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Prospects of Mobile Search

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2 CHORUS+ stands for Coordinated approacH to the EurOpean effoRt on aUdio-visual Search engines. ICT Programme's Grant Agreement Number 249008

Table of Contents

List of Tables

List of Figures

Executive summary

The mobile base will reach nearly 5,000 million subscribers worldwide by 2012. By the end of 2013, broadband mobile connections (3G, 3.5G+) will account for more than half of all connections and 40% of all subscribers will be using mobile internet. In other words, mobile communications, which are already used by three quarters of the world population and will soon reach each and every person, are rapidly evolving to become providers of ubiquitous broadband connectivity. Their widespread adoption will lead to an explosion of mobile content and applications, and is expected to be one of the mega trends that will shape the internet of the future. Numerous examples illustrating this trend could be provided: new entertainment content produced and personalised for the mobile environment, productivity applications for mobile workers, or health and education mobile solutions to increase quality of life. In addition, some Web 2.0 models are already being transferred to the mobile environment since the mobile device is 'a means of harnessing collective intelligence at the point of inspiration'.

Similarly to the wired internet, many of these new mobile web models and applications will require access to data and content in an efficient and user-friendly manner. Search engines, which are already gateways for more than half the users connecting to the internet, will therefore become the means of finding interesting and relevant content and applications and will provide added value to mobile platform services. Furthermore, search will provide added value in the mobile environment. It exploits the fact that mobiles are personal devices that store and regularly capture a lot of data about the user, like the user's location, contact lists, preferences, etc. This will enable context-aware and location-aware search services in current and future ambient intelligent environments (e.g. making use of wireless sensors and cognitive techniques), like geographic location services, or social environments.

In short, search is likely to become equally or even more critical in the mobile domain than in the wired environment. As a result, mobile search is becoming an attractive expansion market. The mobile search market overlaps with two other markets, namely web search engine providers and telecom operators, and its future will be significantly influenced by developments in these two fields. Both are consolidated, and are governed by a few powerful companies, but within the ICT environment these two markets could not be more unequal. They clash in many respects: different business cultures (ex-monopolists vs. start-ups), government influences (highly regulated vs. non-regulated), business models (subscription-based vs. advertising-based) and the relationship between user and service provider (price-based vs. innovation-based). These differences are the origin of tensions amongst market actors, who are trying to position themselves more favourably for the time when the market ramps up.

Background

Applications on mobiles which make use of search technology can be grouped into two broad categories. First, there are those that adapt or emulate existing web search services to the mobile environment. Second, there are search services that exploit the unique features of mobile devices or the environments in which they operate. Examples of such innovative services include context-aware services or services which provide interfaces to the 'internet of things'. This report assesses both categories, particularly

focusing on the second set of applications with a view to understanding how mobile search can impact on Europe's economy and society. It explores possible strategies for the European Union to take the lead in upcoming technological developments and business opportunities, and empower citizens in this context.

Web search is facing two major technical challenges: first, to improve the efficiency of retrieving relevant content in all digital forms and formats, and second, to retrieve relevant information in a range of platforms, including mobile. If these were the only challenges, mobile search could have been achieved by simply migrating established PC-based internet search tools to a mobile environment, with the possible addition of some "mobility" features like user location. For creating new high-value services, however, this is not enough. Mobile search needs to make effective use of contextual information (relevant data embedded in the mobile device, information in the surrounding environment, users' profiles or behavioural patterns) to improve the meaningfulness of the search results and/or to provide a more valuable and entertaining user experience. Here, service providers are interested to know what, how and in which context, people look for information. A number of classification schemes are possible. From a market perspective, different mobile search classifications can be considered, i.e. on device, on portal, open (off portal); meta-search, social network-based, messaging service-based, voice-based, multimedia (audiovisual and or audio), context-aware, or local search. In the next part of the report, we will discuss mobile search categories from a market rather than a technological perspective.

The supply side of mobile search

The use of mobile search is directly related to the deployment of smartphones and their operation in 3G networks. Increasing mobile internet and search use is a common trend, although there are notable regional differences. In the industrialised world, Japan and Korea show high levels of mobile internet use due to early deployment of 3G networks, followed by Europe and the USA. In absolute numbers, however, highly populated emerging economies like China and India are likely to exhibit the highest subscription base in the future. The mobile subscriber base has also increased enormously over the last few years in the emerging economies of Asia, Eastern Europe, Latin America and Africa. In these countries, access to mobile broadband is limited, given its high cost, and prospects to access the internet via mobile are promising, given that mobiles are often the only way to access it.

Interestingly, we detect a gap between the diffusion (potential usage) and the adoption (actual usage) of mobile internet services: many people already have internet-enabled devices, but they do not use them as such. We argue in this report that, in time, this gap will vanish. Subscribers will make full use of their mobiles, beyond voice and messaging, once three conditions are met: quick responses (i.e. networks must be fast), user-friendly multi-functional handsets (i.e. devices must be more intuitive and efficient than they are today) and affordable prices. Once all this is in place, the mobile search functionality could become a disruptive element which will deeply influence users' behaviour and experience.

Given these promising market prospects, many actors are seeking to develop applications that enable them to successfully enter this market. Although experts share their optimism in general terms, especially as regards context-aware applications, the specific value of mobile search for particular applications is, as yet, largely unexplored. However, the question of where and how actors should position themselves to make money, faced by many players entering this market, is not obvious: the search functionality is embedded into the value chain of a number of mobile services of different natures. The business

models for these mobile services are unclear and there are many stakeholders competing and interacting within this 'ecosystem'. The report describes and discusses potential revenue models for search services, including advertising (in its multiple forms: from pure ads to ads linked with product placement), packaged with other services (either search embedded in the mobile device, or by subscription along with services provided by the mobile operator, or even services not related to mobile ICTs), pay-as-you-go, premium or value-added services, subscription, merchandising, and user profiling. It also discusses non commercial models for services which could be maintained either by user communities (free for final users) or by public funding. Amongst all these options, our research and discussions with experts indicate that the business model most likely to emerge is based on advertising and that, compared to web search, mobile search will probably rely more heavily on user profiling.

The demand side of mobile search

From a usage point view, people perform navigational, informational, transactional, logistical, and diversion searches. This taxonomy fits the most common user behaviour patterns and allows us to describe changes in user trends. First experiences are usually navigational, informational or logistical searches in situations where users have no other access to the internet. Once users get accustomed to mobile search, they start to perform transactional and diversion searches, taking advantage of the mobile's ubiquitous features (e.g. on the go). The more frequently they use it in their everyday lives, the more likely it is that they will use it at home. Though users generally continue to take computers as a reference point, respondents to our questionnaire (see Annex I) indicated that they would consider mobile search as an alternative at home when the search experience becomes similar.

Reliable data about mobile search from a user perspective is still scarce. Very few studies on user perceptions have been carried out so far and they are barely comparable because they have been carried out in very different contexts and settings. However, from focus groups consulted for this study and the literature, we can conclude that the adoption and use of mobile internet services seems to be influenced by many different factors such as cultural values, interest in technology, lifestyle, perceived ease-of-use, perceived usefulness, attitude towards use, availability of user-friendly devices, pricing, perception of need, service quality and available content. The effects of these factors are intertwined and their respective contribution to the adoption of mobile search varies by country and over time.

Until 2007, mobile subscribers used handsets predominantly for internet browsing and seldom for search. User demand is changing drastically with the deployment of 3G networks and smart phones. While early adopters of mobile search were typically men who subscribed to business plans, now mobile search is much more widely used by various groups of users. The rapid diffusion of smartphones is changing the scene; practically all owners of smartphones –although with different frequencies and patterns– access the internet and perform searches. We can fairly say that smartphones have become a disruptive force and this movement is currently taking shape. This diffusion pattern is not dissimilar to the early days of desktop-based search, but there are also some differences. A focus group study to investigate this in more detail was carried out in March 2009, with a variety of mobile users from Gothenburg, Sweden.

Our focus group results indicate that the main barriers for adoption are cost and usability issues. Lack of usability is manifested by the fact that –compared to desktop search– queries on mobiles are far less frequent, notably shorter and users hardly interact with the search results. This low level of interaction can partially (and easily)

be explained by the limitations of the interface, but not completely. We found evidence that users perform transactional queries, intending interaction later. The fact that queries that have been initiated do not then result in further interaction may indicate that mobile-specific search technologies are not yet sufficiently mature to enable users to move from browsing operator-type portals to mobile search-adapted applications.

On the 'pricing front', it appears that if the prices for mobile broadband connections and the acquisition of user-friendly devices that allow search are considered too high, many people will refrain from using mobile search unless it is really necessary. Many participants are unaware of the features of advanced mobiles, or of the subscription alternatives. Were users more aware, it is more likely they would be inclined to upgrade their devices and subscribe to new price plans in order to access the internet via their mobile. Service providers (e.g. telecoms, device manufactures) can contribute by promoting better awareness of devices, prices and subscription plans. Though this is an important element for adoption, it is not enough on its own. Sharing mobile search experiences between trusted users is also very important. Word-of-mouth communication seems effective and early adopters have an important function to play as informers and opinion-leaders.

Forward-looking considerations

Three groups of technologies are likely to have a direct impact on mobile search. The first one comprises generic search technologies for retrieving, for example, accurate and enriched content. Such technologies may include semantic approaches, cognitive approaches and multimedia retrieval. The second group comprises specific mobile search technologies. Examples include technologies that render mobile data acquisition, its processing and its matching more context-aware, or that introduce augmented reality technologies to enrich context awareness. Finally, we may consider any technology components that enable mobile applications as a third group, which includes wireless networks (broadband access ubiquity, dynamic spectrum management), sensor networks (RFID, internet of things), devices (multimedia capabilities, location, interoperability, openness), and cloud computing (web browser, connectivity, security, data protection). Interestingly, most of these technological building blocks are either already available or in an advanced prototype stage. However, they have not yet been used to any great extent in commercial services and applications. Thus we conclude that, in the short to medium term, there is no missing 'critical technological component'. Instead, the main technological challenge is to better integrate (existing) technologies. In other words, system integration and technological interoperability is the key to success, rather than the development of new "hard-core" search components.

With regard to the long-term prospects, system integration is particularly challenging, i.e. getting the necessary components operational for the next generation of mobile networks, 4G-type and beyond (arguably the most relevant enabler of mobile search). In addition, current and future networks will also be interoperable with other types of wireless networks such as near field communications for interaction with sensors.

This study also included a two-round Delphi exercise. The first round was a survey of the views of 61 experts, performed online. 19 experts who responded to the first round were then invited to a workshop to discuss the results and take part in the second round. Participants were decision makers from industry, academia and governmental institutions, and experts in mobile technologies or search.

Our Delphi exercise indicates that the critical factors for take-up of mobile search are economic

rather than technological. Unfortunately, the economic factors are difficult to assess due to unclear patterns and some opposing characteristics, both on the supply and on the demand side. For example, from the demand side, the Delphi confirms the focus group results that users expect high-quality search services comparable to PC-based ones, but most of them are not willing to pay directly for such services. There is also a strong claim that smartphones should be more affordable and internet connection cheaper. From the supply side, businesses are still in the phase of evaluating user responses to proposed services and –more importantly– still experimenting with how exactly to monetise these services before embarking on large-scale deployment. In response to the question about which is the most likely future business model for mobile search, the survey pinpoints advertising as the most likely candidate, but the experts remain unclear as to which of this model's many variants will prevail. Another potential business model would be to include mobile search technology as a function integrated within other products or services and to charge for the complete package. The services included would probably constitute a kind of add-on to traditional mobile communications services. The experts believe that if these services remain within the telecom operators' domain ("walled garden" approach), they will probably not form a sustainable model. Other business models for mobile search could be built around a premium service, a value added service, impulse purchases or a subscription service. According to the experts, these latter models are likely only in niche applications which exploit particular location environments in order to satisfy very specific user needs.

With regards to the business framework, two elements appear particularly important. The first is the adaptation of advertising formats to the mobile environment. This responds to the commonly-accepted view that advertising –the only de-facto business model for web search– is also likely to be the predominant one for mobile search. The second element is the market pull towards more personalised and context-aware applications and services. In such applications, mobile devices hold a unique competitive advantage with respect to other platforms. Here, a high degree of positive perception of usefulness (proxy for value for users), of ease-of-use and of user-control will contribute to the success of context-aware mobile search.

The combination of context awareness with relevant, useful and interesting context-related information will make the difference in mobile search. One driver will be the interoperability of wired and non-wired platforms, most notably the 'internet of things'. Cooperation amongst players, and the openness of the platforms they use and offer, would be beneficial to the user. This is not necessarily the case for all market actors. The big providers of internet search (Google, Yahoo!, Bing, etc.) and social networks (Facebook, MySpace, Twitter, etc.) are interested in shaping mobile search as much as possible as an extension of their core activities and services and technological openness, in this case, may clash with business interests. Another relevant driver is the availability of context-based metadata-enabled content or, more generally, content enrichment. Ideally, such metadata would be automatically machine-generated. However, as long as semantics remain a challenge, meta-data will also rely upon users' involvement. Mobile tagging is one example of content enrichment by the users.

Long-term applications will flourish when search engines evolve into fully-fledged "recommendation engines", able to automatically update user preferences in real-time, social network patterns, and use patterns. In this scenario, anticipatory applications, ranging from serendipity content discovery, to learning and entertainment, would be possible. Such applications would require a much higher level of user profiling and behavioural tracking than the level to which we are currently accustomed. This causes a dilemma. On the one hand, the lack of personalised data

severely limits the usefulness of some applications. On the other hand, however, the fact that advanced personalised services require a lot of data about the user provokes privacy concerns. Meanwhile, privacy concerns are growing as more and more data is becoming available to both the public administrations and private players. A privacy backlash could prejudice advanced mobile search. Thus, ensuring privacy by law enforcement, by technological design and by user choice are all necessary elements to pursue. One way of diminishing this risk and alleviating users' privacy concerns would be to empower users by providing digital identity management systems, able to define and control the release of personal data. Such systems should be user-friendly, all-round solutions which can operate across different platforms (mobile, PC, smartcards, etc).

Implications for Europe

To investigate the implications of mobile search for the European Union, a SWOT analysis was carried out as part of this study.

Both the supply and the demand side of mobile search are strong in Europe. On the demand side, Europe has a large base of early adopters and a huge number of wealthy mobile users who could demand, and would be able to pay for, advanced mobile internet services that satisfy their requirements and meet their expectations. On the supply side, Europe's industry can provide users with the required state-of-the-art technology. European companies have expertise in all sections of the mobile search ecosystem. They are particularly strong with regard to telecommunications, handset production and software and application provision. European companies have a significant track record of past successes (and failures) and, more importantly, they are increasingly committed to making mobile broadband widely available. Pushed by market forces, they are also committed to simplifying mobile tariffs and making them more affordable.

One unique European asset is that Europe possesses a large amount of –not yet fully exploited– high-quality digital content, that could trigger the development of advanced mobile search applications at the service of the citizens. Examples of such content include geographic data in cadastres, (digital) artworks in national libraries, data in public registers, or content generated by public broadcasters. These kinds of data are generally held in proprietary databases owned by (private or semi-public) organisations which have received government subsidies, or are directly managed by public bodies. Public administrations seem to struggle with the decision on whether or not they should capitalise on this data and how best to unlock its potential. In some cases, (national) regulation limits the commercial and non-commercial exploitability of subsidised content; in other cases, administrations do not have the administrative capacity or tools to enter into partnerships for the exploitation of such content or are simply still unaware of its potential. A move to 'liberate public content' might not only unlock this potential, but it might also put governments into a better bargaining position to enforce interoperability between (commercial) applications by imposing open models for data portability across applications and players.

Interoperability would also contribute to "reaping the benefits of Europe's cultural diversity". In fact, the most promising applications of mobile search revolve around local information, local culture and specific languages, but they may be hampered by lack of economies of scale. This could be partially compensated for by a process optimisation at European level. One example of enhanced interoperability would be a common way to identify, authenticate and process electronic identities (eID) enabling high-value services. If Europe were to succeed in putting in place a flexible, efficient and user-empowered eID infrastructure, this would bring the EU closer to becoming a single market for advanced electronic services, including those based on mobile search.

The current mobile ecosystem is largely fragmented in terms of both techno-economic models and markets. On the techno-economic side, technological components, like hardware devices, software, applications, networks, development platforms, or content platforms, suffer from closed and non-interoperable standards. On the market side, the European internal market for mobiles is far from established. High roaming charges or stores selling walled-garden applications are examples of incompatible silo models. Prices for mobile broadband connections are still very expensive. They are even more expensive in many situations where mobile search would prove really useful. For example, exorbitant roaming charges dissuade travellers from connecting to the internet to find places in foreign countries.

The mobile search market will continue to be heavily influenced by providers of web search engines. Given that the most influential ones all have their headquarters outside Europe, there is a risk that many strategic decisions that influence the evolution of the domain will be taken abroad. We observe, for instance, that innovative mobile search applications are often (generally) tested and introduced first in the search engine providers' home countries (usually where the headquarters are located) and only afterwards deployed in Europe. This is true not only for search engine providers but also for other industrial actors in the value chain. This delay could put followers at a disadvantage. Such adverse effects might be partially compensated for by creating and nurturing a more supportive (cultural, institutional and commercial) framework for entrepreneurs and innovators in Europe.

A number of regulations related to mobile search are currently under revision or will be scrutinised in the near future. Directives on electronic communications, spectrum management, content, or consumer protection, are a few examples of regulatory measures that will directly or indirectly influence the adoption of mobile search. A stable, clear and forward-looking framework, which addresses the issues arising from advanced mobile applications, would be of great help to the European mobile search market. One of the major concerns for policy makers is to avoid a mobile digital divide. Next generation mobile infrastructures may not cover some geographical areas in the short to medium term. In addition, the price of devices and mobile connections may not be initially affordable for many citizens.

When asked whether it is necessary to regulate mobile search to promote its take-up, experts in our study said that they believed it would be more effective to fine-tune existing measures and adopt some pro-active ones, rather than design completely new policies. First of all, there seems to be a need to further boost the demand side by raising user awareness and then empowering them with the tools to manage their data. This should be complemented with the reinforcement of all polices aimed at innovation: from the support to innovators and entrepreneurs, to the use of Living Labs and more traditional research programmes. On the regulation side, existing frameworks (including privacy frameworks) should be revised to adapt to the new challenges of advanced mobile applications. The experts believe that this adaptation is necessary, because they are not confident that the industry will self-regulate. From an industrial policy perspective, they supported the idea of promoting the use and adoption of open standards and the achievement of a reasonable level of interoperability. They see public administration support as important to develop content for added value mobile search and to force a swifter deployment of 4G-type mobile communications infrastructure. Furthermore, public administrations were seen as playing a potentially leading role for some niche mobile search applications, as they could set the conditions for deployment or even become the providers of such services. Any public support should not, however, go as far as distorting market dynamics or supporting a European champion in the mobile search domain.

Objectives and structure of the report

The JRC Institute for Prospective Technological Studies (IPTS) provides customer-driven support to the EU policy making process by developing science-based responses to policy challenges that have both a socio-economic as well as a scientific-technological dimension. With regard to search, IPTS is participating in the Commission's Coordination Action on audio-visual search engines,[3] in which it has contributed to the analysis of the techno-economic challenges ahead (Compañó, 2008), the study of legal gaps in the use of web search engines (Rotenberg and Compañó, 2007; Rotenberg, 2007), and to the launch of the discussion on privacy and search engines (Giesecke *et al.*, 2008). With respect to the mobile perspective, IPTS has contributed to the understanding of future mobile services (Forge *et al.*, 2005) and the techno-economic aspects of content and applications in mobile platforms (Feijóo *et al.*, 2009a).

The objective of this study is to assess the potential of mobile search. It was carried out as part of the CHORUS+ project. It aims to understand how mobile search may impact on the European economy and society and to explore options and possible strategies for the European Union to take the lead in technological developments, create new business opportunities, and empower citizens.

