybase com/mobilese rvices	2	2	8
http //www sychip com/	3	2	1
http //www symsoft com/	1	2	2
http //www syniverse com	1	1	1
http //www t ht hr/eng/	2	1	582
http //www taisys com/	1	2	7
http //www tatacommunications c om	3	2	1
http //www tataelxsi com/	2	1	2
http //www tataindicom com/	1	1	2
http //www tatung com/	2	1	56
http //www tcs com/	2	3	2
http //www tdf fr/	1	1	2
http //www tec gov in	1	1	2
http //www techmahindra com/	1	1	2
http //www tecnotree com	2	1	2
http //www tecomproduct com/	1	1	1
http //www tecore com/	1	1	2
http //www teiath gr/	3	1	1
http //www tek com/	2	2	2
http //www tekelec com/	1	1	3
http //www tektronix com/	1	1	1
http //www telcordia com/	3	4	2
http //www telec or jp/	3	1	421
http //www telecom co nz	3	2	2
http //www telecom na/	2	1	1
http //www telecom sitronics com	1	3	5
http //www telecom sitronics com	1	1	1

URL	X	Y	A
http //www telecomitalia com	1	2	423
http //www telecomsys com/	1	1	521
http //www teleepoch com/	3	3	6
http //www telefonica com	3	3	6
http //www telefonica- wholesale com/	1	1	43
http //www telekom com	1	1	1
http //www telenor com	1	2	482
http //www telenor com pk/	1	1	1
http //www telepin com/	1	2	1
http //www telespree com/	1	1	1
http //www telesur sr/	1	2	5
http //www teliasonera com/	2	2	5
http //www telit com/	1	1	4
http //www telkom co id/	1	1	1
http //www telkomsel com/	1	1	52
http //www tellabs com/	2	1	7
http //www telmex com	1	1	4
http //www telnamobile com/	1	2	8
http //www telsasrl it/	3	4	1
http //www telsis com/	3	3	2
http //www telstra com au	1	1	1
http //www teltronic es/	1	1	1
http //www telus com/	3	1	2
http //www telusmobility com	1	1	421
http //www terrestar com/	2	1	56
http //www testquest com/	1	1	1
http //www tfl com fj/	1	2	6
http //www thecablesshoppe com/	1	1	5
http //www three com au/	3	4	2
http //www timewarnercable com/	2	3	1
http //www ti-sparkle it/	2	2	2
http //www tmng com/	1	1	1
http //www t-mobile com/	1	2	1
http //www tno nl/	1	1	3
http //www tnsi com/	1	2	7
http //www tnzi com/	1	1	51
http //www tomizone com/	1	2	1
http //www torresnetworks com/	3	2	8
http //www toshiba com/	2	1	2
http //www towerstream com/	1	1	2
http //www tradevan com tw/	1	2	2
http //www trda-inc com/	3	2	2
http //www triatel lv/	2	2	2
http //www triquint com/	2	3	5
http //www tropos com/	1	1	2
http //www truewifi net	2	1	2
http //www trustvesta com/	3	3	8
http //www tstt co tt/	1	2	1
http //www tta or kr	1	1	5
http //www tta or kr	1	1	62

URL	X	Y	A
http://www.ttc.org.tw/	3	1	2
http://www.turboconcept.com/	3	2	2
http://www.turkcell.com.tr/	1	1	3
http://www.turktelekom.com.tr/	1	2	2
http://www.turner.com/	2	4	2
http://www.tycoelectronics.com/	3	2	2
http://www.tyntec.com/	1	1	1
http://www.ubeeinteractive.com/	2	1	2
http://www.ubidyne.com/	1	1	4
http://www.ubiquam.com/	3	4	62
http://www.ubiquisys.com/	1	2	1
http://www.ufone.com/	2	3	1
http://www.uk.sqs.com/	1	2	2
http://www.unic rhw-aachen.de/	1	2	4
http://www.7	1	1	7
http://www.unicel.com/	2	2	1
http://www.unionwireless.com/	3	3	1
http://www.unistars.lv/	4	3	2
http://www.unwired.com.au/	3	3	8
http://www.unwiredaustralia.com.au/	1	2	2
http://www.uq2.jp/	2	1	9
http://www.us.anritsu.com	1	1	56
http://www.uscellular.com	2	1	56
http://www.utimaco.com/	1	1	2
http://www.utu.fi/	2	2	2
http://www.vanso.com/	3	4	1
http://www.vanu.com/	2	1	1
http://www.vee.com.tw/	3	4	2
http://www.velti.com/	1	1	1
http://www.veraznetworks.com/	1	1	1
http://www.verisign.com/	1	1	281
http://www.verizonwireless.com	2	2	56
http://www.vermontel.com/	2	4	1
http://www.viaero.com/	1	1	1
http://www.via-telecom.com/	1	2	56
http://www.vibo.com.tw/	2	2	2
http://www.videotron.com	1	1	1
http://www.vimpelcom.com/	1	1	7
http://www.visafone.com.ng/	3	3	5
http://www.vivotech.com/	1	2	1
http://www.vni.in/	1	1	1
http://www.vodacom.co.za/	2	3	1
http://www.vodafone.co.nz/	1	2	1
http://www.vodafone.com.au	1	1	1
http://www.vodafone.com/	1	1	3
http://www.vodafone.nl	1	1	5
http://www.voxbone.com/	1	3	1
http://www.vtt.fi/	1	1	2
http://www.w2bi.com/	1	1	56