In order to achieve these goals, this study is based on the following methodology:

- Collection of relevant data to describe, present and assess the current techno-economic models and the mobile search landscape in Europe and abroad.
- Description of major trends, drivers and future prospects for mobile.
- Analysis of the future prospects of mobile search and the implications of the current and likely future mobile search scenarios for Europe's economy and society. The main results are presented in the form of a SWOT analysis.
- Validation of results by experts via an online survey and a face-to-face workshop and integration of experts views into the report

The report is divided into six sections:

- In Chapter 1, an introduction to mobile search is provided.
- Chapter 2 is devoted to the supply side of mobile search markets and it includes an overview of the key figures. It also describes mobile markets and gives an outline of main business models and players.
- Chapter 3 is dedicated to the demand side of the market: a general study of users' acceptance and demand is given, complemented by a case study carried on Sweden
- Chapter 4 deals with some of the emerging trends in technology and markets that could shape mobile search.
- Future scenarios for mobile search are presented in Chapter 5. Experts were

3 Coordinated approacH to the EurOpean effoRt on aUdio-visual Search engines (CHORUS+) – http://www.ist-chorus.org

asked to evaluate these scenarios. The main results of the questionnaire were discussed and used to identify drivers, barriers and enablers for mobile search.

- Finally, Chapter 6 explains the implications of mobile search future prospects for Europe, and includes a SWOT analysis. The report concludes with policy recommendations in view of the likely socio-economic implications of mobile search in Europe.

The Annexes to this report give a description of the scenarios, details of the workshop, and information about the project team.

Chapter 1. Introduction to mobile search

1.1. The emergence of mobile search

1.1.1. The expanding mobile internet

Mobile communications, already in use by three quarters of the planet population and soon to reach each and every person (Williams, 2008), are rapidly evolving to become providers of ubiquitous broadband connectivity (Ramos *et al.*, 2009). Their further evolution will lead to an explosion of mobile content and applications (Feijóo *et al.*, 2009), a fundamental part of the expected mega-trends shaping the internet of the future (Reding, 2008). Many examples could be cited: new entertainment content produced and personalised for the mobile environment, productivity applications for mobile workers, or health and education mobile solutions to increase quality of life. Moreover, some web 2.0 models are already being transferred to the mobile environment since the mobile device is "the mean to harness collective intelligence at the point of inspiration" (Jaokar and Fish, 2006).

Similarly to the wired internet, many of these new mobile web models and applications will require access to data and content in an efficient and user-friendly manner. Search engines, which are already the main gateways for more than half of the users connecting to the internet are already becoming the way to reach appropriate content and applications and to provide additional value to services in mobile platforms, as many recent studies show (Cui and Roto, 2008). The growing mobile penetration world-wide and the increasing mobile broadband availability are additional arguments justifying the increasing demand for effective search tools adapted to the mobile environment.

Mobile search will give added value to users when the results it provides match with their personal expectations, which requires, in turn, a simple-to-use end product or service which is a combination of key technologies such as –search algorithms, displays, context-awareness, wireless sensors and cognitive techniques– and also viable business models.

1.1.2. From web search to mobile search

In the future, web search will face at least two major challenges. One of them is to improve efficiency of retrieving relevant digital content in all formats, audio-visual in particular. While at the early days of the internet, information was predominantly text based, more and more audio-visual multimedia content is now available. In addition, peer-to-peer file sharing networks have been a significant and widely used tool for creating, storing, and exchanging multimedia content on the internet for more than a decade. The second challenge is to retrieve relevant information in a range of platforms, including mobile. These two challenges are not independent. Mobile internet is likely to follow a similar development pattern in content retrieval to the web, namely audio-visual information gradually gaining more relevance to text based one.

Applying this logic, mobile search would result in a mere translation or adaptation of the established PC internet search tools to a mobile environment. Even when adding some "mobility" attributes like the location of the user, this would basically result in extending the same approach (and systems and algorithms) to a new platform with its own specific features and limitations. Most of the available literature on mobile search refers to this "transference" of web search to the mobile domain. For instance, Kamvar and Baluja (2007) argue that a typical search session from a mobile device consists simply of formulating and entering a query, browsing the provided

search results and viewing the selected result, and Kolmonen (2008) defines the mobile search engine as "a piece of software designed for a mobile device to provide a service, or a portal, through which the user may submit a query (usually by entering a set of keywords) and get a list of results matching the search criteria".

However, from a mobile user's perspective a lot of interesting and relevant data and content can only be found on the internet with the help of contextual information. Such information can be derived from the mobile device, from the surrounding environment and even in the profile and (past, current) behaviour of the user. In addition, it is worthwhile recalling that mobile search is operated from a different device with which we have a much more personal and intimate relationship. Therefore, the mobile device will truly become a tool to bind together the real and virtual worlds (Feijóo *et al.*, 2009a). As a result, mobile search can go further than conventional web search and it should not be just an adaptation of existing internet search solutions to the mobile domain: it should also include new developments that make use of all of these other types of information to improve the meaningfulness and relevance of the search results and/or to provide a different and more valuable user experience.

Along these lines Zoller (2007) has identified ten attributes, from display and input to connection and reach, where web and mobile search significantly differ. They are summarised in Table 1.

From a techno-economic point of view, managing and exploiting the differences between "traditional web search" and "future mobile search" is one of the biggest challenges that mobile search providers face.

1.2. A categorisation of mobile search

Mobile search is about much more than the mere translation of present web search to the mobile domain, although most of the available literature has focused thus far on this process. Given the novelty of the domain, there is not yet a commonly accepted terminology in the literature. For instance, Morris (2008) introduces some categories, by making a distinction between the process and product of mobile search, while other observers make a distinction rather on technological grounds. The categorisation we propose follows a market rationale. Classification criteria include attributes like the reach of the search, the input parameters, or the features added to the search. Such attributes cannot be clustered

Table 1. Comparison of search in the PC and mobile environment.

ATTRIBUTE	ONLINE/PC	MOBILE/PHONE
Screen size	Large	Very small
Input capabilities	Good	Limited
Personalisation and targeting	Reasonable	Very good
Connection speed	Fast and improving	Reasonable and improving
Site optimisation	Good	Poor but improving
Localisation	Reasonable	Very good
Consumption patterns	Extended, stationary	Short, on the move
Pricing	Flat rate	Metered (but changing)
Degree of openness	Completely open	Traditionally closed (but changing)
Reach	Significant	Huge

Source: Zoller (2007)

into a single property, thus not offering always clear-cut boundaries between categories, but they help to visualize some market considerations. Table 2 presents a classification scheme together with their technology requirements and their implications per category.

Table 2. Mobile search categories

MOBILE SEARCH TYPE	CRITERIA FOR CLASSIFICATION	REQUIREMENTS	COMMENTS
On device	Reach	Typically software preinstalled in the device making use of non-standardised stored information	Retrieves information stored in the device
On portal	Reach	Typically software preinstalled in the device and bundled with operator/provider services. It is usually provided as a "white label"	Typically derived from a "walled garden approach". In disuse
Off portal (open)	Reach	Typically web search engine with result presentation adapted to mobile environment specific features (incl. using context info or presenting sites optimised for mobile devices)	Typically available in smartphones and requires a mobile broadband connection
Meta-search	Method / Input	Blends results from several search engines to improve results in the mobile environment and to include on-portal content	It could help to build context-aware search
Social network based	Method	Social tagging and folksonomies required	Highly complementary to any other type
Messaging service based	Input	Uses SMS or MMS. Requires a short number to send the request. Could include human response to query	Interface with limitations due to length and format
Voice based	Input	Typically similar to the above including in addition a speech recognition system	Nowadays still a slow and inaccurate interface in addition to above limitations if results provided in text
Multimedia (audiovisual and or audio)	Input	Uses the camera and or the micro in the mobile phone to query from a picture or sound. Results provided can be standard web pages and/or audio / audiovisual information	Depends on speech / audiovisual recognition and semantic web developments. Today is still mostly based on annotated content
Context-aware	Features	Uses context information (location, time, enviroment data, pictures, user data and profile, etc) to provide refined results of the query	Still under development
Local search	Features	Subset of the above using just location for improved results	Becoming part of the standard offer of search for the mobile environment

Chapter 2. Dynamics of mobile search: supply side

2.1. Market overview

2.1.1. A qualitative picture

Alongside TV and PC, the mobile phone is nowadays the most commonly used and spread ICT device world-wide. It offers directness and a level of personalisation that no other consumer device can match. Primarily introduced for voice (and later text) communication, mobile phones have turned into a full-feature multimedia device in less than 15 years. And soon they are likely to become prime gateways to content and services designed to enhance the day-to-day life of consumers in a practical such entertaining way, with services such as mobile internet, TV and video, games and music. The number and variety of such services within the mobile services market is constantly increasing (Verkasalo, 2008).

Despite the aforementioned evolution, to date mobiles continue to be predominantly used as interpersonal communication devices, enabling the share of information and the coordination of everyday life activities with family, friends, and colleagues (Ling 2004; Westlund 2007). As a particular example, empirical accounts from a Swedish study in 2007 further prove that mobile is mostly used for interpersonal communication through voice calls and SMS rather than browsing the mobile internet or accessing news information (Bohlin and Westlund, 2008; Bolin, 2008; Bolin and Westlund, 2009; Westlund, 2008a).

Some studies indicate that this behaviour is not restricted to a specific area. Katz and Aakhus (2002) concluded that mobiles are used as interpersonal communication devices in a similar way in the US, South Korea, and several European countries. By contrast, other literature state cultural differences (e.g., Campbell, 2007; Oksman and Rautiainen, 2003), which will become prevalent for the adoption and use of mobile internet services. Indeed, the uptake of mobile internet is much higher in Japan and South Korea than in Europe. According to Ofcom in the UK (2008), the average voice and data revenue per subscription shows the following trend: in Japan about one third is spent on data services, compared to 11% in Sweden. Japan has shown a high adoption of mobile internet, much thanks to the i-mode concept launched by NTT DoCoMo (Ramos *et al.*, 2002, 2001).

Overall, there seems to be a gap between the diffusion (possible usage) and the adoption (actual usage) of mobile internet services, i.e. although many people have internet-enabled devices, they do not use them as such. However, with faster networks, multi-functional handsets and more attractive pricing, the mobile environment may soon turn into a place for developing new services beyond voice and messaging. In this context, many actors are seeking to propose and offer killer applications that can drive mobile internet adoption, among which the development of improved mobile search functionality can potentially become the disruptive factor that could transform users' behaviour and experience.

2.1.2. Mobile market evolution

2.1.2.1. Preliminary assumptions

An important aspect that has been considered in the present report is the need for data comparability. For this reason and given the heterogeneous sources of information consulted, the methodology used to analyse and forecast the mobile market evolution follows similar definitions applied by reporters and market analysts (precisely Chard, 2008, and Lane, 2008), as well as the Database of the

International Telecommunication Union (ITU, 2009). This approach guarantees a certain degree of comparability, at least in terms of the order of magnitude of the forecasted figures. In the following, we will follow in the report –unless especially mentioned– the regional definition shown in Table 3.

Table 3. Segmentation of the world by regions

REGIONS	COUNTRIES
North America	US and Canada
South America	South American, Central American and Caribbean countries
Western Europe	Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Liechtenstein, Luxembourg, Malta, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the UK
Eastern Europe	EU countries not covered above, together with Albania, Belarus, Bosnia-Herzegovina, Croatia, Macedonia, Moldova, Russia, Serbia/Montenegro, Turkey and the Ukraine
Far East and China	China, Hong Kong, Macau, Japan, South Korea and Taiwan
Indian Sub Continent	Bangladesh, India, Nepal, Pakistan and Sri Lanka
Rest of Asia Pacific	ASEAN nations (Brunei, Cambodia, Indonesia, Lao, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam) and Oceania
Africa and the Middle East	Countries within the continent of Africa together with the Levant, the Gulf States, Afghanistan, Israel, Iran, Iraq and Syria

The term mobile internet needs some definition. In the beginning of this century, the trend was transfer web browsing to mobiles based on the WAP protocol and the Wireless Mark-up Language (WML). User acceptance was however low. There were many reasons for this (circuit-switching technology little suited to browsing, high prices, low connection quality, etc.), but more simply we can state that no attractive services and applications were offered to users. Recognizing this fact, the mobile industry started to improve the end-user experience, acknowledging that the mobile internet is not simply about repurposing the internet, but creating a relevant service and experience "made for the mobile".

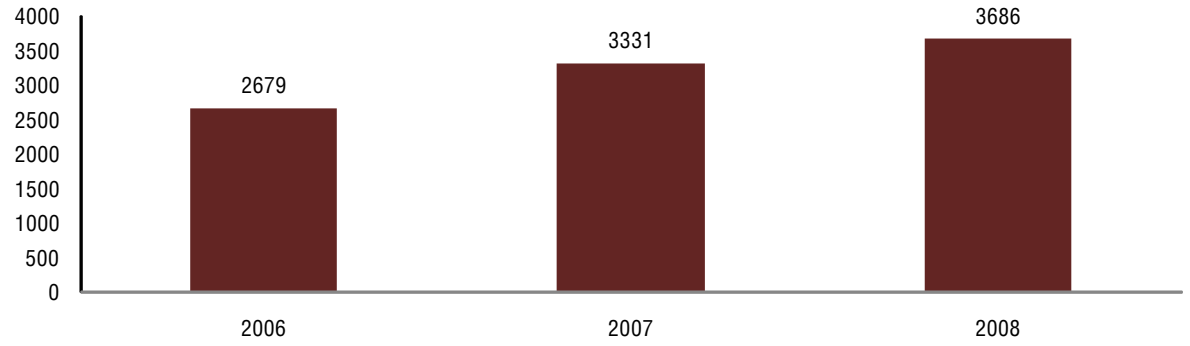
Thus, in this report we will refer mobile internet in the context of services, applications and content specifically developed for mobile users. Following the previous statement, mobile 2.0 would –by analogy to web 2.0– refer to mobile applications and services in which users have a decisive role. Without trying to aiming to provide a firm definition of mobile 2.0, the term refers to user empowerment basically through two main ways: by mobile social computing, and by integrating of the social web with the core aspects of mobility (personalization, location, context-awareness). User-generated content, services and applications that fully leverage the mobile device and the mobile context are constituents of mobile 2.0. In this context, mobile search delivers a richer mobile user experience by providing a smaller set of more relevant search results to the user based on context and location-aware capabilities. Given the need to make preliminary assumptions based on secondary sources of information (analysts and reports), this report follows the mobile 2.0 approach used by main analysts (Chard, 2008; Lane, 2008).

2.1.2.2. Subscribers

The estimated mobile customer base worldwide reached 3686 million users in 2008 (Figure 1). Up from 3331 million in 2007 this means approximately a 10.7% growth.

During the past years the subscriber base has increased particularly in the emerging economies of Asia, Eastern Europe, Latin America and Africa, with China and India being now the largest markets (see Figure 2). In addition, countries like Indonesia, Bangladesh, Ukraine, Brazil, Mexico and Nigeria show the highest potential for growth.

Figure 1. Mobile users worldwide (2006 – 2008).



Source: ITU (2009)

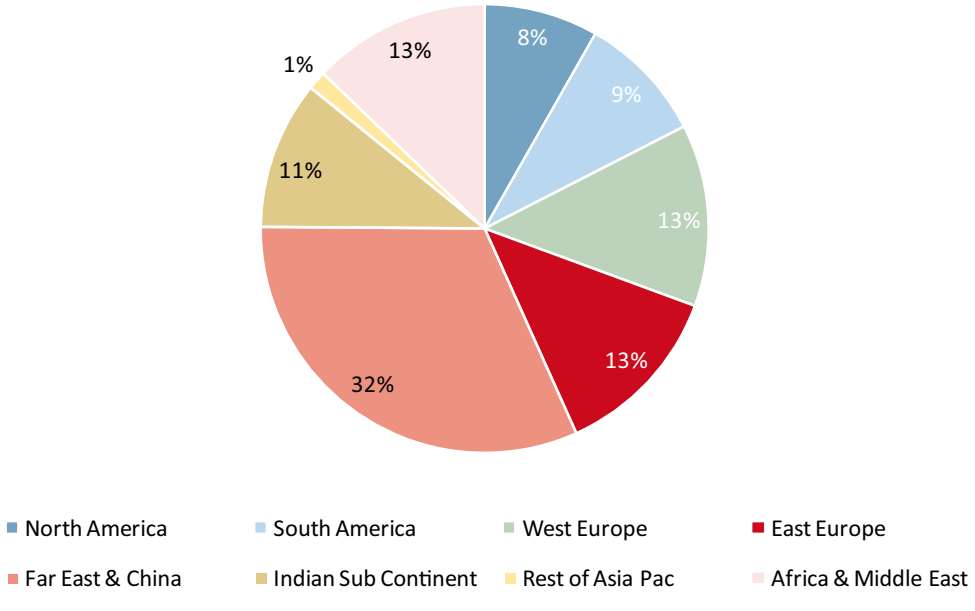
It is expected that this tendency in emerging economies will continue in the following years.

The growth rate in industrialised countries (particularly in Europe with only 3% growth) is notably lower than in the emerging economies, as their markets already exceed 100% penetration in many cases (119% in EU27).

Mobile internet users reached 3,686 millions in 2008 worldwide, representing 19% of all mobile users. By regions, the main concentration is in China and India, accounting more than 50% of users worldwide. Table 4 shows global mobile and mobile internet penetration by regions.

From the previous table it is important to retain that the highest mobile internet penetration is reached in the Far East and China region (which includes Japan and South Korea), although mobile penetration there is lower compared to other regions like America or Europe.

Figure 2. Mobile users by regions (2008).



Source: ITU (2009)

Table 4. Mobile penetration and mobile internet penetration by region (2008).

	Mobile penetration (%)	Mobile internet penetration (%)
North America	70%	11%
South America	77%	4%
West Europe	119%	16%
East Europe	110%	15%
Far East & China	69%	19%
Indian Sub Continent	21%	5%
Rest of Asia Pacific	62%	8%
Africa & Middle East	57%	8%

Source: own elaboration based on ITU, UN, EC (mobile penetration), Juniper Research and Informa Telecoms&Media (mobile internet penetration)

2.1.2.3. Industry revenues

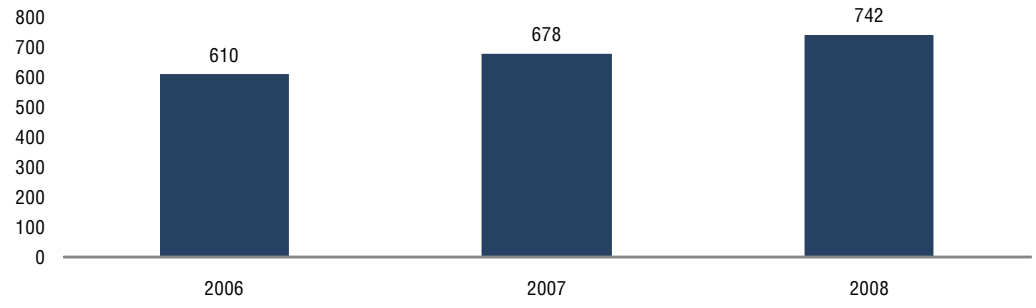
The world market for telecommunication services is estimated at 1,365 billion USD in 2008 –a 4.2% increase over the year before– and is expected to be worth over 1,416 billion USD in 2009 (Enter – IDATE, 2009). Mobile services account for 54% of the telecom services market. The estimated total turnover was 742.2 billion USD in 2008, and the annual growth rate has dropped from more than 12% in 2007 to 8% in 2008 (Figure 3).

From a regional perspective, growth rates vary greatly between mature regions and countries where growth is almost zero, and emerging regions and countries which continue to report a combined growth rate of just over 10%. Growth in North America, for instance, has been higher that in the European Union over the past three years: close to 11% in 2006 and 2007, then 5.2% in 2008 for North America; just under 5% in 2006 and 2007, then 2.7% in 2008 for the European Union. Industrialised countries in Asia have seen positive growth, although slowed down by the economic turmoil and Japanese market decline.

While the mobile customer base worldwide is still growing (12% in 2008), the global average revenue per user (ARPU) is a steady decline, dropping to 18.96 USD a month in 2008 (Figure 4). This reflects also that new customers are attracted in countries with lower incomes.

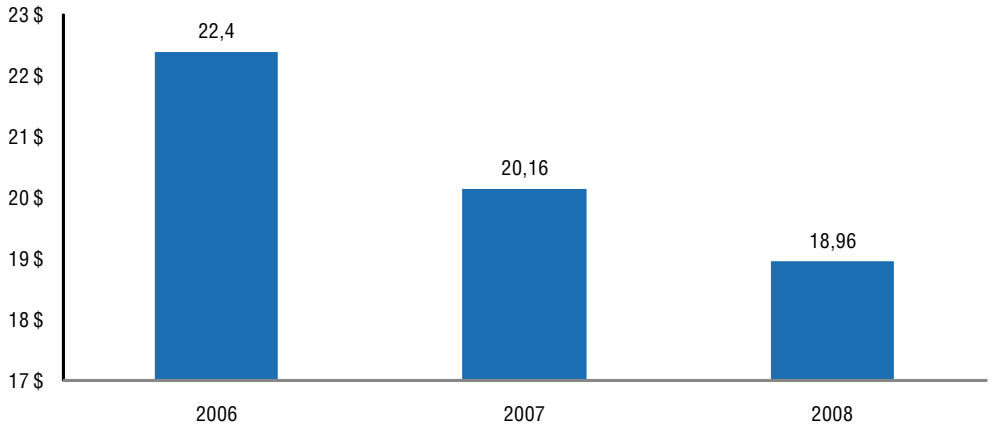
Data revenue continue to remain far behind voice revenue, still around 25% of voice revenue (Figure 5), and coming the most part of these revenues from messaging (two thirds in average). However, operators' investments in high-speed

Figure 3. Global mobile services revenues (2006 - 2009). Data in billion USD.



Source: Enter – IDATE (2009)

Figure 4. Mobile average revenue per user worldwide (2006 - 2007). Data in USD.



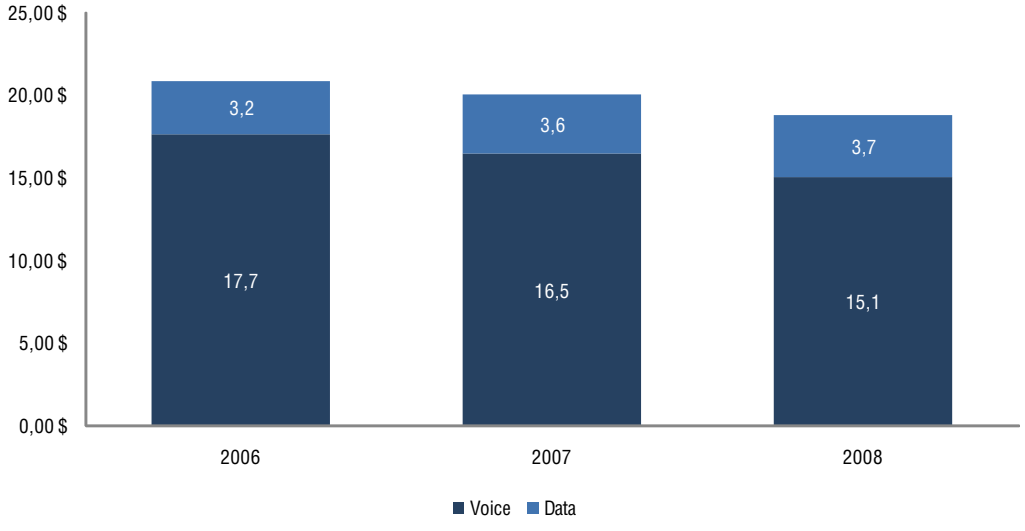
Source: Lane (2008)

data networks are starting to pay off, especially in South Korea and the US, where mobile operators obtain more than 50% of their data revenue from non-SMS services.

Apart from classic voice and SMS services, mobile operators see a growth driver in data services that is indispensable for their expansion. In fact, take-off in mobile data services is becoming real with a 20% share of total data revenue worldwide in 2008 (including messaging and non-messaging revenues).

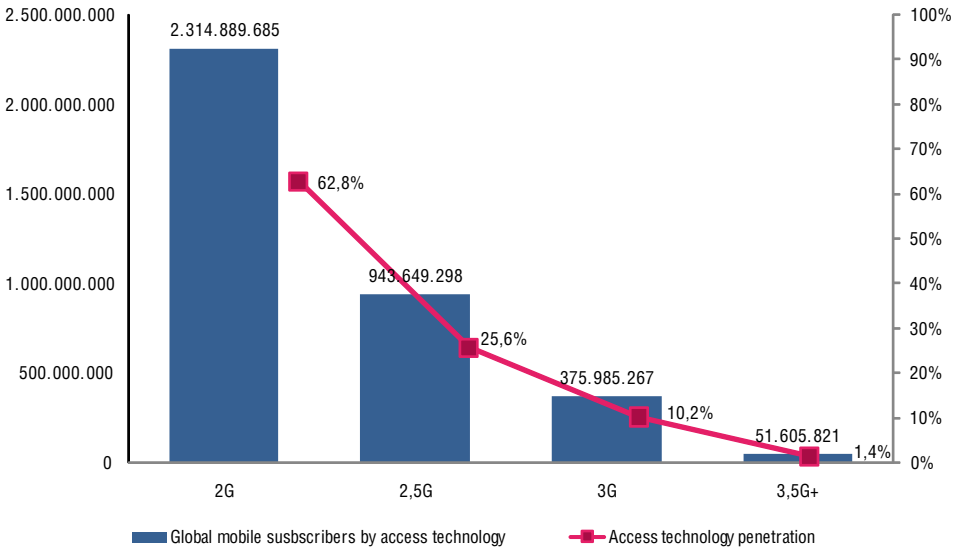
Non-messaging revenues are still low in Europe comparing to other regions, as they only represent 14% of total, with SMS being the predominant source of data revenue. According to a recent study by the EC (European Commission, 2009) most markets continue to register growth in SMS volumes which is compensating for the slight decrease in domestic prices. SMS accounts for an estimated 11% of the total mobile operators' revenues. In contrast, all three South Korean

Figure 5. Mobile average revenue per user: breakdown by voice and data (2006 – 2008). Data in USD.



Source: Lane (2008)

Figure 6. Mobile subscriptions worldwide by access technology (2008).



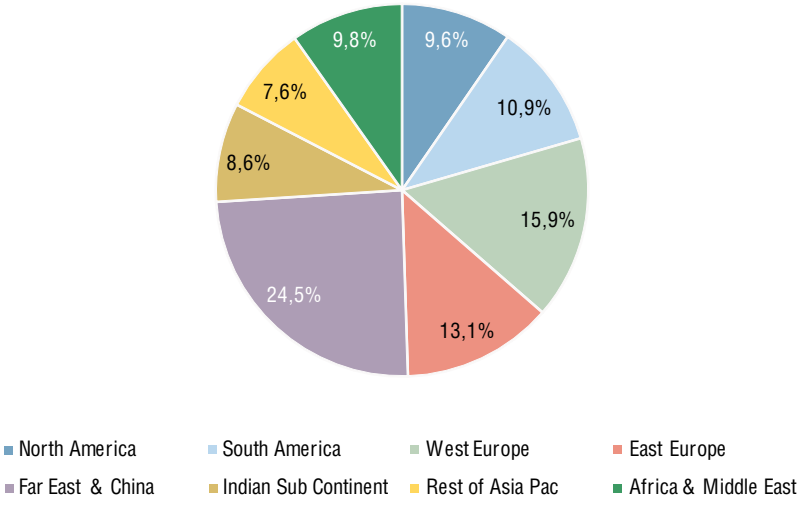
Source: own elaboration based upon data reported by Newman (2008)

mobile operators and the four US national mobile operators have more than 50% of their data revenues generated by non-SMS services.

2.1.2.4. Mobile broadband

By the end of 2008, more than 60% of global subscribers used a 2G connection, while around 11% of global subscribers (see Figure 6) were connected via "real" broadband (3G and higher). Mobile access is expected to shift in the coming years once 3G infrastructure has reached significant coverage levels, and the number of 3G subscribers is indeed growing rapidly. It is expected that broadband mobile connections

Figure 7. 2G+ users by region (2008).



Source: own elaboration based upon data reported by Newman (2008)

(3G, 3.5G+) will comprise more than 50% of total connections by the end of 2013.

From a regional perspective, the Far East and China region accounts for the highest penetration rate of 2G+ users (which includes 2.5G connections), followed by Europe (Figure 7).

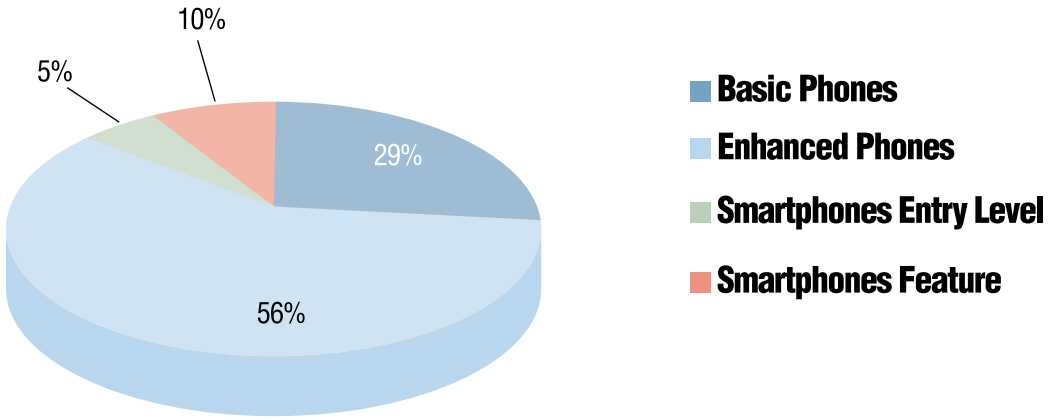
In Europe, mobile network operators are gradually catching up with fixed-line providers on price and speed for broadband, which might encourage fixed to mobile broadband switch over and mobile-only households (European Commission, 2009). In addition, flat rate pricing is fostering mobile broadband take up European mobile broadband users now represent a 15% of total subscribers.

2.1.2.5. Mobile handsets

In 2006 smartphones accounted only for 6.9% of the total market, while in 2007 this market segment reached 10.6%. This increase in sales reflects an excellent adoption of data-enabled devices. In fact, total annual sales of mobile devices reached 1,275 million units in 2008, with 71% of them sold with data facilities, of which 15% (of total sales) correspond to smartphones (Figure 8).

In Europe, 280 million units were sold in 2008, of which 19.3% were smartphones and 65.5% enhanced devices. These figures suggest that Europe is ready for data services consumption, although still behind frontrunners like Japan, with half of the mobile phones sold

Figure 8. Global mobile handset sales by device category (2008).*

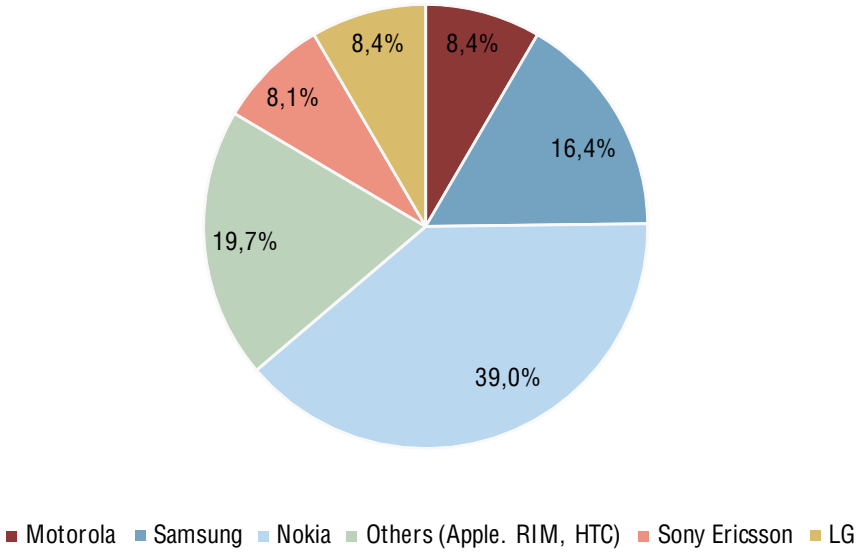


Source: Gartner (2008)

** The categories suggested by Gartner (2008) are defined as follows:*

Basic phone: *Voice-centric, entry-level mobile device costing up to $100 before subsidy with basic functionality targeted at emerging markets and first-time users and is often used for prepaid subscriptions.*
Enhanced phone: *Voice-centric mobile terminal with enhanced features, such as camera, MP3 player, video player, Java support, and calendar and contact synchronisation. These devices support data services, such as web browsing and multimedia messaging.*
Smartphone — Entry-level: *Smartphone closer to an enhanced phone in specification and usage, but because it runs on an open operating system, it is classified as a smartphone. The device primary focus is on voice communication.*
Smartphone — Feature: *Smartphone optimised in its specification and features to support one or more primary functions like music, video, gaming, pictures, browsing, mobile TV, navigation, messaging. Compared to entry level smartphones, these devices usually have larger displays, more powerful processors, more embedded memory and better battery capacity. These devices can have a touch screen to help the manipulation, consumption of content and data input.*

Figure 9. World mobile handset market by manufacturers (2008).



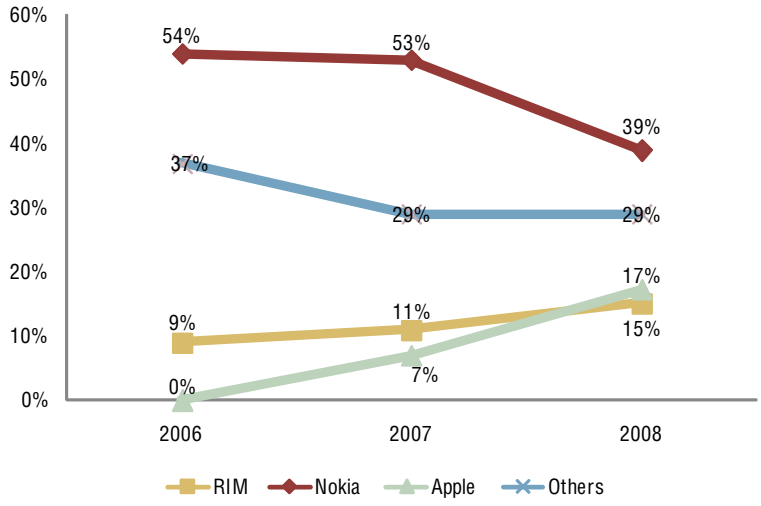
Source: Enter – IDATE (2009)

being smartphones in 2008 (more than 48 million). North America, with 20%, shows similar sold smartphone rates to Europe, with 20%. Although the Asian region (including India and China) showed a 17% growth from 2007, major sales correspond to basic phones, achieving 47% in 2008, and only 10% correspond to smartphones.

In terms of mobile phone manufacturers, Nokia has been leading the overall market (see data for 2008 in Figure 9), although specialised smartphone, particularly Apple, manufacturers are rapidly gaining market share.

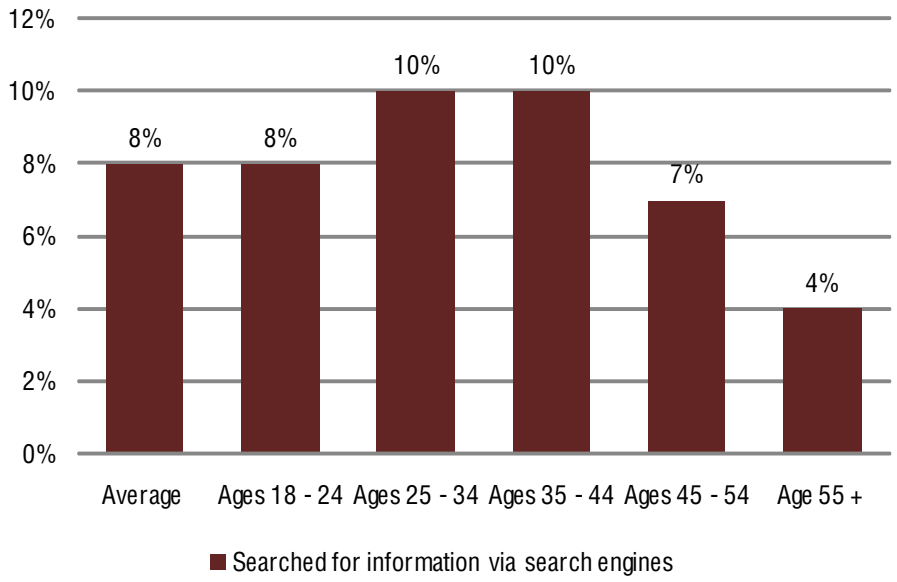
Focusing on the smartphones market, it is important to highlight the growth of Apple and RIM devices, while the relative decline of Nokia's

Figure 10. Market share for smartphones by manufacturers (2006 – 2008).



Source: own elaboration based on Enter – IDATE (2009)

Figure 11. Share of mobile internet users of mobile search services in the US by age (2008).



Source: Jupiter Research (2008)

market share is worrying albeit still the market leader for smartphones in 2008.

2.1.3. Mobile search market evolution

2.1.3.1. Mobile search users

One proxy towards understanding the activity of mobile search users is the age structure. According to (Jupiter Research, 2008), Figure 11 estimates the average figure of mobile users using mobile search services at 8% based on the results from a survey in the US. Interestingly, the adoption is slightly higher in the young adults segment (ages 25–34; 10%) compared to younger consumers (ages 18–24; 8%), which usually represent the early adopters segment for mobile data services. In any case these figures suggest a trend that will require further research to be validated.

Other studies suggest a direct correlation between age and use of or interest in mobile services: the younger the customers, the more they use SMS and new multimedia services (Jupiter Research, 2007). Also, users aged 15–24 are more willing to accept ads on their mobile phones than are average mobile users (24% and 16%, respectively).[4]

Even though overall adoption rates of mobile search remains in single digits, active mobile browsers are also searching from their cell phones, with 51% of daily browsers having used a familiar online search engine. These early adopters show that, similar to PC behaviour, search is often the default mechanism for navigating the mobile web. Driving more consumers to mobile browsing will likely increase the volume of searches from phones.

In line with these expectations, the "white label" mobile search provider JumpTap reports an average 100% month-over-month increase in searches across its carrier partners during 2008. Also, Google reported 50 times more searches from Apple iPhone users (on flat fee tariffs) using Google Search than from any other cell phone

4 An in-depth analysis of the mobile search demand components can be found in Chapter 3.

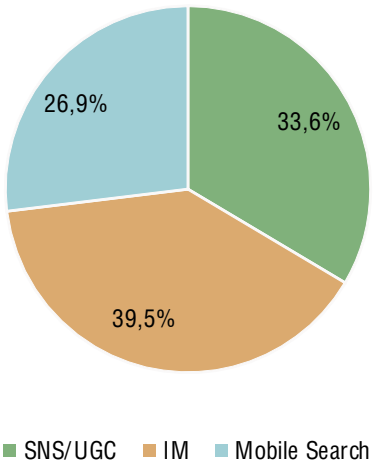
model, just nine months after Apple launched the iPhone

2.1.3.2. Industry revenues

The mobile search market is at an early stage of development. Its size is estimated at 1,480 million USD in 2008 of which 30% were generated by advertising and 70% from data traffic. The most important markets were China, West Europe and North America, with 85% of total revenues (Figure 12).

Although the mobile search market represented only a tiny 0.2% of the global mobile market in 2008, it is gaining relevance among mobile 2.0 revenues, representing 27% of mobile 2.0 market (estimated at 5,490 million USD in 2008) (Figure 13).

Figure 13. Global revenues for mobile web 2.0 by application (2008).