URL	X	Y	A
http://www.wandtel.co.ug/	2	3	2
http://www.wandtel.com/	2	3	1
http://www.wasko.pl/	2	2	2
http://www.watchdata.com/	1	2	1
http://www.wavesat.com/	2	1	2
http://www.8lliance.net	1	1	8
http://www.wedotechnologies.com	1	2	1
http://www.westcentral.com/	3	3	1
http://www.westlinkcom.com/	3	2	1
http://www.wichorus.com	2	1	423
http://www.2bg/	2	3	2
http://www.22020.com/	3	1	2
http://www.2forum.org/	1	1	2
http://www.wimoss.com/	4	3	2
http://www.windmobile.ca/	2	2	1
http://www.windriver.com/	1	1	2
http://www.wirelesslogix.com/	3	2	2
http://www.wisperhighspeed.com	3	2	2
http://www.witech.it/	1	2	2
http://www.wi-tribe.com/	2	3	2
http://www.workssys.com/	3	2	2
http://www.worldmax.nl/	1	2	2
http://www.xintec.com/	1	3	1
http://www.xirkachipset.com/	4	3	2
http://www.xit.net/	2	1	1
http://www.yemenmobile.com.ye/	4	3	5
http://www.yota.ru/en/	1	2	2
http://www.ytlcomms.my	2	2	2
http://www.ytlesolutions.com/	2	2	28
http://www.zain.com	1	1	1
http://www.zong.com.pk/	3	3	1
http://www.zscaler.com	2	2	1
http://www.zte.com.cn	1	1	564 23
http://www1.globe.com.ph/	1	1	2
http://www2.btcbahamas.com/	1	2	5
http://www2.ctcak.net/	3	4	1
https://www.nethawk.fi/	1	1	3
https://www.wireless.att.com	1	1	1

Legend

	1 GSMA
	2 WIMAX
X-1 Group E	3 LSTI
X-2 Group F	4 NGMN
Y-1 Group G	5 CDG
Y-2 Group H	6 CCF
X & Y Group I	7 UMTS
A Consortia	8 WBA
	9 OPA

Appendix B: Hierarchical Decomposition

As indicated in de Nooy (2005), in social network analysis a position in the network is indicated by a particular pattern of ties. Actors with similar patterns of ties are said to be relationally equivalent, to constitute an equivalence class or occupy equivalent positions in a network. Two vertices are structurally equivalent if they have identical ties with themselves, each other and all other vertices.

Structural equivalence could be calculated based on the dissimilarity of two vertices and is expressed by an index that ranges from zero (completely similar) to one (completely different). The hierarchical clustering is a statistical technique which allows the clustering of vertices based on the structural equivalency. The clustering process can be visualized by a dendrogram, which can be used as a reference when creating a partition with classes of companies belonging to the same cluster. It is up to the researcher to decide the number of classes. For this study we aimed at having clusters with a sufficient number that offers a sample large enough for subsequent factor analysis.

The Pajek⁴¹ hierarchical clustering is based on dissimilarity “d1” which represents the number of neighbours the 2 vertices don’t share. The hierarchical decomposition for the initial sample groups Q1, Q2, Q3 and Q4 is presented next:

⁴¹ <http://pajek.imfm.si/doku.php>

Appendix C: Factor Analysis Results

E1 Mobile Services (I)	Loading	
	E S1	E S11
a) "mobile AND content AND delivery"	902	89
b) "mobile AND services AND (commerce OR billing)"	896	912
c) "(consulting OR engineering) AND services"	870	845
d) "mobile AND messaging AND services"	778	817
e) "customization OR customize OR customized OR personalize OR individualize"	719	715
Average Loading	833	83
Variance after Rotation (%)	14 97	13 90

E2 Testing Solutions (I)	Loading								
	E S1	E S2	E S3	E S4	E S5	E S6	E S7	E S8	E S9
a) "measurement"	878	883	877	875	878	878	877	875	881
b) "instrumentation OR instrument"	861	869	862	862	867	851	848	856	849
c) "(performance OR optimization) AND (analysis OR audit)"	808	791	792	796	794	814	804	813	798
d) "test AND evaluation AND equipment"	798	800	828	828	821	811	805	818	807
e) "test AND equipment AND manufacturer"	689	676	691	695	685	703	712	696	710
Average Loading	807	804	818	811	809	811	809	812	809
Variance after Rotation (%)	14 41	14 39	13 88	14 36	14 25	14 79	15 48	14 82	16 22