SNS/UGC: Social Network Services/User Generated Content – IM: Instant Messaging
Source: own elaboration based on data provided by Chard (2008)

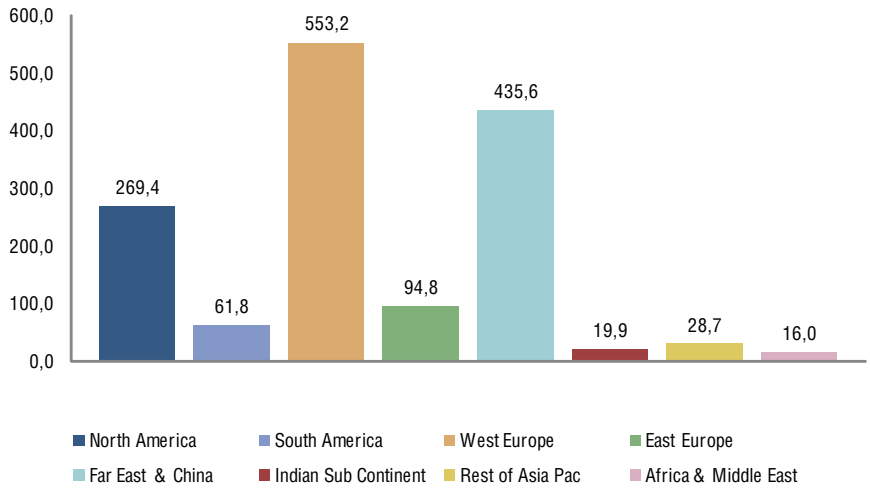
2.2. Mobile search business models

2.2.1. Mobile search value chain

The traditional value chain of the mobile industry (Figure 14), mainly rooted in voice and SMS and dominated by mobile operators, is evolving rapidly. The mobile internet is the key driver in this change as the moment to monetise past high expectations could have been arrived.

Different actors have different stakes and expectations. Mobile operators are seeking for ways to stop the declining average revenue per user

Figure 12. Mobile search revenues by region (2008) (data in million USD).



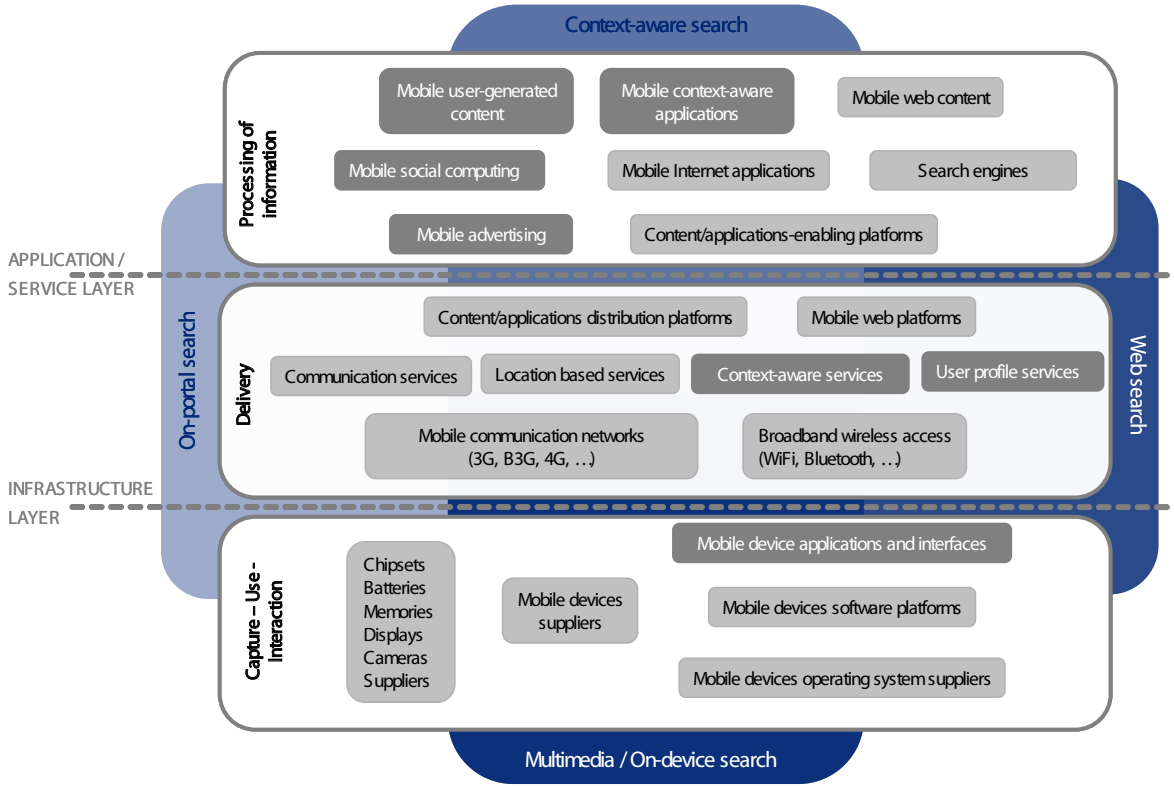
Source: own elaboration based on data provided by Chard (2008)

Figure 14. Traditional mobile value chain

(ARPU) in developed markets (saturated markets with penetration rates over 100%). Voice has been the predominant but declining source of income and mobile data business, thus mobile internet, appears to be the long term solution. In turn, traditional internet and media players are interested to expand into the mobile sector attracted by appealing business opportunities. They try to deliver new applications, services and content to attract users' interest and hence make a profit.

However, the main difference in these developing markets is the opening-up of the value chain to new players that will bring dynamism to the creation of new offerings that are attractive to the end users. The mobile internet value chain (and the business relationships between players) does not follow the "linear" model any more. It is rather a complex ecosystem where stakeholders compete and interact. The ecosystem metaphor is useful to refer to a high number of players that interact within a given environment and where none of them is able to control it completely, thus collaborating and competing at the same time. The "mobile ecosystem" is currently characterised by increasingly intense mobile

Figure 15. Mobile internet ecosystem



platform competition (Ballon, 2009a; Ramos *et al.*, 2004) and in general terms, it can be said that the focus of the mobile industry has shifted "from single-firm revenue generation towards multi-firm control and interface issues" (Ballon, 2007).

Adapting the proposal of Feijóo *et al.* (2009b), the roles of players in any mobile content or application value network can be broadly divided into three main stages: (1) processing of information, (2) delivery, and (3) capture/use/interaction of/with information. This three-layered structure is typical of ICT ecosystems (Fransman, 2007). As a particular mobile service, the mobile search value chain fits well within this same three-layer scheme. Figure 15 shows the main activities that players can adopt. The figure also illustrates the evolution of mobile search from the initial on-portal approach (left) to include on-device and additional input functionalities (down), the appearance of the mobile version of web search (right) and, finally, the context-aware search (up). In addition, the figure highlights (in the dark grey boxes) the activities which could be considered new and specific to mobile search.

2.2.2. Business models and revenue schemes

Using the aforementioned framework and taking into account revenue models discussed in literature on mobile web, applications, content and service models (Ballon, 2007; Ballon, 2009; Bouwman, 2003; Feijóo *et al.*, 2009b; Feijóo *et al.*, 2009a; Rappa, 2007; Uglow, 2007), Table 5 summarizes the revenue models that mobile search providers are using or the ones they could possibly use. These revenue models are shown from the perspective of the end user and therefore; intermediate provision models (e.g., white labels, wholesale, brokerage, billing services, software development, hosting, etc) are not considered. Likewise, the revenue models for mobile operators and (hardware and software) suppliers are neither shown in the table although some of them could benefit indirectly from the adoption of mobile search. The table includes an example scenario of usage and an indication of their current existence in practice. Finally, note also that the revenue schemes presented are not exclusive and some could be complementary to each other.

This list highlights the expectations put on advertising and user profiling as main revenue streams in mobile search. In the advertising model typically the search results are provided free-of-charge to final users, and the revenues are generated from third-party advertisers. Advertising models include several very different business tactics. For instance, there could be off-portal campaigns for certain categories of services such as travel, restaurants, automotive, or consumer electronics to name a few. The traditional strategy consists of simply adding banner ads to search results, usually including a direct response method as well (a link to a microsite, a click-to-call link, or a short code). This approach fits well, for instance, for events. As another example, click-to-call text links connected to search results is a simple way to leverage the voice capabilities of mobile devices. Off-portal keyword bidding, especially for marketers offering digital content is another main example. Without exhausting all possible options, ad campaigns for product related to what mobile operators offer on their mobile portals (ringtones, games, wallpapers, music, video, etc) is an example of on-portal search. Each of these examples could be equally applied to the case of user profiling in exchange of providing mobile search results.

The list also gives a hint to the still mostly unexplored potential of value added applications where mobile search, typically of the context-aware category, is the engine within. Mobile applications providers are looking for business models to incorporate the revenue flow from the application itself, therefore departing from the traditional pay-per-download. There are different business tactics here as well. These can include time-based billing for services, event-based billing for specific situations or item-based billing as a function of the results obtained in the search.

Table 5. Main revenue models for mobile search

REVENUE MODEL	CURRENTLY IN USE IN GENERAL	EXAMPLE OF SCENARIO OF USAGE
Pay-as-you-go (impulse purchase)	No	Travel
Premium services (basic functionality free)	No	Leisure
Value-added services (additional contract for services on top of conventional ones)	No	Productivity
Subscription	No	Well-being
Merchandising - Affiliation	No	Consumer goods
Packaged with the mobile device	Yes	Information Example (2007): Nokia is developing a Semantic Visual Search Engine to organize the multimedia content on mobile phones. According to patent filing, the technology enables "a system to learn, categorize and search items such as images and video clips according to their semantic meanings"
Packaged with the (voice, data) services of the mobile operator	Yes	Content Example (2009): O_2 Germany users can access to Yahoo!'s mobile-optimized search engine on O_2's mobile portal. Users can also sync their PC and mobile homepages. Yahoo! also delivers sponsored search results for O_2. It also includes links to and content from other Yahoo properties
Packaged with some product or service not related with mobile ICTs	No	Health
Advertising in general	Yes	Information Example (2009): Aroundme application (Tweakersoft, Italy) for the iPhone App Store, able to use location to search for main categories of services of potential interest for the user (parkings, banks, pharmacies, restaurants, etc)
Advertising linked with product placement	No	Additional value in purchase of goods
Exploiting user profile derived from mobile search for marketing purposes	Yes	Marketing Example (2008): Local.com is a local-based search engine for businesses. They use "sponsor links" based on users query and profile. Currently onlyoperates in the USA
Maintained by user community (and free for final users)	Yes	Community Example (2009): Openmoko is a open source software stack for mobile phones working on Neo FreeRunner phone where drivers are also open sourced as well as schematics and CAD files. Many open source applications do use the location capabilities to provide navigation and search features
Public service (not a commercial one)	No	City planning services

Forecasts of industry analysts offer valuable information on the potential of advertising and value added applications. For instance, Feijóo et al, (2009a), using data from an own survey of innovative firms in the mobile content and applications domain, provides some figures for the whole mobile domain: advertising was used by 24% of firms in the sample; pay per use / on-demand / pay-as-you-go was also a popular revenue model (17%), far outnumbering the subscription model (6%); the "secondary" revenue models of the internet (brokerage, user profiling, merchant, community, affiliation, etc) were also relatively well represented in the sample (11%). Interestingly, some form of sharing revenues (mainly with the mobile operator) was considered by less than 1 in 2 companies in the sample (44%), and less than 1 in 4 were explicitly using

"on-deck" strategies on the mobile operators' portals (22%).

Specifically in respect to mobile search, Chard (2008) expects the advertising contribution to the total mobile search revenues to grow from 30% in 2009 to 40% in 2013. According to the Mobile Entertainment Forum (MEF), advertising revenue split ratios will likely be similar to internet with about one third for the search solution provider and about two thirds for the publisher, including as a main difference with the web, a residual percentage up to 10% for other players in the mobile value network.

2.3. A snapshot of mobile search players

Mobile search is an emerging market and its dynamism explains the notable movements that are currently taking place. New developments and promising innovative services are practically launched every week. Acquisitions, alliances and mergers are happening as small companies need scale, whereas large firms can afford the risk of buying small and innovative companies. This is expected to continue in the future, as market maturity is not at sight. The information in this section of the report is a snapshot of the mobile search market as of Spring 2009.

2.3.1. Players in the main mobile search categories

The categories of mobile search described in Table 2 are useful to determine the principal activities of players in the mobile search marketplace and will be used below to list some of the main players.

2.3.1.1. On device search

With increasing storage capacity, search for information stored on the mobile device gets increasingly more important. The more handsets evolve to resemble mini-computers, the more users will be overwhelmed by their capabilities but will also suffer the complexity of their devices. Poor menu navigation is already a stumbling block to buying content and accessing services. That users are aware of an available mobile data service does not mean that they know how to access it or, more importantly, install it on their device.

On-device-search is still a niche market, facing some adoption hurdles. The need for improved navigation is there, however, difficulties around distribution and business models must be addressed before it can have significant impact. Usually, software pre-installed in the terminals performs the search. Players in this market include Boopsie, Kannuu and Nuance (through acquisition of Tegic, developer of T9 predictive text, and Zi Corp).

Tegic/Nuance offers a software tool that utilises search-based navigation to enable easy access to phone data, applications, settings and services. It allows users to access them with only a few key presses instead of scrolling through the menus. Similar to shortcuts on a desktop, the software personalises the mobile phone screen with the most commonly used content and services. Additionally, the solution's active memory remembers user data for future access and prioritises frequently used personal selections based on individual usage patterns, placing them high up on the device display.

Similarly, Kannuu's user interface presents the user relevant options at each menu level, along with a way for them to make their next move. The algorithms and the indexing capabilities work with the interface component to ensure the user gets shortcuts to content that is indeed available. Kannuu's technology can also be fine-tuned to learn over time which content is most useful to the individual user and place those results at the top of the list.

2.3.1.2. On portal search

On-portal search refers to search in closed frameworks. Often mobile companies restrict their services to their own network and applications

("walled garden" approach). "White label" search companies offer mobile operators mobile search solutions they may rebrand and provide to their customers in this manner.

The view that operator portals will keep dominating the mobile internet is becoming increasingly unlikely. Users want more and more going off-portal to explore the content and destinations they want and not the ones mobile operators have chosen or created for them and, increasingly, white label mobile search is losing momentum and market players are shifting their strategies. JumpTap, for instance, was rebranded as a mobile advertising solutions provider shifting from the original mobile search business. Medio Systems, a company that had a number of prominent mobile operators as customers, has also shifted following JumpTap's lead and sharpened its focus on providing advertising solutions to publishers.

2.3.1.3. Open search

The currently most common way to operate mobile search is via a separate application or a browser-based web site that seeks pages from the mobile internet. These are usually based on algorithms such as PageRank-like ones. Here, present open search solutions are internet search retrofitted for the mobile web. Search results then classified, adapted and presented in a suitable way for the terminal. For example, the number of results per page as well as the length of web-site titles can be adapted to the mobile terminal display size.

Users may still be satisfied with current performance, but this will quickly change. Mobile users want similar tools they accustomed from the desktop search. In a near future they will demand a higher quality in user experience. Therefore, open search is going to evolve from just tailoring the search to the device features to actively using various context variables such as location, the social communities users are linked at, past searches and user actions, user profile, etc in the search process and experience.

Open ("universal") search engines currently dominate also the mobile search market. Their strength resides upon PC search "inherited" behaviour and brand strength. Players include giants like such as Google, Yahoo!, and Microsoft's owned Bing. Note that Google is market leader on web search in the United States and most EU Member States, but has a less prominent role in emerging markets like Russia (leader is Yandex), China (leader is Baidu), or India (leader is Ziva Technologies owned Zook).

Whether and how providers of web search engines will ultimately lead also the mobile environment is yet unclear; though their technology expertise is a very valuable asset. Yahoo just released (spring 2009) new services and functionality and its approach, though universal, seems finely tuned to mobile. Similarly, Google offers an interface that includes four information repositories: the standard web search, local/geography based search, image search, and mobile web search. The latter means that the search only includes results of sites tailored for presentation on mobile.

2.3.1.4. Meta-search

Meta-search engines inquire a variety of content sources and providers and "blend" and combine a multitude of search results. This allows users to search across a number of content providers through a single interface. Meta-search engines deal with technological challenges frequently encountered in the mobile space such as heterogeneity of content, and the incompatibility of devices and systems. Meta-search is likely to gain popularity with progress in mobile commerce and online stores.

Players include MCN (Mobile Content Networks) and Motricity. MCN's customers base includes many of the major Asian/Japanese operators/providers (such as Yahoo Japan), and operators in Europe such as Telenor, as they offer a white-label search platform. Motricity gained significant traction in North America, but internal and financial issues might hamper further make

its expansion. Indeed, in early 2009 the company closed down its operations outside the United States.

2.3.1.5. Social network-based search

Searching for content within the proprietary database of a social network is technologically not dissimilar to web search. The data may be stored on a centralised or decentralised servers and data is enriched by users (e.g. tags, voting, reputation, etc.). Social classification of information (the "mobile social computing search" approach) is effective in web search and can improve search strategies also in the mobile environment, particularly in two different ways.

The first one is a specific case of context-aware search (see below), the information coming from the social network can be used to refine the search process, establishing different priorities in the way the information is presented or the results are offered. For example, if a user belongs to a social network about cars, it is expected that the search term "engine" is very likely to refer to a car engine. The second one that merits consideration as a distinctive search is the people-powered social search, using the social network to deliver not only raw information coming from a website but personal information or opinions.

Social search addresses some of the shortcomings of purely automated search. The introduction of an approach that effectively infuses human preferences and human judgments into computer algorithms gets us much closer to being able to pinpoint truly relevant information and better answers. A particular example case illustrating this is the "question and answers (Q&A)" within the group: a user poses a question expecting the response from a peer of the social network ("recommendation" engine).

Social search benefits from the increasing popularity of peer recommendation. A survey from Jupiter Research shows 64% of users will try a service or content recommended by a friend, and 69% will pass what they like along to between two and six friends.[5] Naturally, search results would benefit from some crowd-sourcing.

As a weakness of this kind of search, the over-dependence on human involvement can limit the ability of social search sites to scale and many argue social search results can never be as comprehensive as the results from universal search engines. Another problem is what the Nielsen Norman Group calls the dilemma of "participation inequality". As a rule, participation in the online world more or less follows a 90-9-1 rule, with 1% of users accounting for most of the contributions, 9% contributing from time to time and 90% of users preferring to lurk in the background rather than make a contribution. This is obviously an issue for social networks search engines across the board.

While technological challenges around scalability and algorithms might affect pure social search engines such as Hiogi, approaches combining machine-driven algorithms with social elements, can, to an extent, overcome these challenges. This is, for instance, the case of Wikia and also with Taptu, which crawls and indexes the social networking sites and destinations to expose an eclectic mix of results. In addition to aforementioned Taptu, Wikia and Hiogi, other actors include Abphone, WikiAnswers.com (coming to mobile soon with a Wiki approach), Yahoo (drawing from size, scope and strength of with Yahoo Answers community), Mahalo (a company building, and paying, contributor communities to direct searchers to relevant results), or nimble newcomers like NosyJoe (a private beta social search engine that relies on people to "sniff the Web for interesting content").

2.3.1.6. Messaging service-based search

Text-messages-based search services allow users to send a question to a central database (usually calling a special short number) and

5 Data taken from http://www.msearchgroove.com/2009/03/05/will-tapping-the-wisdom-of-crowds-outsmart-mobile-search-giants/

receive a reply using text based features (usually SMS), or in some cases receiving a MMS with more information, or a link to a web address where the user can find the response to their question. The response can be delivered by two ways:

- Human based: The answer service is provided by a person who looks for the requested information. Two cases can be distinguished: For professional services, questions are displayed from the central data base of the company providing the service to a pool of professional researchers. For social network based services (a particular case of social network search), questions are delivered to the social network members asking for a response through a centralised server. The strategy for subscribing and publishing may be defined upon the mobile social network rules.

- Technology based: In this case, the question is processed either directly (as a normal search using the same technologies as for a web search engine), or via semantic analysis using natural language to produce a coherent response.

The strength of text-messages-based search is its simplicity and ease of use: all mobile users are capable to send search queries via SMS. In addition, this allows mobile users without broadband access, which is still a large mass market, to search for information.

On the other hand, Schusteritsch *et al.* (2005) rightly pinpoint to the limitations of this interface, notably the limitation in the length of message and that the user has to know the number (to send the query to) and the message format. As a consequence, this is neither an engaging user experience nor there is room for differentiation.

Tough competition, in a buoyant and quite crowded market, does not allow for high revenue margins and forces companies in this market segment to come up with ways to purchase SMS in bulk and defray additional costs. ChaCha is market leader in the United States. The relative strength of players outside the United States is less clear. Important local provider include 4 INFO (focused on delivering alerts and advertising); MINFO (Chinese with English language service Guanxi); textperts (acquired by 118118 in the UK); Answers.com (primarily online with mobile offer), AnyQuestionAnswered (AQA), Ask and AskMeNow. Google also offers SMS search.

2.3.1.7. Voice-based search

Progress in speech recognition paved the way carry out a search by speaking into a phone. Voice-based search fits well mobile lifestyles and the legal requirements for hands-free communication while driving, for example. Technologically speaking, voice-based search is a tougher speech recognition problem than, for instance, selecting a name from a list of contacts (voice dialling). Given the technological complexity, speech recognition functions are usually are not embedded in the device itself. Rather the speech recognition and processing runs on the server. The server receives the digitised speech through the mobile data channel for recognition. Once the question has been recognized, the search algorithm comes into operation. The results are then sent back and typically displayed as in the format of a web search text box. Alternatively the answer is sent back via SMS or "outspoken" employing a text-to-speech converter.

Systems capable of turning a query into a dialog, posing and answering questions about the request, can be foreseen in the near future. In cases of query ambiguity, narrowing the request by reducing its scope is an important part of a conversation in real-life, and so it will likely become equally important on mobile search. Despite undeniable improvement in speech recognition, user acceptance it is not clear. Users may feel more comfortable to type text rather than using voice, or vice versa.

The market leader in speech technology is Nuance Communications. Nuance has a subscription-based voice search service, Nuance Voice Control 1.0, which is been used by operators such as Sprint Nextel, Rogers Wireless, or Telus. Next integrated solution, Nuance Voice Control 2.0, is said to use both on-device and in-network technology that includes voice search, but goes well beyond it, even allowing a user to dictate a text message.

Another interesting player is SMS search specialist ChaCha. This company uses voice recognition technology to interpret queries submitted by customer's calling the 800 number from their mobile phones. The questions are then answered by ChaCha personnel, who conduct the internet search on the user's behalf, and delivered to the customer's device via SMS (see messaging-service-based search section). Recently they released a voice search service for iPhone.

Big companies like Yahoo!, Google and Microsoft are also trying to penetrating the voice-based search market. Google recently launched a voice search solution (a free Google Mobile App) to download for Apple's iPhone. This application uses a range of commercially available and internally developed speech technologies. Google has also voice search service tailored to Android mobile phones.

Microsoft made the grade announcing a five-year deal with Verizon to use their voice-enabled web search. The speech technology has been developed internally by Microsoft and the Microsoft Research website states the objective plainly: "In the Voice Search project, we envision a future where you can ask your cell phone for any kind of information and get it".

On its part, Yahoo! announced its "oneSearch with voice" in a keynote talk at the CTIA Wireless meeting in April 2009, using a solution from Vlingo, which in turn used speech recognition technology from IBM. Vlingo Corporation had introduced its own voice search service when it launched Vlingo for BlackBerry in June 2008. This was followed by Vlingo for iPhone in December 2008. The company plans to also launch Vlingo for Symbian and Windows Mobile devices.

2.3.1.8. Context-aware search

The relevance of retrieved information improves the more the system is aware of the search context, i.e. takes into account the context the user is in, including the location of the user, its profile or any other useful information about the personal environment. Mobiles, being personal devices, offer valuable contextual information, because the location is (usually) known and easily identified. Using information about the user's context, the search engine can perform a personalised search and offer tailored results. Although sometimes the participation of the user is required, these technologies are different from the "search-based on preferences", in which an action to predefine preferences or to refine results is needed.

Mobile operators are ideally placed to develop context-aware search solutions of their own. With the limits of law, they have access to users' location and context, profiles and purchases, the sites they browse, and the search results they consider relevant. With the adequate solutions, harnessing operator analytics and customer data, telecom operators may opt to compete with established (web) search engines and even introduce own brands. Additionally, if mobile operators chose to bolt on the mobile advertising module, they can position themselves to offer paid search advertising from a variety of advertising networks. Services making use of the terminal and user context are expected to build up in the forthcoming years; business models (e.g. personalised advertisement[6]) will have to be adapted to it. Established "universal" search players are already developing alternative

6 Privacy and data ownership information management are major issues for context-aware search. Privacy and data policies are outside the scope of this document.

context-aware solutions. In addition to telecom operators and big search companies, there is a window of opportunity for specialised companies like Openwave to compete in this market.

2.3.1.9. Local search

A simple context-aware search application is looking for information about places or objects which located in the surroundings of the user's (e.g. restaurants near M street in the city N). Here, the context of the query is the (present or future) location of the user; relevant information is, thus, only those contained within determined spatial perimeter. Value to this basic search would be added by matching the retrieved results with the user's preferences. In the aforementioned example, the nearby restaurants may –for instance– be ranked by price and fitting the typical economic profile of the user. Maps and tourist information are other examples of applications where mobile search will be a key tool for the deployment of local search services.

Towards developing "fully-conscious local" applications, a number of approaches are under way to be investigated. Four distinct, but not necessarily non-overlapping, categories can be identified:

- In the past, so-called "operator assisted yellow pages", whereby agents help users to find listings or other information, were repeatedly introduced without permanent success. As of today, is seems that ad-supported directory assistance appears to have a future. In 2006, roughly 6.5 billion calls were made to 411 numbers in the United States; and many more to similar numbers world-wide. Because of several factors (e.g., corporations blocking 411), directory assistance continues to shift to mobile phones. Hundreds of companies in this segment do exist, prominent examples being Jingle Networks, Yellowpages and Dial Directions.

- Messaging service-based local search is very prominent, although loosing attraction in favour of "real" mobile internet browsing. In addition to the search service, many of companies also allow content and contact details to be received via text message in addition to audio (some with ad jingles or other audio advertising). Players in this segment include 4Info (partly owned by newspaper publisher Gannett), Citysearch, Microsoft's Tellme SMS, Google SMS and a slew of yellow pages publishers ranging from Yell.com to YellowPages.com.

- Web local search is the growing group of local search players. Companies in this group include Yelp, Local.com, mobilePeople and Yahoo's oneSearch. In India, innovation in local search is happening, with at least a dozen companies including AskLaila, JustDial, Onyomo, Yulop and Alabot in this business.

- Major search providers offer downloadable applications, many of which are being pre-loaded on phones (using, for instance, the Where and Zumobi platforms). These applications offer a rich user experience. A drawback is that applications must be downloaded first; thus representing a barrier to adoption for users. Providers, thus, aim at getting these applications preloaded on new phones and/or offering the application in an open web environment. This is a common approach of leaders like Google and Nokia (since acquiring Navteq). Nokia has a long track record in local search, dating back to 2004-2005 when it brought together more than ten local search providers for its mobile search application.

Local search is a natural fit for mobile phones. Providers of directory assistance have a paved road to get local businesses involved into mobile search and paid search advertising. This is hailed as an effective way to deliver advertising, although few brands are actually harnessing location to deliver a marketing message. Local search markets are fragmented, many players competing is small markets, making large distribution and brand awareness a big issue. Click-to-call advertising is the major revenues, and it has generally been difficult for companies to scale up. One option could be to team up with famous search engines; but at the risk of directory assistance companies being cut out of the value chain, as it happened in the desktop internet scenario.

2.3.1.10. Multimedia search

Different techniques are applied to audio and visual search. Using text or multimedia information as input, (different) multimedia information has to be obtained as a result. The most common way to search consists in (ideally semantically) annotating the multimedia contents with algorithms which classifies the contents. The approaches to perform the content annotation and indexing depend of the content format (video, audio, speech, images...). In addition, in a mobile environment it is necessary to adapt any multimedia search designed for PCs. For instance, in the case of searching for images on a mobile, it could be necessary to select an area of the image which contains the main interesting information for the user.

The multitude of vertical content segments (music, games, images, video) means a lot of companies playing in this space: Abphone (for images, games and music), Vtap (Veveo service for web video and embedded in a variety of devices); Truveo (also video search), Thumbplay (own tools for mobile content search), Fox Mobile (developing own applications for search and recommendation of content); plus dozens of iPhone search apps for music (overlap with offers here such as TinEye, a visual search service with focus on music).

In many cases, the content business model preserves the walled garden or silo approach, making it potentially difficult to offer users related content (images related to music downloads), or cross-sell and up-sell when the aim of the search is to find and buy content. Companies in this space must generally go direct to consumer or rely on word-of-mouth. Building a mass market reach can be difficult.

2.3.2. Case study on visual search

Visual search is a special case of multimedia search. The most appealing service based on visual search permit users to start a search by just snapping a photo of something with their cameraphone. A mobile search engine processes input with the help of algorithms and returns relevant digital content based on its interpretation of the user's visual query. MMS is the usual way to send the query.

The value proposition of visual search is simple and powerful: what you see is what you get. Unfortunately, today's services are still limited by the mobile camera's characteristics not to able process blurry photos or intolerance to poor lighting. The search process needs to start form an image of sufficiently high quality, which is often not the case as users take casual snapshots.

In this section, we discuss the visual mobile search market as of spring 2009. It includes a landscape of the main players: mobile operators, vendors and a more detailed analysis of Nokia's strategy.

2.3.2.1. Mobile operators

At the March 2008 Cebit trade show in Germany, Vodafone demonstrated Otello, a service using images as input to mobile search. Users send pictures via MMS from their mobile phones and Otello returns information relevant to

the picture. The technology behind the service is not disclosed, but in November 2008 Vodafone Ventures Ltd., the venture branch of Vodafone, participated in financing raised by Evolution Robotics Inc. Evolution Robotics' technologies of visual pattern recognition and autonomous navigation are used by over 100 organisations and companies worldwide in many commercial and consumer applications.

Similarly, Japanese KDDI also offers visual search using the mobile's camera. Its technology, ER Search, is provided by Bandai Networks and powered by Evolution Robotics' ViPR visual pattern recognition system. As in the previous case, users can snap an object with their camera and then get content about the object sent back to the device. For example, by snapping a CD cover, the user will receive web information about the artist, sound clips of their songs and offers to download them.

In the same way, T-Mobile and Verizon subscribers can use Thrrum MMS Search (provided by 23half Inc.) to find and browse information related to their physical environment using the MMS service integrated into their phones. The publicity of the company argues that "with Thrrum, any text users see around them becomes a hyperlink that can be 'clicked' upon with their camera phone". The Thrrum MMS Search beta service is available free of charge to subscribers in the United States. The MMS Search technology is protected by an extensive suite of patents pending worldwide.

2.3.2.2. Vendors

Kooaba focuses on "creating hyperlinks between objects in the real world to relevant content on the mobile internet". Founded as a spin-off company from the Federal Institute of Technology (ETH) in Zurich, the company's technology does not rely upon artificial identifiers or tags attached to objects, but on pattern recognition, i.e. it tries "to recognise" the object. The target audience is publishers and advertising agencies, and the value proposition centres around cross-media publishing and advertising through linking print material to digital content as part of an integrated marketing strategy to increase brand awareness.

IQ Engines was founded as a collaboration of computer neuroscientists at University of California in Berkeley and in Davis. According to their website, its goal is to "bring advances in biological vision models to practical image and video search, using algorithms that are hierarchical and massively parallel (fast and accurate)".

Mobile Acuity, a spin-off of University of Edinburgh, is focused on enabling interactive brand marketing campaigns. The flagship offer of the company is its Visual Interactivity platform. The company recently made this technology available for incorporation into applications on the Android and iPhone platforms. Services for other mobile platforms are announced. In addition to image recognition capability, Mobile Acuity's Visual Interactivity technologies/features include Image Zoning (which determines which section of an image the consumer is pointing at and returns an appropriate response), Color ID (which analyzes the dominant colours present in an image and uses these to create a customised response), Virtual Blue-screening (which can extract the foreground of an image and reuse this within the response to the user), and Face Finder (which, in this case, extracts faces from the image for reusing them within the response returned).

SearchMe takes a different approach to visual search and lets users see what they are searching for. As users start typing, categories appear that relate to the query. Users can choose a category and see pictures of web pages that answer the search. Users can then review these pages quickly to find just the information they are looking for, before they click through. However, SearchMe has gone offline (as of November 2009) due to financial troubles. It is expected they will sell their intellectual property.

SnapNow tries to differentiate itself by including in its responses not only links to relevant web pages related to the image received, but also a number of options including a call-to-action, comparative pricing information or the chance to enter a contest. It is literally stated that the company's patented technology "can turn any image anywhere into a URL". SnapNow's growing client base ranges from Woman's Day to Manchester United to Madonna (Warner Music) to "snap-enable" their content. In the case of Madonna, SnapNow "snap-enabled" a music video, making every frame interactive and allowing consumers who capture an image to access content related to the music video on the mobile phones.

SnapTell, acquired by Amazon's subsidiary A9.com in June 2009, is another company whose focus seems to be on enhancing print advertising, where they have a number of high-profile clients including Sports Illustrated, Rolling Stone and Martha Stewart Weddings (one of the issues is full of interactive ads that invite users to Snap.Send.Get and get tips, special offers, downloads and store locators). SnapTell claims to offer the industry's most scalable image recognition technology for camera phones. It filed a patent (pending) for image matching said to operate with databases of millions of images, whose algorithm for image matching has been called "accumulated signed gradient". The technology would be integrated as complete hosted mobile marketing solution available to interested companies. They also offer their technology in targeted applications for platforms such as the iPhone and Android.

Idée's initially focused on music; yet they announced future releases that will include also books, games and support for smartphones. The service allows users to find out more about a CD by taking a picture of the cover, as well as get pricing information and music reviews. In the case of TinEye (their application for iPhone), the image identification system recognises it and delivers users links for that album on iTunes, allmusic. com, YouTube, and Wikipedia. TinEye Music does not use image metadata or watermarks.

The activities of big players in this domain are somewhat unclear. Microsoft research has taken the wraps off of a prototype visual search engine called Lincoln. No further news has been announced, as of spring 2009. Google plans are also unknown. The company made no announcement since their acquisition of mobile visual search pioneer Neven Vision in 2006. It has become also become "quiet" about Mobot, since the company was acquired by barcode and marketing company NeoMedia in January 2007.

2.3.2.3. Case study: Nokia

Nokia had been talking up its visual mobile search capabilities since 2007, when they took over Pixto, a San Francisco-based start-up in the domain. In spring 2009, Nokia introduced Nokia Point & Find, in what they call a "new way to connect with information and services on the go". A beta version of Nokia Point & Find, focusing on movies, is available in the United Kingdom and the United States and will be expanded to other countries.

Nokia Point & Find is an open service platform whereby businesses would be able to target engaging experiences and calls-to-action to consumers. The first Nokia Point & Find-based service for movies allows users to receive information on trailers, reviews, and theatres it is show by pointing the camera at a movie poster. Nokia is inviting marketing agencies and content providers to propose how their visual search service might be introduced for specific applications, campaigns or promotional activities.

Nokia's press release states that Point & Find uses real-time image processing and recognition technologies. It uses the picture and GPS position to evaluate the object. When the object is identified, it searches a database of tagged items for associated content and services and returns a set of relevant links. For this, Nokia uses a tagging

tool that it and its content, brand and advertising partners are using to build content for the service. Once tagged, the URLs for all images and related internet information that have been tagged for the service become part of the Point & Find database. At the outset, this database will be specific to a particular service, which Nokia will be building and commercialising it one content sector at a time. But the concept is unlimited, and Nokia intents to build it out as far as it will go. Speed is said to be another asset: the content comes up on the screen immediately, as soon as the device "sees" the physical object.

It can be concluded that Point & Find is more than a mobile search tool and that Nokia has clearly taken position in visual search. It might represent a step of Nokia's wider business strategy to bring closer together software, services and advertising.

Chapter 3. Dynamics of mobile search: demand side

3.1. Demand and social acceptance

Understanding adoption behaviour of mobile search seems to be largely overlooked in literature as our review on relevant studies on the use of mobile device functionalities and services illustrates. A recent benchmark exercise by ComScore includes ten different mobile internet activities but none of the indicators takes mobile search into account (ComScore M:Metrics, 2008b). A report by Morgan Stanley from 2008 on iPhone usage illustrates the frequency of usage for sixteen mobile service functions but again excludes mobile search (Pascu, 2008a). Another survey carried out in Finland during fall of 2007 with 579 panellists measured the intentions and usage related to seventeen mobile services. Again none explicitly measured mobile search (Verkasalo, 2008). Another indication that this area is at its infancy is illustrated by the conclusions of a literature review of "mobile commerce" from 2007: mobile commerce refers to any transaction through a mobile network that has monetary value; however, the authors' categorisation did not include mobile search (Ngai and Gunasekaran, 2007).

Fortunately, a few interesting studies on mobile search use do exist. Moreover, mobile search is not a service created from scratch. Therefore, common factors impacting adoption and use of mobile internet services relate also to the area of mobile search. For this reason we will describe adoption and use of mobile internet services first from a general point of view.

3.1.1. Adoption and use of mobile internet services

Similar to other advanced ICTs, the adoption of mobile services is likely to follow some basic factors acting as drivers or barriers for acceptance and use. Here, the technology-acceptance model (TAM) is one established method to analyse the deployment such new technologies. The TAM concept makes use of variables like the perceived usefulness, the perceived ease-of-use and attitude towards use. Examples such a methodological approach include a studies of mobile services in general (Pedersen and Thorbjørnsen 2003); of mobile internet business use (Pedersen 2005); of using mobile calendars (Sell and Walden, 2006); and of mobile news services (Westlund, 2008b).

The size of the screen and keypad, the transfer rate, the payment model and the quality of service are recurring factors in the context of adoption in many studies. In 2008, Verkasalo (2008) carried out a quantitative analysis of a mobile service adoption process, concluding that user-unfriendly devices are the most outspoken argument for not using mobile services frequently, followed by pricing and the absence of feeling of a real need to use the service. Other factors such as configuration, installation or performance of services are perceived as less important. The importance of cost and users statements not seeing the use a service are appear also in other qualitative studies (Westlund, 2007b). Kolmonen (2008) identifies flat-rate tariff pricing as a driver for diffusion, and low usability –especially the resolution of small screen and cumbersome character input– as a major barrier.

Ling and Roe (2009) studied the use of the mobile device comparing iPhones with other devices. They analysed the data actual traffic data of 3,917 (anonymous) Norwegians. They monitor that iPhone owners downloaded approximately 35 megabytes per month, while users of other devices downloaded about 2 megabytes. Nine out of ten among iPhone users had become

regular mobile internet users, while about half of the general users never did so. Ling and Roe observe that iPhone-users not only use mobile internet more often than other users, but –more importantly– they also altered their behavioural habits. Possible explanations include the socio-demographic structure of iPhone owners, the user-friendliness of iPhones and convenient data subscriptions offers. Other studies, also confirm that the innovative smartphones facilitate the adoption of advanced mobile services. A study by M:Metrics from January 2008 shows that 85% of iPhone users read news and information from the mobile device, while only 13% among general mobile phone users did so (Pascu, 2008b).

Cultural factors also matter. According to Barnes and Huff (2003), the main reason for the relatively high adoption of mobile internet in Japan is that it fits Japanese cultural values, particularly their enthusiasm for electronic devices. They also argue that the Japanese have a strong cultural tendency towards group conformity, which helps to accelerate adoption and usage once a technology reaches critical mass. Similarly, Heres *et al.* (2002) conclude that mobile internet has had a wide diffusion in Japan because Japanese tend to spend much time outdoors due to their small living space, which offers little privacy. These discussions stress the relevance of culture and lifestyle factors.

Concerning perceived usefulness, the services and content offered in the mobile sphere is, of course, the critical aspect. Bauer *et al.* (2005) have examined the market potential for the mobile as a multi medium and to be used for mobile marketing. Their conclusion is that the main drivers for use are entertainment and information. There has been a lack of killer applications driving the use of the mobile internet.