E3 Fee Based Business Solutions (I)	Loading							
	E S1	E S2	E S3	E S4	E S5	E S6	E S7	E S8
a) "(data OR voice) AND plans"	801	801	815	820	812	813	818	817
b) "unlimited AND (calling OR text OR distance)"	784	783	786	797	801	805	798	798
c) "(“Mobile Terminal Supplier” OR “Mobile Terminal” OR manufacturer) AND mobile AND phone"	761	761	749	752	764	752	754	752
d) "internet AND mobile"	671	682	675	662	643	633	641	639
e) "customer AND (options OR choice OR choose)"	645	654	642	617	624	620	632	631
Average Loading	732	736	733	730	729	725	729	727
Variance after Rotation (%)	12 04	11 52	11 41	11 87	11 92	12 76	13 09	12 59

E4 WiMAX Technology and Standard (I)	Loading				
	E S1	E S2	E S3	E S9	E S11
a) "wimax"	735	740	742	741	739
b) "TDD OR FDD"	712	724	717	701	711
c) "IEEE AND 802 16"	712	758	752	695	753
d) "ecosystem AND mobile AND broadband"	707	646	650	708	658
e) "forum"	665	555	573	681	58
Average Loading	706	685	687	705	688
Variance after Rotation (%)	10 59	10 68	10 22	12 23	10 00

E5 Hardware (I)	Loading	
	E S1	E S2
a) "microprocessor OR processor OR microcontroller OR DSP OR 'RF subsystem' OR 'power management' OR chips OR chipsets OR sensor"	800	807
b) "semiconductor"	799	799
c) "design"	724	723
d) "packaging"	702	699
Average Loading	756	757
Variance after Rotation (%)	10 30	10 32

E6 3GPP Standard and 4G Technologies (I)	Loading				
	E S2	E S3	E S4	E S5	E S11
a) 'Radio Access'	746	750	790	794	683
b) "LTE OR 'Long Term Evolution' OR eUTRAN"	738	741	779	787	684
c) "3GPP"	727	726	740	744	654
d) "IMS OR 'IP Multimedia Subsystem"	717	703	673	653	776
e) "(product OR process OR service) AND (evolution OR evolve)"	692	683	679	671	665
Average Loading	724	720	0,732	730	69
Variance after Rotation (%)	12 20	11 87	11 85	12 33	11 01

E7 Revenue Management Solutions (I)	Loading					
	E S3	E S4	E S5	E S6	E S7	E S8
a) "solution AND (OSS OR 'Operation Support System')"	871	864	882	892	888	888
b) "BSS OR 'Business Support System'"	829	826	848	851	849	849
c) "solution AND (outsourcing OR delivery)"	713	727	700	701	710	710
d) "billing"	706	703	689	683	685	685
e) "provisioning"	671	669	659	663	662	662
Average Loading	730	758	756	758	759	759
Variance after Rotation (%)	12 50	13 00	13 01	13 34	13 98	13 42

E8 Security Solutions (I)	Loading
	E S4
a) "(protect OR protecting OR promote) AND (consumers OR users)"	842
b) "(security OR 'customer protection' OR protection) AND (virus OR malware OR 'inappropriate content' OR spam OR phishing)"	775
c) "authentication OR security OR signature"	724
d) "authority"	529
Average Loading	718
Variance after Rotation (%)	9 69

E9 Interoperability Solutions (I)	Loading				
	E S5	E S6	E S7	E S8	E S9
a) "(SMS OR MMS) AND services"	799	788	783	784	765
b) "VAS OR 'Value Added Services'"	701	685	681	691	697
c) "roaming OR NRTRDE"	693	697	701	704	722
d) "network AND operator"	654	699	699	635	731
Average Loading	712	717	716	704	729
Variance after Rotation (%)	9 90	10 30	10 74	10 72	10 50

E10 Reputation (I)	Loading		
	E S6	E S9	E S11
a) "reputation OR competence"	758	741	746
b) "agreement"	699	706	690
c) "governance OR govern"	692	672	662
d) "regulator OR regulate OR supervise OR regulation OR regulatory"	647	644	655
Average Loading	699	691	688
Variance after Rotation (%)	8 95	10 20	8 66

E11 Research (I)	Loading		
	E S7	E S9	E S11
a) "(university OR universities) AND research"	843	846	85
b) "research OR innovation OR 'research and development'"	817	777	725
c) "science AND technology"	688	712	75
Average Loading	783	778	775
Variance after Rotation (%)	8 85	9 31	7 56