Will mobile 2.0 become a killer application? Since mobile phone has become so successful as a communication medium, it would not be surprising if social networking that is so popular over desktop internet would gain similar success also in the mobile domain. A report on the international communications market confirms that mobile social networking is beginning to grow in popularity (Ofcom, 2008). More concretely, ComScore M:Metrics (2008b) report that mobile social networking grew 152% from November 2007 to November 2008. However, the average penetration rate across all measured European countries is yet barely 5%, although the trend is indicating increased usage. Pascu (2008b) also warns on exaggerated optimism. After discussing the emergence of different types of social computing applications such as micro-blogging, podcasting and social tagging (even integrating context-aware aspects that are unique to mobile devices), she notes that the diffusion of mobile devices does not automatically translates into a rapid adoption of mobile internet and that the current user base is limited.

To sum up, previous research shows that the adoption and use of mobile internet services is related to a dozen main factors. The non-exhaustive list of mutually non-exclusive factors include: 1) cultural values, 2) interest in technology, 3) lifestyle, 4) perceived ease of use, 5) perceived usefulness, 6) attitude towards use, 7) existence of user-friendly devices, 8) pricing matters, 9) general perception of need, and also 10) quality of the services and content offered. In the following section we will argue that most of these factors are also related to mobile search.

3.1.2. Adoption and use of mobile search

3.1.2.1. Demand for mobile search functionality

A critical question is whether there is a real consumer demand for mobile search or not. Haddon and Vincent (2008) have conducted focus groups with 11-16 years old children in the United Kingdom. The following quote is extracted from a discussion with a group of 11 to 12 year olds on what kind of mobile internet services they wish to use (Haddon and Vincent, 2008:16):

Annabel: My friend, she forgot her homework. So she looked something up in Google on her phone and wrote the definition down.

Alicia: Wow. Oh, I want Google (…) I'd do my homework on the way to school.

Is mobile search generally as appealing for everybody as it is for Alicia? A European study conducted in late 2005 revealed that 6% of mobile users actively use mobile search (Church *et al.*, 2007). More recently, ComScore M:Metrics (2008a) measured how many mobile users used their mobile device for search in France, Germany, Italy, Spain, the United Kingdom and the USA. They recorded the average number of users in April, May and June, comparing the years 2007 and 2008. In 2008, there were 20.8 million mobile search users in the United States (9.2%) and 4.5 million in the five listed European countries (5.6%). This represents an increase of 68% and 38% from June 2007, respectively. The United Kingdom showed the highest penetration rate followed by the USA and the other European countries. In addition to the rise in mobile search users, the report shows also that also the frequency of activity is growing as high as close 50% in the all countries. Analysts at ComScore explain this by an expanded 3G penetration, an increased adoption of advanced mobile devices, better offerings of mobile search services and flat-rate data plans. At the time, Google had the highest mobile searcher penetration (60%) in all of these countries, while Yahoo and MSN/ Windows Live Search (now Bing) alternated in the second position.

Pascu (2008b) discusses two additional M:Metrics studies. The first study, carried out in the USA in January 2008, shows that 58.6% of American iPhone owners used the mobile search function, compared with 37% among other smartphone users and 4.6% for the entire mobile market. The second study in a European context (France, Germany and the United Kingdom) from July 2008 illustrates that mobile search is even more popular among iPhone users from these countries (more than 80%). Meanwhile the amount of other smartphones users who access the mobile search function (32%) is less than in the USA and the total market is at an equivalent level.

The most detailed studies are probably those carried out in Sweden and in Japan. Both nations have a high general adoption of ICTs, being Japan the higher of the two. In Sweden, a representative survey –called the Mobile Barometer– was carried out during the fall of 2007 and reports the usage of a number of mobile services (Bohlin and Westlund, 2008). The results illustrate that 13% of Swedes aged 16-65 used mobile internet on a monthly basis; of which half of them used search engines. The survey further illustrates a gender imbalance; men using mobile search more frequently than women. There is a gap between users aged 16-49 on the one hand and those aged 50-65. Among the 16-49 year group, about one in five use internet services on a monthly basis. The number is close to one in ten for mobile search, witnessing about a similar gap in usage compared to people aged 50-65 years. Table 6 reveals that there are significant differences in usage between different user groups, depending on which payment model. While pre-paid cards owners use mobile internet and mobile search the least, it is slightly more common among private-based subscribers, and especially among people with business subscription. The study shows also correlation of increased usage with high income, as well as among 3G-users with expressed interest in technology.

The Swedish Mobile Barometer survey included a potential demand analysis. About one in four said not having used mobile search at the moment, but potentially doing so in the future. Although this means that there seems to be a consumer demand for mobile search, 56% said they have no interest in using such a service in the future at all (Bohlin *et al.*, 2007). Also in Sweden,

Table 6. Usage of mobile internet and mobile search in Sweden (2007).

	Mobile internet users	Mobile search users
Everyone	13%	6%
Gender		
Man	20%	11%
Woman	8%	3%
Age		
16-29 years	19%	8%
30-49 years	18%	9%
50-65 years	4%	3%
Payment model		
Private pre-paid	7%	3%
Private subscription	12%	5%
Employee subscription	24%	14%

Source: Mobile Barometer 2007 postal survey. The table is adapted from Bohlin and Westlund (2008).

Karlsson (2008) conducted a web survey of 925 Swedes, based on a non-representative sample. The respondents were mostly early-adopters since 94% expressed that they had access to the mobile internet, amongst which 96% used it sometimes and 41% use it on a daily basis. An interesting results is type of services used by early-adopters: news accessed through a mobile website ranked as the most common service (82% of the respondents), followed by mobile search, with 64%.

In Japan, the research company Myvoice analysed mobile use through an internet survey of 19,602 internet users aged 10-59 in November 2007. 9% of the respondents said that they use "often" mobile search (Myvoice, 2009). Also in Japan, Mobile Society Research Institute at NTT DoCoMo performed yearly surveys (2005 to 2007) including question on future mobile search services. The survey question was: "Which contents do you want to use on your cellular phone including those you use now?" Table 7 shows that the responses were relatively stable over the years: about one in five Japanese said that they use or want to use their mobile for search activities.

The most demanded activity is seeking for information about bus and train schedules, while searching information related to health is less common. Unfortunately, it is not possible to determine how the actual usage has changed over the years, in relation to the perceived demand for such services. The NTT DoCoMo survey analysed the demand for mobile search by gender and age groups. During 2005 and 2006, females used the mobile search functionality more than men, but

Table 7. Demand for mobile search functionalities in Japan (2005 – 2008).

	Search	Searching information on bus and train schedules	Searching information for medical institutions	Searching information for conditions of diseases and drugs
2007	20.7	12.5	5.6	4.2
2006	20.7	15.7	6.5	4.3
2005	18.3	-	-	6.4

The number of respondents varied between 3000 (2005), 2179 (2006) and 2500 (2007).

Source: NTT DoCoMo (2007)

in 2007 differences were practically non-existent. There are, however, significant differences between age cohorts: 36% among people aged 15-19 expressed a demand for mobile search in 2007, compared to 18-21% among people aged 30-49.

3.1.2.2. Mobile search usage patterns

A common approach to carry out studies on mobile search usage patterns is to analyse large-scale logs of mobile searchers behaviour, based on the search engine databases. This method reveals what people do, but does not allow to cross-check with users demographics or user's experience (such as the context or inspiration of the search activity).

In two subsequent studies, Kamvar and Baluja (2006, 2007) provided insights into Americans mobile search behaviour based on large-scale logs analyses of a Google database. The 2006 study, for example, analysed more than one million page view requests. Baeza-Yates *et al.* (2007) analysed the characteristics of mobile search queries submitted to Yahoo in Japan, comparing one million mobile search queries with a set of one hundred thousand desktop search queries. While the aforementioned studies focused on mobile search behaviour with one specific search engine, Church *et al.* (2007) in their analysis (European countries, from late 2005) used a data set consisting of data from 30 search engines. The analysis was based on 600,000 European mobile subscribers, among which approximately 50,000 were mobile searchers, generating more than 30 million mobile internet requests. In their subsequent study of European mobile subscribers, Church *et al.* (2008) carried out an exhaustive analysis of European mobile subscribers' use of mobile search engines. The data was based on 2.6 million subscribers, among which 260,000 had carried out at least one search request, generating a total of about 6 million mobile searches.

There are methodological difficulties comparing above studies, although at a first glance they may seem to be similar to each other (for a general discussion we refer to Livingstone, 2003, and Haddon, 2005). Despite differences in terms of place, time, database size and number of search engines analysed, we can come to some general conclusions regarding mobile search usage activities and patterns. Studies on mobile search usage activities through large-scale logs analyses suggests a discussion along the following three themes: 1) search input and scope; 2) search topics; and 3) interaction with results.

3.1.2.2.1. Search input and scope

Church *et al.* (2008) detect that the length of queries contains circa 2.2 terms or 13.4 characters on average. These numbers are rather consistent with previous studies. Kamvar and Baluja (2007) report that the average mobile query was 2.56 words and 16.8 characters, and that it takes the average user about 40 seconds typing their query. Compared previous years users now type faster; they also click more often on links while exploring in their sessions (Kamvar and Baluja, 2006). A similar study in Japan (Baeza-Yates *et al.*, 2007) illustrates a close correspondence between the number of terms in mobile queries (2.29 terms per query, on average) compared to desktop queries (2.25 terms per query). The authors observe that the mean number of characters used for mobile queries is 7.9,[7] notably shorter than the 9.6 used for desktop queries, motivated by the fact that it is more difficult to type with a mobile device.

Church *et al.* (2008) also analysed the number of searches per user and day. Based upon the 10% of users that actually used mobile search during the one week long test period, they concluded

7 This figure is much lesser than the quoted for Europe and USA (almost the same). This difference may possibly indicate only that in mobile phones you use Latin characters of kajin or hiragana. Therefore, the number of characters per query is not an adequate indicator. The terms per query (i.e. how many words) is a more useful one. Consequently there is hardly difference between countries. This makes sense and is perfectly in line with desktop web search findings.

that the usage is rather limited, as more than half of the users only made one search query per day. On the other extreme there was group of heavy users, accounting for 16% of users that submitted at least four unique queries per day.

Regarding on how queries are performed, Church *et al*. (2007) realised that 23% of the queries (averaging 2.1 terms per query) were modifications of previous queries, i.e. most commonly simple substitutions of terms. In their subsequent study, Church *et al*. (2008) found that it had become more common for searchers to modify their searches, making it more appropriate to refer to these as "search sessions". An average such search session accounted for 8.6 queries, up from 5.8 queries in the previous study. Another finding is that users increasingly have difficulties to locate the information they were searching for. The authors found that mobile searchers repeated identical queries (73%). The reason is possibly that –given the limited screen space to list the results– mobile internet make additional search requests to receive a similar number of results as the searcher of the desktop internet. In comparison with their previous study, the number of identical queries had increased, indicating that mobile searchers are less successful in finding what they are looking for.

3.1.2.2.2. Search topics

The research on mobile search activities involves two aspects, firstly what type of search topics users are directed towards, and secondly a taxonomy of mobile search behaviour intentions.

In Japan, the most popular mobile search queries are related to online shopping, sports and health (Baeza-Yates *et al.*, 2007). In Europe and US, mobile search topics follow a different ranking: the most popular search category is adult content.[8] Kamvar and Baluja (2006, 2007) find that besides adult material, the search topics of entertainment, internet and telecom[9] and local services are the most popular. Church *et al*. (2007) report that 53% of the top-500 queries were adult-related, while multimedia was the second most popular, accounting for about 10%. In their subsequent study, Church *et al*. (2008) show that adult-related content accounts for about 60% of the top 500 mobile search queries. The rise in popularity of adult content is at the expense of searches for entertainment, multimedia, and games.

Kamvar and Baluja (2007) discuss two hypotheses about the high percentage of adult mobile search queries. Adult category used to be very prominent in early web history, until it declined in popularity. The first hypothesis is that mobile search will follow a similar decline the more it develops and attracts more users. This argument has also been suggested by Church *et al*. (2007). The second hypothesis is that people feel more comfortable querying adult terms on the mobile than on the web. It is perceived as a private device immune to strangers prying into digital history marks such as URL history lists and cached pages.

Regarding the search topics, there has been a discussion in literature whether usage patterns are becoming more or less homogeneous. On one side, Kamvar and Baluja (2006) reported that the most popular query accounted for 1.2%, while the top 1000 queries accounted for 22%. In their subsequent study from 2007 they found that the top query accounted for 0.6% and the top 1000 queries for 17%. Thus, mobile search query usage patterns would become less homogeneous. On the contrary, although their study is not fully comparable with Kamvar and Baluja (2006) since they analyse the top 500 queries instead of the top 1000 queries, Church *et al*. (2008) indicate that search queries are becoming more homogeneous. They find out that the most popular query accounts for 2% of all queries, and

8 Often, and especially in the USA, the term adult content covers more than pornography; it includes also dating services and other social relationships (not necessarily sex related).

9 The "internet and telecom" category refers to searches such as looking up Facebook, MSN, etc.

the top 500 queries account for a stunning 26% of all queries.

The second aspect of search topics regards the taxonomy of mobile search behaviour intentions. According to Church *et al.* (2008)'s taxonomy, mobile search queries can be categorized into three categories: navigational, informational, and transactional. Navigational queries (10.2%) refer to a class of queries where the immediate intent is to reach a particular site, such as domain suffixes or company names.[10] Informational queries (29.4%) involve situations in which users attempt to find information online but no further interaction is expected.[11] The most used category by far is transactional queries (60.4%), i.e. whenever the user seeks for further interactions such as shopping, gaming, downloading files (images, videos, music, etc.). This category also includes adult-related queries (Church *et al.*, 2008).

Church and Smyth (2007a) carried out a complementary study of mobile search intentions and needs from a different perspective and with another methodology than the studies discussed so far. During four consecutive weeks in late 2007, they followed a diary study approach with twenty participants having a mean age of 31 years. Their most important finding is that mobile searchers consider the context valuable for their information needs, especially with regard to location and time. When it comes to location, it is evident that people want to search for services/ products that are geographically located close to where they live or work. Regarding temporal dependencies, people express information needs including temporal cues.

3.1.2.2.3. Interactions with results

The click-through behaviour, i.e. how users interact until they get to their desired objective, offers important for marketers and system optimizers. Its relevance becomes apparent when reading the results of study by Karen *et al.* (2006). For seven search engines, the authors explored how search results are displayed sampling twenty different search queries. They conclude that a high proportion of the responses are either unsatisfactory or irrelevant.

There is only one study of how users interact with the search results they gain, giving insight into the perceived relevance of search results and the extent to which search engines deliver good results to searchers. This study has been carried out by Church *et al.* (2008) and is based on a Google database (accounting for 85% of the search activities among users). Assuming that interactivity (number of clicks) with the displayed results is an indicator for relevance (the more clicks the higher the relevance), they recorded the number of clicks. Within one search session, about four out of ten searches lead to the selection of one of the search results. Assuming that click-through is a measure of success of search results, it can be concluded that most result-lists failed to attract searchers' attention. An alternative explanation is that users were already satisfied by reading the result snippet. They question this argument since only three out of ten searches were navigational, and the results indeed illustrate that the usefulness of current mobile search engines is limited. One reason they give is the limited level of usability: many mobile devices had weak interaction capabilities (especially at the time of the study). Having analysed that, assessing the real significance of these figures would have required to compare the results with those obtained repeating the search experience on a PC.

3.1.2.3. Mobile search as a medium specific service

Thirty years ago it was considered that every media has its own unique logic and is specific.

10 The user may be aware of the name of company or website name beforehand, but is perhaps not aware of the website address, especially not the mobile website address.

11 For example, a group of friends meet at a restaurant and initiates a discussion on politics, and realise that they cannot agree on the name of a minister.

Thus, its functionality and services therefore must be developed having this logic in mind (Altheide and Snow, 1979). It is common that new technologies and media imitate its predecessors. An example from the news media industry shows that radio news imitated newspapers, TV-news imitated radio news, and internet-news imitated all the others. After some time new media forms were developed and found their own logic.

Feijóo *et al.* (2008) have proposed a classification of the mobile content space that follows the media logic theory. Their four categories are: a) adapted (already-existing content from other media); b) re-purposed (content re-used and adapted); c) original (content specifically designed for mobiles); and d) augmented (content with mobile specific properties of increased value). Similar arguments have been brought forward by industry representatives. For example, Rick Hutton at Lycos Wireless motivate their choice of partner for mobile search as "because they focus on wireless infrastructure and search, rather than being internet focused, and take what they've done and make it conform to the wireless space" (Kennedy, 2009). Among initiatives taken by the industry, Microsoft and Yahoo have started to develop tools such as auto-completion, related queries and a voice-based user interface.

Mobile search engines can be improved in order to increase the demand by enhancing the mobile search user experience through more mobile specific developments. Church *et al.* (2005) showed that the search listings could well be accompanied by more informative related queries. A major advantage for the provision of mobile search is that related query terms only need a fraction of the screen space. Karlson *et al.* (2006) argues that text entry and search off the device could be altered for the search model applied to mobiles, which they consider too similar to web search. They suggest that mobile search should be used to explore search scenarios. Arter *et al.* (2007) explored opportunities for in-situ sharing of user's mobile search activities, based on logged usage data in combination with interview and diary protocols. The idea is to present to a user in given geographical location, the search queries of other people at the same place. This approach might help users in finding non-obvious insights beyond results they intended to find. Church and Smyth (2008) proposed a context-sensitive mobile search; one that combines location, time, and community preferences where instead of requesting from users to formulate their own queries, they could use previous results and queries from an interactive map-based interface.

3.2. Users' vision of mobile search: a case study in Sweden

Given the lack of literature on qualitative explorations into the personal mindsets of users with regard to mobile search, we carried out a focus group study to investigate these matters. In March 2009, five focus groups with a variety of mobile users have been conducted in Gothenburg, Sweden.

The focus group method relies upon the assumption that a researcher is able to follow the mindsets of people on a specific topic by discussing with the respondents. This is a common method employed to investigate unexplored research topics using the interactions between the respondents in the group to facilitate a more initiated discussion. We followed a standard procedure for the method, using an interview manual with a set of themes to systematically explore the personal experiences and perceptions among the group members.

3.2.1. Methodology

Table 8 describes the methodology followed for the focus group survey.

The focus group respondents were recruited through several communication channels of the regional newspaper Göteborgs-Posten. Advertising

Table 8. Focus group methodology

Method	Focus group interviews
Date of field work	Wednesday 4th of March
Length of each focus group	1.5 hours
Interview technique	Semi-structured
Recruitment of respondents	Media advertisements and personal networks
Rewards to respondents	2 cinema tickets and refreshments at the discussions
Number of groups:	5
Total number of respondents:	29
Group constellations	Mixed
Recording system	Videocamera
Analysis technique	Qualitative content analysis

banners were placed on the front page of the news web site during 5 consecutive days (weekly reach; 350,000 unique visitors per week), as well as in the mobile specific website (80,000 unique page impressions per week). Personal encouragements to participate in the study were sent to subscribers of the newspaper's SMS-based news service (subscriber base of more than 500 people), to the subscribers of the company's newsletter (about 30,000 subscribers) and to the consumer panel (more than 1,000 people). Furthermore, one local high school arranged for students to participate during normal school hours. In addition, personal networks were activated to encourage users of mobile internet to participate.

The initial intentions were to form specific groups with different types of experienced users, such as a group of touch-screen users and another of smartphone users. Meanwhile, due to difficulties in the recruitment process, mixed groups of respondents had to be compiled. These groups did, however, fulfil minimum standards in terms of profiles: ages from 17 to 54 years, 17 females and 12 males, employed and students, non-users and heavy users, etc.

Following standard methodological procedures, an interview manual with a set of themes was used to systematically explore the personal experiences and perceptions among the group members. The introductory theme covered the background of the respondents, and how they use their mobiles in their everyday life. It included an extensive discussion on their experiences of using the mobile for different types of internet related services. Non-users were naturally less active in discussions, but did nevertheless add value to it by expressing what types of internet services and content they would like to use with their mobiles. The following theme covered attitudes to adoption of mobile internet services in general, in order to foster a sound understanding of what factors are perceived as important by the respondents. The third theme elaborated more specifically on experiences and attitudes related to mobile search in particular.

From the themes of the focus groups, four sections of analysis have been derived: 1) mobile internet adoption factors, 2) mobile internet usage patterns, 3) exploring mobile search behavioural profiles, and 4) perceptions on the mobile search usage experience.

3.2.2. Mobile internet adoption factors

Respondents perceive as most important drivers of (or barriers to further) mobile internet service development and adoption to be usefulness, expressive functionality and perceptions of control/private integrity.

Usefulness comes on top. The appeal of the mobile device to be used as an internet tool is high: it is always carried on and it gives users the freedom of accessing information from a range of sources on their own conditions. However, while some respondents value this freedom very positively, others argue that their need is really limited and that they have no problem in waiting to access information until when they can use a computer. Others even feel stressed about using the mobile for multimedia content.

The device is an important factor by itself. The respondents agree that there must be a sound balancing between the size of the device and its usability. A larger display is preferred for the mobile internet experience, but not at the expense of being cumbersome to be carried along. Compared to earlier studies from Sweden (Westlund, 2007a), there is no doubt that the iPhone and other devices with large touch-screens have become very appealing and respondents say they would access the internet more frequently mobile if they would possess a better device. Yet a number of respondents argue that the design of the mobile can be just as important as its functionality. Users, who do not value mobile internet functionality so high, argue that small mobiles are more practical and appealing. Here, we should not forget that the mobile fulfils an expressive function – as the design of mobile devices also reflects the 'images of their owner'. For example, Sofia (F, 26) wants people to perceive her in a specific way through her mobile, and it is important to her to have a mobile with appealing design and outlook. In this line, she finds that although the iPhone is appealing in terms of functionality and design, the hype that has surrounded its introduction has made it too commonplace. This view is shared also by others focus group participants.

Another usability issue regards navigation: respondents find it more troublesome to navigate with a traditional mobile with a keypad than with a touch screen. Browsing internet sites is considered too slow; which is partly caused by the insufficient bandwidth of mobile internet networks, and partly by the limited processing power of mobile devices.

When it comes to cost there are basically two concerns at hand; firstly, people feel uncertain about the real costs of use, and secondly, they think that prices are too high. Regarding the uncertainty, people are largely unaware and find it difficult to determine the costs charged to access the internet. Some believed they are charged per minute; others thought by traffic. Both groups, however, were not aware how their usage would translate into costs. Those who checked their bills, come to the conclusion that using mobile internet for services that are predominantly text-based is not expensive, and will continue doing so. Concerning the overall costs, many are not willing to pay for mobile internet access at all, since they are already paying for internet access via their PC. Others would pay for access to the internet with the mobile but think that the present prices are too high. There is broad consensus that flat-rate is the best option, giving a sense of control and freedom. Anyhow current prices are not appealing. Ideally the flat-rate pricing to access the internet with their mobile should be roughly the same as domestic broadband via PC. Several said the service via domestic broadband is better, and that this gives them a higher user satisfaction.

Surprisingly, security, privacy and trust matters did not come to much at the fore during the focus groups discussion. People are largely unaware that mobile content providers might monitor usage to optimise a personalised proposition of services, for example for location-based services. The respondents seem overall happy using the mobile for internet services and content in the current situation, possibly because their experience of personalised services is yet limited. Due to that, no respondent encountered any problem with regard to security or privacy. Only during the discussion they started thinking about the need to control privacy for personalised

services and on how it would impact if personal information would be used to offer commercial value propositions.

3.2.3. Mobile internet usage patterns

People use their mobiles in diverse ways: some just as an interpersonal communication tool for voice calls and SMS; others more as a multimedia device (MP3-player, music exchanger, camera, etc). Only good data capabilities allow using mobiles to communicate through e-mail and social networking sites (such as Facebook). Indeed, many respondents are using these functionalities several times a day. Other prominent uses include visiting news sites and collecting information about public transport, recipes, weather, time and places. People say they use search functionality to access information relevant to their needs in particular situations.

People's habits of accessing information through the mobile internet do vary. Some people start internet surfing from the telecom operator's portal. Such portals usually contain a wide range of content, they are easily accessed and the headlines can be browsed free of charge making them "attractive to get into the internet". Other respondents are less enthusiastic; they find the content too limited and the advertising often irrelevant. Using bookmarks is commonplace, which helps users navigating directly to the websites the users are fond of. Users must, of course, have found the website for the bookmark in the first place. Usually they have done so by either inserting the entire web address manually, but more often by querying the web address through a search engine. Novice users first explore opportunities within the telecom provider's portal, but soon move on to explore websites and internet content more independently through bookmarks and applications. Users of advanced mobile devices have also adopted more sophisticated applications. This behavioural pattern follows pretty much their experiences from the desktop internet.

Interestingly, respondents use their mobiles to connect to the internet not only on the move but also when at home, but there are differences. A novice user typically uses mobile internet while on the move only, i.e. when he/she cannot access the internet in any other way. More experienced users access the internet via mobiles also in those situations where they could use also the computer, i.e. when they just consider it a more convenient alternative. For instance, the mobile is the most accessible option to access the internet during a short commercial break on TV or while lying in bed.

Being in control of the information flow is perceived to be important. Most people stress that they prefer to use mobile internet on demand, when they really feel that they need it. When it comes to push-services, such as e-mail, news, SMS, etc., some users tend to 'loose the feeling of control'. Others, on the contrary, have simply assumed the behaviour changes associated with constant accessibility. Lina (F,23) –for instance– says having intensified significantly her usage since she got her iPhone half year ago. She acknowledges that it is not socially correct to browse internet while being in company with others, but she cannot stop checking e-mails and updates on Facebook, and she tries to do so in discretion. While socialising with peers she has hidden her iPhone in a book or purse while using it for mobile internet. She argues that she finds it comforting to take a pause from her social environment and just focus on herself and her needs by using mobile internet. This is a way for her to create some personal space within the public domain.

It was argued that there is an interest in personalised and location-based services. Several users said they would be willing to register personal information if this enhances the information they can access. This includes the usage of geographical positioning, which they believe could be used for finding restaurants etc. in their vicinity. It is generally difficult for people

to visualise how specific location-based services would fit their everyday life needs, but they this does not refrain form positive and negative reactions to such services. Anna (F,27) argues that any personalised services must be tailored to user's needs: info of traffic jams is only relevant when she drives a car and on her way. Some are concerned of companies' use of their personal data gathered by behaviour patterns to sell commercial services and express desire to be able to control this type of information. Some say getting personally offended if the information is too personal, as it affects their personal integrity.

Also noteworthy is that there were the occasional users, those having somewhat older mobile models with a more limited user interface, who did express large demand for more mobile specific services. Contrary, respondents accustomed to using the mobile for search more frequently with a touch screen device, do avoid more often using mobile specific sites. From their point of view, they become most satisfied when they can access the full version internet sites with their mobiles, as they are used to accessing them with their computers.

3.2.4. Exploring mobile search behavioural profiles

The focus group sessions uncovered a variety of user patterns related to mobile search. The members of the focus groups use differently their mobile device for search, depending on the type of device. Some use Google from its mobile website, whereas others access it as an integrated application with the mobile device.

Our observed patterns only partly be attributed to the three types of searches and integrated into the taxonomy proposed by Church *et al.* (2008): 1) navigational searches, 2) informational searches, and 3) transactional searches. To fit better our findings, the following four categories are proposed:

- *Navigational searches*. Similar to Church et al. (2008) definition: the purpose is to reach a particular site, such as a company domain.

- *Logistical information searches*. The aim is to search for information that solves a logistical problem. When on the go, people use the mobile to interrogate the timetable of trains or public transport. They also require geographical positioning through map services, such as finding directions or the address of a restaurant where they have an appointment. Local information can be implicit or explicit in geographical searches. Also browsing the website of the university department for updated information on lectures etc. would fall into this category.

- *Transactional searches*. Similar to Church et al. (2008) definition: the user seeks for further interactions as in the case of shopping.

- *Leisure searches*. Here, search is in the realm of spending or organizing private time, even to the extreme to enjoy the search process itself. Beyond searching at the specific occasions where they perceive it as necessary, users use it for fun or spend spare time, both on the go and at home. Typically users search for content such as lyrics, videos and images.

The data gathered from the focus groups indicate that every mobile search user occasionally carries out navigational, informational or logistical searches. In general, such searches are more often carried out while on the go, in situations when people do not have access to desktop internet. Magnus (M,43) values the freedom to access mobile internet information whenever needed. At the same time, he uses mobile search only if he

absolutely must, otherwise he waits until he can make the search from a computer.

Another finding is that transactional and leisure searches are handled mostly by more experienced users, who tend to have an advanced mobile device and a flat-rate subscription on mobile internet. They do not only use the mobile device for searches while on the go, but also when at home, lying in the sofa or bed, sitting at the kitchen table or while paying a visit to the toilet. For some of these people the mobile has become ubiquitous, providing constant access to mobile internet.

The respondents generally see a great future usefulness in logistical information searches. By using the mobile for such searches on the go, it allows them to plan less in advance. With the wide diffusion of mobiles, people can easily interact with each other on the go adjusting their arrangements in real time. A consequence is that people tend to make more loose arrangements with each other. This freedom increases having by the possibility of searching for shows, films or restaurants when after meeting. In a similar way, the habit of planning beforehand prior to doing routine activities can also be altered. For example, people used to consult timetables for public transport at their PC before their departure at home or at the office. Some people stress that it works perfectly well to continue to do so, and will only use the mobile when there are no other means to gain the information. Others argue that the mobile is a very convenient way to access information on the go, strongly advocating such usage.

3.2.5. Perceptions of mobile search usage experience

How people evaluate their mobile search experience varied notably amongst participants. Some people lacked any experience at all of doing mobile search. Others tried mobile search a couple of times, but that their experience was unsatisfactory and that they therefore did not continue to use such functionality. For example, Lisa (F,26) once used mobile search to know the final score of a football match while at a summer party in a cottage. Since it took her the ´eternity´ of fifteen minutes to retrieve the information, she felt discouraged to try it again.

Among people who use newer and more advanced mobile devices, such as touch screen devices, some consider the mobile as a very good means to search and to find relevant information, while others think their experience of using the mobile for search does not yet meet their expectations. A recurring pattern is that respondents often refer and compare their experiences of web searches via mobiles with their computers.

Some respondents are critical with their mobile search experiences. Johan (M,33) finds it difficult to navigate and find information on the mobile. He complains that his mobile only shows the top five results, and that he normally does not click to see the next page of results as it takes too much time. Sara (F,18) says the search process with the mobile involves too many steps, and that the usability level therefore is low. Lennart (M,34) complains that he often must make modifications of the search queries, which takes him unreasonably long time with the mobile user interface, particularly when using a somewhat older mobile device. Stefan (M,23) shows little patience when conducting searches with the mobile, sometimes getting stressed when the requested information is difficult to find. Fredrik (M,18) finds it troublesome to enter Google search queries with his mobile, mostly because the search field is too small. He also argues that the user interface has not been well adapted from the computer to the mobile, and that he wishes that excessive information could be deleted to enable an improved overview. In this sense, Sofia (F,26) appreciates websites that have been specifically adjusted to the mobile, such as the mobile website of the public transport company in the Gothenburg region, a simple but clean text-

based website containing two fields; “from” and “to”. The user can easily insert their query and search for upcoming departures for the public transport system. While some users wish for more mobile specific search engine interfaces, others prefer to view on the mobile the same web sites as on their PC. Common to these users is that they possess and use a touch-screen mobile device, have a flat-rate subscription plan, and prefer to access all the information they normally access with their computer also with their mobile. Both Lina (F,23) and Stefan (M,23) for example, have tried a number of mobile search engines but are most satisfied when they use mobile search from traditional search websites.

Chapter 4. Forthcoming trends

4.1. Technologies driving the evolution of mobile search

From a general perspective, there are three main technology families that have a direct impact on mobile search: enabling technologies, search technologies (in general) and specific mobile search technologies, as described in Table 9.

These different technologies are presented to show their expected evolution path and the emerging trends that can foster the use of contextual parameters (such as the user location or user profile), the rise of mobile social network(s), and the evolution towards a real multimedia search in mobile environments.

4.1.1. Enabling technologies

4.1.1.1. Network technologies

From a European mobile sector perspective, mobile broadband technologies are present all over the EU, particularly 3G (UMTS) and 3.5G (HSPA), following the technology evolution defined by the ETSI/3GPP system architecture (also followed in other regions). The different releases show the network evolution and the future standards for mobile radio networks, with 4G being the next technological challenge for the industry, referred as Next Generation Mobile Networks.

The target architecture defined will be an optimised packet switched network architecture, which will provide a smooth migration from existing 2G and 3G networks towards an IP network with improved cost competitiveness and broadband performance.

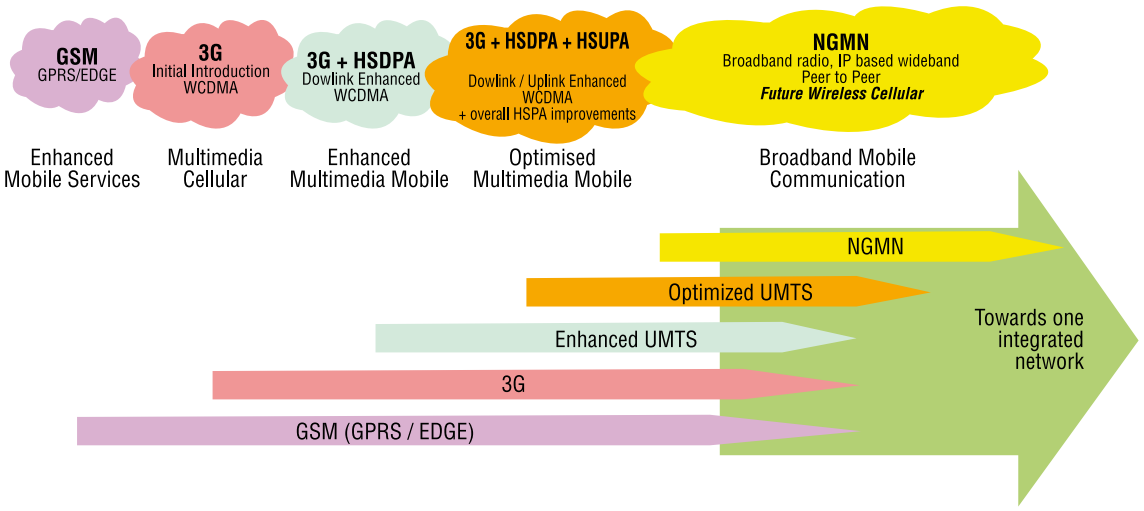
The term 4G refers to the next level of evolution in the field of wireless communications. 4G systems will replace completely existing communication networks, providing a more comprehensive and secure IP based solution to users on an "anytime, anywhere" basis and at much higher data rates compared to previous generations.

Table 9. Technologies directly impacting on mobile search.

	Technology	Keywords
Enabling technologies	Wireless networks	Broadband access ubiquity, dynamic spectrum management
	Sensor networks	RFID, internet of things
	Devices	Multimedia, location, interoperability, openness
	Cloud computing	Web browser, connectivity, security, data protection
Search technologies (general)	Semantic and multimedia	Enriched content search
	Cognitive	Environment understanding
Mobile search technologies (specific)	Context awareness	Context acquisition and processing
	Augmented reality	Enriched context awareness

Source: own elaboration

Figure 16. The roadmap from GSM over UMTS to NGMN.



Source: GSM: Global System for Mobile Communications, UMTS: Universal Mobile Telecommunications System, HSDPA: High-Speed Downlink Packet Access, HSUPA: High-Speed Uplink Packet Access, NGMN: Next Generation Mobile Networks

Therefore, 4G can be viewed as a further step in the evolution of current industry efforts in the HSDPA, HSUPA, and EVDO arenas, enabling a personalised broadband access experience and consolidating the diversity of networks operated by mobile network operators.

In this context, Long Term Evolution (LTE) is the last stage from existing 3G to 4G, currently under discussion by the 3GPP. LTE is a set of enhancements to the Universal Mobile Telecommunications System (UMTS) introduced in 3GPP Release 8, basically focused on enhancing the Universal Terrestrial Radio Access (UTRA) and optimizing 3GPPs radio access architecture. The aim is to provide an average user throughput of 3 to 4 times the release 6 HSDPA levels in the downlink (100Mbps), and 2 to 3 times the HSUPA levels in the uplink (50Mbps).

The evolution towards a higher bandwidth in mobile systems and the subsequent reduction of both distance among cells and cell area, can enable a better user experience in the context of multimedia search (higher broadband capability) and context-aware search (more precise location) where the concept of femtocells (e.g. a UMTS femtocell) is a crucial milestone.

4.1.1.1.1. Mesh networks and cognitive radio

Progressive cell size reduction leads to a further step: mesh networks, in which every device can act as a network node and interact with nearby devices. The topology of a mesh network is stable and highly reliable, as each node is connected to several others. If one node drops out of the network due to hardware failure or any other reason, its neighbours can easily find an alternative route using a routing protocol.

In addition, cognitive radio technologies allow that either a network or a wireless node changes its transmission or reception parameters to communicate efficiently avoiding interferences with surrounding users.

All these features show the potential of cognitive radio technologies and mesh networks as enablers of context-aware and augmented reality applications and services, due to their capability of monitoring and adjusting several factors in the user environment, such as radio

frequency spectrum, user behaviour and network state.

4.1.1.2. Sensor networks

Context-aware search relies on technologies that provide trustworthy and reliable information of the user environment to further convert context information into services and applications.

4.1.1.2.1. Wireless technologies as context enablers

Main context-aware enablers in wireless technologies are referred to the advances in the devices and technologies based on RFID, Wireless Sensor Networks (WSN) and ad-hoc wireless networks which can be coupled to the mobile device and other enabler embedded technologies to the mobile device or network such as the location systems using the mobile network parameters.

The main trend in WSN is developing new communication standards that provide better location information and more bandwidth such as IEEE 802.15.4a. The family of standards IEEE 802.15[12] allows high aggregate throughput communications and low power usage within the scope of the user environment, defining the so called Wireless Personal Area Networks (WPAN).

Near Field Communication (NFC) appears as one of the most promising extensions of RFID technologies for mobile devices. As defined by the NFC Forum,[13] "*Near Field Communication (NFC) is a short-range wireless connectivity technology that evolved from a combination of existing contactless identification and interconnection technologies. Products with built-in NFC will simplify the way consumer devices interact with one another, helping people speed connections, receive and share information and even make fast and secure payments*".

Although NFC was expected to be used mainly for payment operations using the mobile phone, it allows different alternatives as enabler of mobile search applications based on the user context.

4.1.1.2.2. Environment monitoring

Environment monitoring is referred to those technologies designed to "tag" and "understand" the environment, which can be combined with wireless technologies or cooperate separately. Examples include the Sekai Camera[14] for the Apple iPhone, which combines the visual information from the mobile device camera with the GPS or 3G network location information and the stored information about the local environment where the user is located. Another example is the audio matching techniques to tag the environment with the sound received using the mobile device microphone for example, for a song search.[15] These same techniques and technologies can be applied to obtain information about the user environment.

In addition, all the mentioned technologies for enabling search applications should perform in connection to a reliable information database. Apart from textual information, a major challenge in this context is the creation of complete

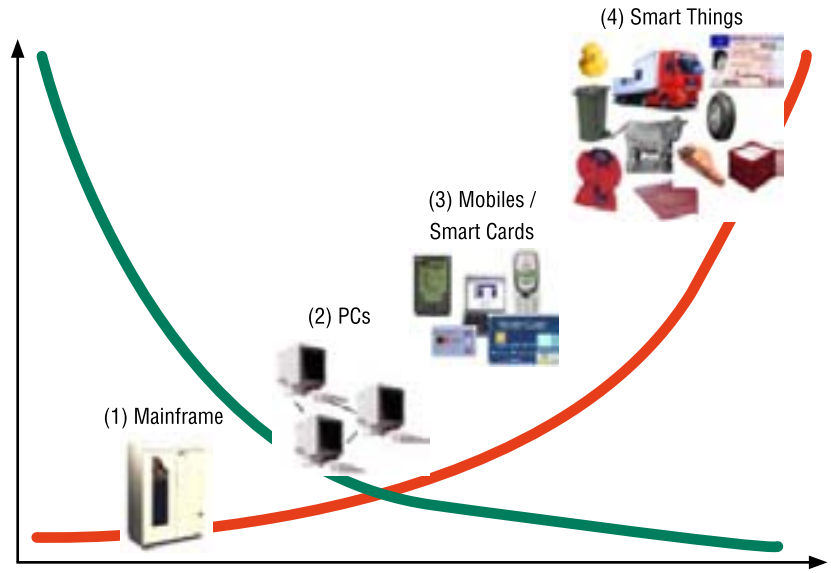
12 IEEE 802.15.4-2006 is a standard which specifies the physical layer and media access control for low-rate wireless personal area networks (LR-WPANs). It is maintained by the IEEE 802.15 working group. As an example, it is the basis for the ZigBee, WirelessHART, and MiWi specification.