E12 3GPP Standard and 3G Technologies Evolution	Loading	
	E S8	E S11
a) "GPRS"	768	846
b) "UMTS"	762	629
c) "GSM"	724	771
d) "WCDMA"	656	559
Average Loading	727	701
Variance after Rotation (%)	10 07	9 29

F1 Fraud Detection (I)	Loading								
	F S1	F S2	F S3	F S4	F S5	F S6	F S7	F S8	F S9
a) "(analyze OR monitor OR test) AND fraud"	945	943	944	944	947	949	946	947	947
b) "fraud AND (control OR detection)"	920	913	907	915	919	925	922	924	920
c) "analyse AND revenue AND (loss OR risk)"	876	905	897	902	903	877	894	894	906
d) "assurance AND (customer OR service)"	821	825	825	825	824	810	819	815	818
Average Loading	891	897	893	897	898	890	895	895	898
Variance after Rotation (%)	19 56	20 89	19 81	19 70	19 48	21 01	20 80	19 57	19 44

F2 Business Opportunity Solutions (I)	Loading	
	F S1	F S10
a) "new AND (market OR industry)"	817	793
b) "solution AND (outsourcing OR delivery)"	784	681
c) "strategy AND development"	779	762
d) "network AND operator"	700	574
e) "end-to-end AND communication AND solutions"	681	708
Average Loading	752	704
Variance after Rotation (%)	19 05	14 27

F3 Revenue Management Solutions (II)	Loading									
	F S1	F S2	F S3	F S4	F S5	F S6	F S7	F S8	F S9	F S10
a) "BSS OR 'Business Support System'"	904	882	881	880	878	888	881	880	880	920
b) "solution AND (OSS OR 'Operation Support System')"	890	917	917	915	914	909	914	914	915	883
c) "activation AND mediation AND service"	869	880	878	880	880	882	881	879	879	865
d) "'cost of ownership' OR 'optimise infrastructure' OR 'optimize infrastructure'"	720	761	760	763	766	756	760	764	767	695
Average Loading	846	860	859	859	860	859	859	859	860	841
Variance after Rotation (%)	18 47	18 95	17 80	17 94	17 95	19 02	19 09	17 94	17 82	14 32

F4 Hardware (II)	Loading		
	F S1	F S2	F S9
a) "signal AND processing"	853	836	840
b) "microprocessor OR processor OR microcontroller OR DSP OR 'RF subsystem' OR 'power management' OR chips OR chipsets OR sensor"	749	716	730
c) "multi-standard"	748	803	778
d) "'base station' OR 'base-station'"	681	712	664
Average Loading	758	767	753
Variance after Rotation (%)	14 18	15 27	14 37

F5 Security Solutions (II)	Loading		
	F S2	F S3	F S4
a) "(protect OR protecting OR promote) AND (consumers OR users)"	928	926	921
b) "reputation OR competence"	903	899	903
c) "(security OR 'customer protection' OR protection) AND (virus OR malware OR 'inappropriate content' OR spam OR phishing)"	837	840	831
d) "conformity OR compliance"	595	597	606
Average Loading	816	816	815
Variance after Rotation (%)	17 54	16 50	16 54

F6 Interoperability Solutions (II)	Loading	
	F S3	F S10
a) "(SMS OR MMS) AND services"	890	878
b) "roaming OR NRTRDE"	840	840
c) "mobile AND messaging AND services"	738	703
d) "VAS OR 'Value Added Services'"	723	719
e) "GSM"	505	527
Average Loading	739	733
Variance after Rotation (%)	17 05	14 89

F7 Fee Based Business Solutions (II)	Loading	
	F S4	F S5
a) "phones OR smartphones OR PDA OR accessories OR cards"	778	775
b) "customer AND (options OR choice OR choose)"	770	772
c) "(data OR voice) AND plans"	761	758
d) "unlimited AND (calling OR text OR distance)"	707	703
e) "choose AND different AND plans"	693	700
Average Loading	742	742
Variance after Rotation (%)	16 58	16 37

F8 3GPP Standard and LTE Technology (II)	Loading		
	F S5	F S6	F S7
a) "3GPP"	883	888	884
b) "MIMO OR 'smart antenna'"	883	883	887
c) "LTE OR 'Long Term Evolution' OR eUTRAN"	865	857	868
d) "TDD OR FDD"	666	670	665
Average Loading	824	824	826
Variance after Rotation (%)	16 32	17 36	17 34

F9 Monitoring Solutions	Loading	
	F S6	F S10
a) "solutions AND network AND monitoring AND analysis"	889	816
b) "(performance OR optimization) AND (analysis OR audit)"	790	732
c) "solutions AND (telematics OR metering OR tracking OR alarms OR monitoring)"	660	585
d) "automation"	623	738
Average Loading	741	718
Variance after Rotation (%)	15 27	10 72

F10 Licenses and Regulation (I)	Loading		
	F S7	F S8	F S10
a) "(issue OR administer) AND (licence OR licensing)"	790	796	794
b) "market AND (regulation OR oversight)"	778	782	716
c) "(enable OR enabling OR promote OR promoting) AND competition"	728	734	717
d) "authority"	683	662	665
Average Loading	745	744	723
Variance after Rotation (%)	14 32	13 47	10 69

F11 Conformance and Certification (I)	Loading	
	F S8	F S9
a) "conformance"	889	912
b) "test AND equipment AND manufacturer"	822	822
c) "validate AND technology"	793	787
d) "certified OR certification"	690	657
e) "interoperability"	528	495
Average Loading	745	735
Variance after Rotation (%)	17 14	17 22

G1 Mobile Services (II)	Loading					
	G S1	G S3	G S4	G S5	G S6	G S7
a) "(consulting OR engineering) AND services"	873	865	848	862	848	872
b) "mobile AND content AND delivery"	867	887	892	890	897	867
c) "database AND services"	866	872	866	869	871	856
d) "mobile AND services AND (commerce OR billing)"	851	862	871	866	883	847
Average Loading	865	873	869	872	875	861
Variance after Rotation (%)	14 74	12 74	18 76	18 73	18 61	20 13

G2 Business Opportunity Solutions (II)	Loading				
	G S1	G S2	G S3	G S4	G S5
a) "solution AND provider"	835	849	843	843	843
b) "'end-to-end' AND communication AND solutions"	763	750	741	760	767
c) "solution AND (outsourcing OR delivery)"	739	779	756	723	716
d) "new AND (market OR industry)"	689	667	661	693	698
e) "cost AND (reduce OR reduction OR saving OR effective)"	661	628	665	701	708
Average Loading	737	735	733	744	746
Variance after Rotation (%)	14 37	17 65	12 39	18 46	18 49

G3 Fee Based Business Solutions (III)	Loading					
	G S1	G S2	G S3	G S4	G S5	G S7
a) "subscription OR activation OR contract"	810	802	788	819	817	826
b) "ringtones OR games OR songs OR wallpaper OR screensavers OR tones OR IM"	750	752	776	765	777	743
c) "service AND mobile AND (banking OR payment OR money OR financial)"	735	758	764	770	770	743
d) "new AND (contract OR collaboration OR partner)"	715	746	688	713	694	725
Average Loading	752	765	754	767	765	759
Variance after Rotation (%)	12 01	13 73	10 11	14 69	14 69	16 38

G4 WiMAX Certification	Loading			
	G S1	G S2	G S3	G S6
a) "'base station' OR 'base-station'"	789	761	780	767
b) "wimax"	766	777	763	801
c) "forum"	716	734	726	723
d) "management AND spectrum"	593	618	607	589
e) "certified OR certification"	549	465	527	557
Average Loading	683	671	681	687
Variance after Rotation (%)	11 80	14 02	10 28	14 86

G5 Interoperability Solutions (III)	Loading	
	G S1	G S7
a) "roaming OR NRTRDE"	797	797
b) "solutions AND (roaming OR VAS OR 'Customer Care')"	790	801
c) "network AND operator"	694	717
d) "(SMS OR MMS) AND services"	686	668
Average Loading	742	746
Variance after Rotation (%)	11 26	15 12

G6 Hardware (III)	Loading
	G S2
a) "microprocessor OR processor OR microcontroller OR DSP OR 'RF subsystem' OR 'power management' OR chips OR chipsets OR sensor"	802
b) "design"	786
c) "(product OR process) AND (modularity OR modular OR module)"	710
d) "system AND integration"	669
Average Loading	742
Variance after Rotation (%)	13 89

G7 Reputation (II)	Loading
	G S3
a) "reputation OR competence"	792
b) "governance OR govern"	691
c) "agreement"	669
d) "regulator OR regulate OR supervise OR regulation OR regulatory"	560
Average Loading	678
Variance after Rotation (%)	8 39

G8 Security Solutions (III)	Loading
	G S3
a) "(protect OR protecting OR promote) AND (consumers OR users)"	715
b) "conformity OR compliance"	691
c) "authentication OR security OR signature"	636
Average Loading	681
Variance after Rotation (%)	7 30

G9 Research (II)	Loading		
	G S4	G S6	G S7
a) "(university OR universities) AND research"	802	794	785
b) "research OR innovation OR 'research and development'"	710	720	717
c) "science AND technology"	694	698	693
d) "technology AND development"	683	626	701
Average Loading	722	710	724
Variance after Rotation (%)	13 41	14 03	14 17

G10 Testing Solutions (II)	Loading	
	G S5	G S6
a) "(performance OR optimization) AND (analysis OR audit)"	805	783
b) "measurement"	696	712
c) "test AND coverage"	695	725
d) "research AND testing"	660	536
Average Loading	714	689
Variance after Rotation (%)	12 45	12 16

H1 Fraud Detection (II)	Loading		
	H S1	H S2	H S5
a) "analyse AND revenue AND (loss OR risk)"	901	900	871
b) "fraud AND (control OR detection)"	890	892	902
c) "(analyze OR monitor OR test) AND fraud"	877	883	801
d) "billing"	705	703	618
e) "assurance AND (customer OR service)"	685	681	755
f) "GSMA OR 'GSM Association' OR gsmworld"	606	609	597
Average Loading	777	778	757
Variance after Rotation (%)	18 11	18 13	17 49

H2 3GPP Standard and LTE Technology (III)	Loading			
	H S1	H S2	H S3	H S5
a) "(product OR process OR service) AND (evolution OR evolve)"	828	825	821	827
b) "(product OR process) AND (modularity OR modular OR module)"	804	805	801	806
c) "(performance OR optimization) AND (analysis OR audit)"	803	797	791	801
d) "convergence"	779	781	787	78
e) "'cost effective' OR migration OR evolution OR path"	683	691	690	684
f) "LTE OR 'Long Term Evolution' OR eUTRAN"	557	559	553	557
Average Loading	742	743	741	742
Variance after Rotation (%)	16 16	16 18	15 26	16 15

H3 Testing Solutions (III)	Loading
	H S1
a) "test AND coverage"	862
b) "solutions AND (VoIP OR 'Voice over IP' OR RCS OR 'Rich Communication Suite' OR VCC OR 'Voice Call Continuity')"	818
c) "system AND solution"	785
d) "multi-standard"	739
e) "automation"	607
Average Loading	762
Variance after Rotation (%)	14 39

H4 Licenses and Regulation (II)	Loading		
	H S1	H S2	H S5
a) "regulator OR regulate OR supervise OR regulation OR regulatory"	844	861	847
b) "market AND (regulation OR oversight)"	824	803	816
c) "guidelines OR rules OR regulation"	812	792	815
d) "(issue OR administer) AND (licence OR licensing)"	693	694	698
Average Loading	793	787	794
Variance after Rotation (%)	12 50	13 09	15 18

H5 Security Solutions (IV)	Loading	
	H S2	H S3
a) "(protect OR protecting OR promote) AND (consumers OR users)"	929	929
b) "reputation OR competence"	854	858
c) "(security OR 'customer protection' OR protection) AND (virus OR malware OR 'inappropriate content' OR spam OR phishing)"	745	736
d) "router OR gateway"	716	707
e) "conformity OR compliance"	486	512
Average Loading	746	748
Variance after Rotation (%)	13 92	12 83

H6 Mobile Services (III)	Loading
	H S3
a) "mobile AND applications"	793
b) "mobile AND messaging AND services"	781
c) "device AND management"	776
d) "mobile AND services AND (commerce OR billing)"	732
e) "mobile AND (advertising OR marketing)"	720
f) "(data OR voice) AND plans"	702
g) "(consulting OR engineering) AND services"	651
Average Loading	736
Variance after Rotation (%)	16 76

H7 Interoperability Solutions (IV)	Loading	
	H S3	H S5
a) "(SMS OR MMS) AND services"	816	807
b) "solutions AND ('SIM card' OR 'smart card')"	766	777
c) "solutions AND (roaming OR VAS OR 'Customer Care')"	743	724
d) "service AND mobile AND (banking OR payment OR money OR financial)"	704	705
e) "roaming OR NRTRDE"	643	633
Average Loading	734	729
Variance after Rotation (%)	13 53	12 50

I1 WiMAX Technology and Standard (II)	Loading			
	I S1	I S3	I S4	I S5
a) "OFDMA OR 'Orthogonal Frequency Division Multiple Access'"	762	764	756	755
b) "IEEE AND 802 16"	743	745	744	754
c) WiMAX	649	664	651	671
c) "'base station' OR 'base-station'"	630	628	63	64
e) "TDD OR FDD"	608	651	6	67
Average Loading	679	691	676	698
Variance after Rotation (%)	9 61	7 85	8 96	8 26

I2 Hardware (IV)	Loading			
	I S1	I S3	I S4	I S5
a) "microprocessor OR processor OR microcontroller OR DSP OR 'RF subsystem' OR 'power management' OR chips OR chipsets OR sensor"	77	78	78	79
b) "semiconductor"	74	74	74	75
c) "design"	74	72	73	74
c) "signal AND processing"	60	60	59	60
Average Loading	71	71	71	72
Variance after Rotation (%)	8 15	7 38	7 72	7 34

I3 Conformance and Certification (II)	Loading		
	I S1	I S3	I S4
a) "interoperability"	738	714	742
b) "conformance"	650	728	638
c) "certified OR certification"	634	649	632
d) "standards"	558	537	565
Average Loading	645	657	644
Variance after Rotation (%)	7 42	6 83	7 00

I4 UMTS	Loading			
	I S1	I S3	I S4	I S5
a) "'UMTS Forum' OR (umts AND forum)"	912	908	909	909
b) "HSPA OR 'High Speed Packet Access'"	803	806	801	806
c) "UMTS"	738	752	739	754
Average Loading	818	822	816	823
Variance after Rotation (%)	7 34	6 59	6 91	6 98

I5 Wireless Broadband Alliance	Loading	
	I S1	I S5
a) "'Wireless Broadband Alliance' OR wballiance"	942	942
b) "'collaboration opportunities'"	935	934
c) "'business ecosystem' OR 'business eco-system'"	644	641
Average Loading	840	839
Variance after Rotation (%)	7 30	7 10

I6 CDMA Technology and Standards	Loading			
	I S1	I S3	I S4	I S5
a) "CDMA OR 'code division multiple access'"	767	772	771	787
b) "1xRTT"	713	688	696	702
c) "EV-DO OR EVDO"	679	671	668	603
d) "3GPP2"	595	612	608	713
Average Loading	689	686	685	701
Variance after Rotation (%)	6 88	6 27	6 53	6 83

I7 3GPP Standard and LTE Technology (IV)	Loading	
	I S1	I S4
a) "LTE OR 'Long Term Evolution' OR eUTRAN"	761	752
b) "3GPP"	730	723
c) "MIMO OR 'smart antenna'"	587	6
Average Loading	690	69
Variance after Rotation (%)	6 58	6 23

I8 Research (III)	Loading			
	I S1	I S3	I S4	I S5
a) "research OR innovation OR 'research and development'"	754	747	746	757
b) "(university OR universities) AND research"	740	743	743	714
c) "science AND technology"	630	642	631	622
d) "research AND testing"	591	573	59	638
Average Loading	679	676	675	682
Variance after Rotation (%)	6 58	6 01	6 21	6 44

I9 Revenue Management Solutions (III)	Loading
	I S2
a) "solution AND (OSS OR 'Operation Support System')"	871
b) "BSS OR 'Business Support System'"	846
c) "solution AND (outsourcing OR delivery)"	636
d) "'cost of ownership' OR 'optimise infrastructure' OR 'optimize infrastructure'"	581
e) "billing"	561
Average Loading	699
Variance after Rotation (%)	9 24

I10 Fee Based Business Solutions (IV)	Loading		
	I S2	I S3	I S4
a) "(data OR voice) AND plans"	798	793	744
b) "unlimited AND (calling OR text OR distance)"	739	734	723
c) "phones OR smartphones OR PDA OR accessories OR cards"	685	734	683
d) "customer AND (options OR choice OR choose)"	665	703	714
e) "(“Mobile Terminal Supplier” OR “Mobile Terminal” OR manufacturer) AND mobile AND phone"	584	593	589
Average Loading	694	711	69
Variance after Rotation (%)	8 56	7 83	8 05

I11 Fraud Detection (III)	Loading
	I S2
a) "fraud AND (control OR detection)"	892
b) "(analyze OR monitor OR test) AND fraud"	855
c) "analyse AND revenue AND (loss OR risk)"	679
d) "assurance AND (customer OR service)"	588
Average Loading	754
Variance after Rotation (%)	8 34

I12 Interoperability Solutions (V)	Loading		
	I S2	I S3	I S5
a) "(SMS OR MMS) AND services"	786	763	768
b) "VAS OR 'Value Added Services'"	765	736	735
c) "roaming OR NRTRDE"	755	780	797
d) "solutions AND (roaming OR VAS OR 'Customer Care'"	745	788	794
Average Loading	763	767	773
Variance after Rotation (%)	8 21	7 68	8 04

I13 Testing Solutions (IV)	Loading
	I S2
a) "measurement"	749
b) "test AND equipment AND manufacturer"	683
c) "test AND evaluation AND equipment"	643
d) "(performance OR optimization) AND (analysis OR audit)"	622
e) "instrumentation OR instrument"	606
Average Loading	660
Variance after Rotation (%)	7 84

I14 Security Solutions (V)	Loading
	I S2
a) "(protect OR protecting OR promote) AND (consumers OR users)"	853
b) "(security OR 'customer protection' OR protection) AND (virus OR malware OR 'inappropriate content' OR spam OR phishing)"	776
c) "authentication OR security OR signature"	629
d) "reputation OR competence"	626
Average Loading	721
Variance after Rotation (%)	7 69

I15 Licenses and Regulation (III)	Loading	
	I S2	I S5
a) "guidelines OR rules OR regulation"	744	752
b) "regulator OR regulate OR supervise OR regulation OR regulatory"	723	756
c) "(issue OR administer) AND (licence OR licensing)"	680	646
d) "authority"	618	692
Average Loading	691	711
Variance after Rotation (%)	6 94	6 77

Appendix D: Membership Distribution

Group E	312	WiMAX	GSMA	CDG	NGMN	LSTI	UMTS	CCF	WBA	OPA
WiMAX	144	144	20	14	21	14	5	8	7	6
GSMA	124	20	124	12	15	10	6	7	3	4
CDG	43	14	12	43	10	5	3	13	1	1
NGMN	37	21	15	10	37	16	6	7	2	2
LSTI	25	14	10	5	16	25	7	4	3	2
UMTS	20	5	6	3	6	7	20	3	0	1
CCF	20	8	7	13	7	4	3	20	0	1
WBA	15	7	3	1	2	3	0	0	17	0
OPA	6	6	4	1	2	2	1	1	0	6

Group E distribution

Consortium	WiMAX	GSMA	CDG	NGMN	LSTI	UMTS	CCF	WBA	OPA
Members	144	124	43	37	25	20	20	15	6
Percentage [%]	46.15	39.74	13.78	11.86	8.01	6.41	6.41	4.81	1.92

Group F	202	WiMAX	GSMA	CDG	NGMN	LSTI	UMTS	CCF	WBA	OPA
WiMAX	108	108	12	12	8	3	3	4	4	2
GSMA	65	12	65	10	4	3	2	1	2	0
CDG	37	12	10	37	2	2	3	10	2	0
NGMN	12	8	4	2	12	4	2	1	0	0
LSTI	8	2	3	2	4	8	2	1	0	0
UMTS	9	3	2	3	2	2	9	1	0	0
CCF	13	4	1	10	1	1	1	13	0	0
WBA	7	4	2	2	0	0	0	0	7	0
OPA	3	2	0	0	0	0	0	0	0	3

Group F distribution

Consortium	WiMAX	GSMA	CDG	NGMN	LSTI	UMTS	CCF	WBA	OPA
Members	108	65	37	12	8	9	13	7	3
Percentage [%]	53.47	32.18	18.32	5.94	3.96	4.46	6.44	3.47	1.49

Group G	305	WiMAX	GSMA	CDG	NGMN	LSTI	UMTS	CCF	WBA	OPA
WiMAX	141	141	23	18	20	15	7	9	6	4
GSMA	115	23	115	16	13	11	7	5	3	1
CDG	58	18	16	58	8	6	5	15	2	0
NGMN	32	20	13	8	32	17	8	6	2	1
LSTI	30	15	11	6	17	30	9	5	2	1
UMTS	21	7	7	5	8	9	21	3	0	0
CCF	25	9	5	15	6	5	3	25	0	0
WBA	11	6	3	2	2	2	0	0	11	0
OPA	5	4	1	0	1	1	0	0	0	5

Group G distribution

Consortium	WiMAX	GSMA	CDG	NGMN	LSTI	UMTS	CCF	WBA	OPA
Members	141	115	58	32	30	21	25	11	5
Percentage [%]	46.23	37.70	19.02	10.49	9.84	6.89	8.20	3.61	1.64

Group H	228	WiMAX	GSMA	CDG	NGMN	LSTI	UMTS	CCF	WBA	OPA
WiMAX	119	119	7	4	7	2	0	2	6	3
GSMA	74	7	74	2	4	1	0	1	1	1
CDG	20	4	2	20	1	0	0	7	0	0
NGMN	15	7	4	1	15	2	0	1	2	1
LSTI	5	2	1	0	2	5	0	0	1	0
UMTS	8	0	0	0	0	0	8	0	0	0
CCF	12	2	1	7	1	0	0	12	0	0
WBA	13	6	1	0	2	1	0	0	13	0
OPA	4	3	1	0	1	0	0	0	0	4

Group H distribution

Consortium	WiMAX	GSMA	CDG	NGMN	LSTI	UMTS	CCF	WBA	OPA
Members	119	74	20	15	5	8	12	13	4
Percentage [%]	52.19	32.46	8.77	6.58	2.19	3.51	5.26	5.70	1.75

Group I	736	WiMAX	GSMA	CDG	NGMN	LSTI	UMTS	CCF	WBA	OPA
WiMAX	346	346	36	28	31	18	8	15	13	10
GSMA	265	36	265	24	20	13	8	8	5	4
CDG	111	28	24	111	13	8	6	25	3	1
NGMN	54	31	20	13	54	21	9	9	4	3
LSTI	39	18	13	8	21	39	10	6	3	2
UMTS	36	8	8	6	9	10	36	4	0	1
CCF	47	15	8	25	9	6	4	47	0	1
WBA	32	13	5	3	4	3	0	0	32	0
OPA	12	10	4	1	3	2	1	1	0	12

Group I distribution

Consortium	WiMAX	GSMA	CDG	NGMN	CCF	LSTI	UMTS	WBA	OPA
Members	346	265	111	54	47	39	36	32	12
Percentage [%]	47 01	36 01	15 08	7 34	6 39	5 30	4 89	4 35	1 63