13 For further details see http://www.nfc-forum.org/home.

14 Sekai Camera is an iPhone-exclusive social tagging service developed by Tokyo-based mobile application provider Tonchidot. The key idea is to use the iPhone as a mobile information terminal, linking the real world with tags generated by Sekai Camera users, Tonchidot itself, and information scraped from other web services. Users walk around town looking at the iPhone's display to get information on their surroundings. While walking through a mall, for example, Sekai Camera tags would show where you can find something to eat, additional information about a certain product tagged before, or how many calories are in a chocolate bar.

15 Like the Orange service "Cazacanciones" for the Spanish market. See: http://movil.orange.es/servicios/musica/cazacanciones/

Figure 17. Evolution of miniaturization and price reduction enablers.



Source: ITU (2005)

audiovisual databases to support multimedia search.[16]

4.1.1.2.3. Internet of Things

The RFID Working Group of The European Technology Platform on Smart Systems Integration (European Commission – EPoSS, 2008) says that the definition of "internet of things" can have different facets depending on the perspective taken. From a functionality and identity point of view it is defined as "*things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental, and user contexts*". A different definition, that puts the focus on the seamless integration, is "*interconnected objects having an active role in what might be called the Future Internet*".

From a general perspective the concept of internet of things could be considered as the ideal combination of technologies and communications systems presented in previous sections in which short-range mobile transceivers are embedded into all kind of gadgets and everyday items, enabling new forms of communication between people and things, and between things themselves.

The internet of things represents the real technological revolution and challenge for the present and future of computing and communications. As the ITU suggests (ITU, 2005), "*a new dimension has been added to the world of information and communication technologies (ICTs): from anytime, anyplace connectivity for anyone, we would have connectivity for anything*".

In this context, RFID and related identification technologies will become the cornerstone of the upcoming internet of things, using a single numbering scheme to make every single object identifiable and addressable. Smart components would be able to execute different set of actions, according to their surroundings and the tasks they are designed for.

According to European Commission – EPoSS (2008), to reach such a level of ambient

16 This is the case of Google and its investment plan for digitalizing city streets visual information.

intelligence major technological innovations and developments will need to take place, amongst them governance, standardisation and interoperability being absolute necessities to develop the internet of things vision. New power-efficient, security-centred and global communication protocols and sustainable standards must be developed, allowing vast amounts of information to be rapidly shared between things and people. The ability of the smart devices to withstand any kind of harsh environment and harvest energy from their surroundings becomes critical. Furthermore, a major research issue will be to enable device adaptation, autonomous behaviour, intelligence, robustness, and reliability.

One of the key issues of the internet of things will be related to trust, privacy and security, not only for what concerns the technological aspects, but also in terms of the education of the people at large. The growing data demand and higher data transfer rates will require stronger security models employing context related security, which in return will help citizens to build trust and confidence in these technologies rather than increasing fears of total surveillance scenarios.

4.1.1.3. Device technologies

Big players are closely following the mobile platform due to its importance for designing the user framework in which services, applications and content will be based upon. Industry is analysing diverse options with regard to the openness of platforms, from closed (walled-gardens) to open environments (Ballon and Wallravens, 2008). On one side, the closed approach has the advantage of offering search capabilities adapted to the specific platform, in order to provide a particular service only available through the corresponding platform. This is the case of the Microsoft OS platform for mobile devices, which is evolving towards providing a complete solution with embedded search capabilities. On the other side, platforms, on their side, are evolving towards unification in a single standard that could be implemented first on top segment devices. Major initiatives towards creating one open mobile software platform are Symbian OS, S60, UIQ and MOAP(S) (Nokia, Sony Ericsson, Motorola and NTT DOCOMO). In addition, Google Android and the Linux project are developing open source platforms with the support of device manufacturers including HTC and Motorola. It is expected that the number of platforms will be reduced and converge towards providing integrated search features, as a vast majority of mobile players agreed that platform openness is the key feature for promoting mobile search and other mobile data applications.

4.1.1.3.1. Devices

The development of location-based and context-aware search services are favoured by embedded GPS receiver and tactile screens for mobile web navigation, which facilitates an enriched user experience that has a positive impact on search applications. Embedded

Table 10. Major smartphone manufacturers (2008).

Manufacturer	Most popular smartphone	Comments
HTC	HTC Magic, HTC Touch	Multimedia and high processing power capabilities. It has developed a mobile device with Android.
Apple	i-Phone	One of the most popular devices. Based on previous handheld music and video players.
Nokia	N97	Nokia is evolving towards multimedia devices based on Symbian platform.
Motorola	Ironman	Motorola is orienting its strategy towards developing Android smartphones.
RIM	Blackberry	Proprietary operating system and applications.
Sony-Ericsson	P Series	It is based on the Symbian operating system.

Source: own elaboration

camera and sensors within the mobile phone (gyroscopes and accelerometers) and easy-to-use mobile phones displays (bigger, tactile) are also useful feature for facilitating the use. These features are increasingly demanded, as smartphones sales showed for 2008, and offered by the main vendors and manufacturers. Table 10 offers an overview of some of the main smartphone manufacturers.

4.1.1.4. Cloud computing

Cloud computing is on-demand computing service; the software does not reside at the users' device. The computing resources are owned and managed by a service provider and the users access the resources via the internet. Cloud computing is a highly important phenomenon influencing network and computing architecture, thus also setting the framework under which mobile data services and applications will be developed. As in this architecture user's files and folders are stored in the "cloud", users can access their data and applications everywhere and at any time only requiring a mobile device with internet access. Current cloud computing applications in the mobile realm include mobile email, mobile search, and navigation apps. Among the benefits of cloud computing, the location independence is an obvious one. Device independence is equally important and cloud computing may pave the way for further convergence of PC and mobiles as services regards.

As could computing 'only' needs a browsers –which is are already provided with any smartphones (and more alternative browsers available for download)– this technology could free-up processing and storage power of handsets. Thus, it could become a "standard" in the way mobile applications are built and run and allowing developers to create a single version of their applications, promising greater future compatibility.

Could computing will shape the way doing business both in the PC and the mobile world. In the mobile environment, cloud computing is a potential way to bypass mobile applications that are tied to a certain carrier or manufacturer, and may contributing to opening the market to alternative providers. The value chain may also shape up differently. Future mobile data applications, like mobile search, are online services likely to be provided over the internet through a web browser, while the software and data are stored on the servers. Mobile search tools would benefit from cloud computing as the user information is centralised on a number of "cloud" servers, thus simplifying search operations. A major challenge will be to keep a real time update of the user's context and device data in order to provide accurate mobile search services, particularly context-aware services. In this context, data security becomes critical. Security typically improves with centralization of data operations, but raises concerns about the potential loss of control over (sensitive) data (personal data, location data, etc). This calls for a transparent and secure manner to guarantee user's privacy.

4.1.2. Search technologies

4.1.2.1. Multimedia search

Currently the most common process to conduct multimedia search is to retrieving meta-data annotated to the audiovisual content. Relevant metadata to the content can be annotated either automatically through algorithms or by personal/social interaction (an example is Google's Image Labeller game). A review of annotation techniques can be found in Kompatsiaris (2008). The research progress is steady in overall terms, but with differences by topics, given the complexity of the research challenge.

Ideally, the most useful schemes for multimedia retrieval would not require previous annotation or done on the spot, i.e. the retrieval would be based on direct visual and/or audio search. Considerable research effort is spend in this

world wide; at Europe scale by the ICT programme of the European Commission (DG Infso).[17]

In visual search, a common request is finding an object embedded in an image or a video clip. An example would be receiving information about an object captured by a mobile camera. A typical procedure for "augmented reality" or "reality mining" applications would be taking a picture of a mountain landscape and getting back the names of the peaks indicated on top of each of them. It is also conceivable to search for codes or characters embedded in the query image are conceivable (Xie *et al.*, 2008). Despite technological developments, search in video files will take long time to be operational (perhaps 5 years or more). There are no commercial developments with remarkable results yet, but there are two areas with clear progress and already in some practical use. The first one is the so-called "2-D bar codes" where a logo or a specific pattern composed of points are captured by the mobile device camera and compared with a pre-existing database. This kind of application is being used for marketing purposes and for ticketing (events, travel, etc). In the second area, is an augmented reality browser that uses the images captured by the mobile device camera (for instance a skyline of a city) to retrieve some information about the objects around (for instance, information about a building). Side information, like the geographical location and orientation of the camera, is used to improve the search process to supply more relevant results. Main applications stores (i.e., iPhone's and Android's) contain an increasing range of instances of such browsers.

Audio search is definitively gaining momentum and further improvements are expected in the coming next 3-5 years. The number of applications is increasing and search technologies are becoming more effective and reducing the error rate. There are several techniques for audio search based on the process of low-level characterisation of the audio signal (signal low level coefficients) and the matching of similarities between signals. Typical examples in use are looking for ringtones (Lie *et al.*, 2008) or trying to find the title of a song played in the user environment using the mobile device (e.g. the application "Listen" installed on the Apple's iPhone).

Two final notes on multimedia search. The first one relates to the increasing relevance of multimodal queries (Xie *et al.*, 2008) that allows to query by different types of content (annotations, metadata, audio and video) and that takes into account additional side-information (location, context, etc). Multimodal queries are more complex to carry out and this performed in practice by dividing the search task into several processes which are later combined to supply the result of the query. The second note refers the long-standing difficulties in performing multimedia search on how to bridge the "semantic gap" between high and low level descriptions of multimedia content. As an example, the analysis of an image using algorithms is different from what a human can understand by looking at and analysing the same image: this is what is called the semantic gap. In this sense, evolution in multimedia search has been conditioned by an appropriate talking of search, considered in the next sub-section.

4.1.2.2. Semantic search

Semantic search refers to the process of using semantic ontologies for retrieving results with meaningful concepts and sentences rather than just independent terms, which often may even not related with the real aim of the query. An ontology specifies the formal representation of a set of concepts within a domain and also the relationships between those concepts including the definition of classes and functions.

17 The research activities are organized by the Future Networks & Services Directorate. Information about current and past projects can be found at the CHORUS+ portal www.ist-chorus.org

The goal of semantic techniques is to develop an interconnected database of information and documents (the web 3.0 Internet in its most ambitious incarnation) accessible through the "natural" way humans ask questions and obtain responses. Applying this goal to search, it implies obtaining and presenting results related to what the question really means and not only a "blind combination" of the terms of the search.

As in the case of multimedia search, progress in semantic techniques relates also to advances in artificial intelligence. Both methods share the objective to improve the man-machine interface; the search process and the presentation of results in such a way that it resembles the way humans "interpret and interact with the world". In the particular case of the mobile domain, introducing both kinds of techniques could enhance the usability and usefulness of search since users have customary routines with multimedia information (voice, pictures) and the input and output means are limited.

Some companies (mainly from the USA) like Yahoo!, IBM, and Google are making important efforts towards providing a more human-adapted search. In Europe there are some research initiatives funded at the level of the European Commission[18] and at the level of EU Member States, more notably the French QUAERO project[19] or the German THESEUS.[20]

4.1.2.3. Cognitive technologies

Cognitive technologies refer to technologies that "understand" the information captured from the user environment in a similar way to what humans do, and therefore they are able to process it and attribute it with some meaning. They belong to the general field of artificial intelligence. Cognitive technologies for mobile search find already some modest implementations for at least three purposes, namely to profile the user, for recommendation and priority ordering, and for processing the environment.

4.1.2.3.1. User Profiling

To enable personalised mobile search (and also contextually adapted search) it is necessary to capture the user profile and process it to transform it into information linked with user interests and desires and, therefore, able to improve the results of search.

Profiles can be constructed from various types of information sources, including user's tastes, user's behaviour inferred from the consumption of mobile services, the social networks to which they belong, etc., or a combination of all. Services consumption is normally measured using audience measurement techniques, and further analysed through data analysis statistical methods. Lancieri and Durand (2006) describe some methods for internet user behaviour analysis based on access traces and its application to discover communities based on a self-similarity model. Other authors (Murata and Saito, 2006b, 2006a; Murata, 2004) extract audience information and user's interest from the routine visits and web log data. Over the past years, audience measurement technologies have evolved to cover several services platforms.[21] User's profiles have been created and user's behaviour has been modelled based on such data in several research studies, e.g. in Álvarez *et al.*

18 See the CHORUS+ website for an overview of European Activities (http://www.ist-chorus.org).

19 Quaero (Latin for "I seek") is a European research and development program which has the goal of developing multimedia and multilingual indexing and management tools for professional and general public applications (such as search engines). See http://www.quaero.org/modules/movie/scenes/home/

20 THESEUS is a research program initiated by the German Federal Ministry of Economy and Technology with the goal of developing a new Internet-based infrastructure in order to better use and utilize the knowledge available on the Internet. See http://www.theseus-programm.de/en-us/about-theseus/default.aspx

21 For instance, the ICT Integrated Project ARENA aimed to devise a basic audience research methodology that can be applied across these platforms and services (http://www.ist-arena.org/).

(2009). A method for inferring identity from user's behaviour using Bayesian statistics can be found in Carey *et al.* (2003).

4.1.2.3.2. Prioritising and Recommending

Cognitive technologies are employed to offer recommendations on content supplied to users based on their past behaviour on content consumption. They are mostly based on content filtering tools (Xie *et al.*, 2008) and can be clustered into three main methods: content-based filtering, collaborative filtering and hybrid methods, which are briefly described in the following.

Content-based filtering is a technique related with user profiling, where the user's preferences are inferred from the consumption of mobile services. Collaborative filtering acknowledges the fact that for privacy reasons or for marketing purposes it is highly desirable to characterise the profile of homogeneous communities of individuals. It is lately been improved thanks to the success of user communities and social networks. In this area two major groups of algorithms can be distinguished: memory-based (Yu *et al.*, 2004) and model-based approaches (Melville *et al.*, 2002). In memory-based approaches, a rating prediction is made upon the ratings of other users with similar interests. A model-based collaborative filtering technique (Melville *et al.*, 2002) first completes a statistical model on the community of users. Then it predicts the ratings based on the acquired model parameters. Hybrid methods (Boutemedjet and Ziou, 2008; You and Wong, 2007) use input from multiple services and applications to build a recommendation prediction. They are mainly used for textual search, and are now expanding also into other multimedia search.

4.1.2.3.3. 'Processing the Environment'

Once a profile is created and recommendations are proposed, the results can be combined with the user context, which need also to be captured. It is also possible to directly tailor the results from the recommendation engine could be tailored to the location and other information on the surroundings of the user.

Due to the diversity of potential context information, the cognitive systems do focus on a limited set of environment variables, later to be used in the extraction of meaningful information about the context. Among the different types of information currently available in the mobile environment, location is the prime example.

Typical information about the surrounding objects is amongst the most used. Here, information about the location is captured either by GPS or through mobile signal information processing. In the first case, the GPS provides an excellent precision of the location but consumes a significant amount of batteries energy. The second option consists in locating the terminal via the cell ID of the mobile network or using other signal processing techniques, e.g. the signal strength or the time-of-arrival (Gustafsson, 2005). The precision is lower, but also the energy consumption.

Location is just one piece of information. The increasing network of sensors and emitters in the environment and embedded readers mobile device is additional way to obtain information on the context. Other examples of relevance include gyroscopes (for orientation), accelerometers (for in-device movement tracking), or weather measures (temperature, pressure, wind, etc). Cognitive technologies to use this information in the mobile environment and improve search result belong to the context-awareness techniques discussed below.

4.1.3. Mobile search specific technologies

4.1.3.1. Context-awareness

Context awareness is regarded as an enabling technology with a high potential for mobile data applications, particularly in field of mobile search. It refers to all technologies concerned with the acquisition of context (using sensors to collect information about the surroundings or environment), the abstraction and understanding of context (matching a perceived sensory stimulus

to a context), and application behaviour based on the recognized context (triggering actions based on context). These systems capture and use contextual information in dynamic way as to optimize, change, or create communications flow and business processes. Contextual information can be collected for any mobile asset involved in a business process, and this includes not just devices and products but also people.

4.1.3.2. Augmented reality

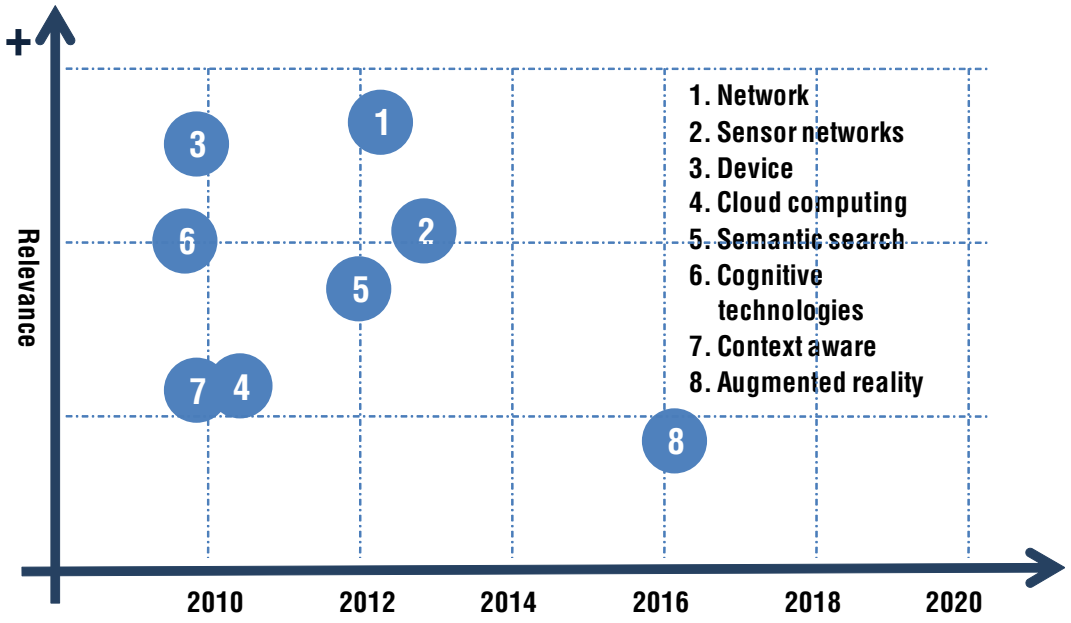
Augmented reality (AR) is a field of computer graphics research that deals with the combination of real-world and computer-generated data (virtual reality), where computer graphics objects are blended into real footage in real time. At present, most AR research is concerned with the use of live video imagery which is digitally processed and "augmented" by the addition of computer-generated graphics. There are many applications of AR currently developed in different fields, i.e. in advertising, medicine, navigation, emergency services, prospecting in hydrology, ecology or geology, visualization of architecture, enhanced sightseeing, flight simulation, and entertainment. AR-enabled interfaced will enrich context-aware technologies, by rendering contextual search more precise and intuitive.

4.1.4. The way forward

One of the purposes of the expert workshop on "Mobile Search Prospects" (Sevilla, 16-17 April 2009) was to identify key issues to take into account for a technological roadmap for mobile search. Participants see a couple trends that are going to influence technological challenges. First, there is a real and increasing need for pure mobile search applications: "find a timetable", "get me home", etc. These applications will need technologies and developments that are tailored specifically for the mobile environment and are distinct from the general PC-based search environment.

Second, mobile search does and will coexist with popular dual usages PC/mobile. Although the technical requirements are clearly distinct,

Figure 18. Expected availability and relevance of important technologies for mobile search (2010 – 2016).



Source: own elaboration based on experts' workshop

people want to perceive the search as a seamless experience across media. This is currently not the case and actions should be taken for consumers to perceive a similar quality of service. Therefore, there is an interest in "convergence" of technologies. This leads to the final challenge: the most important "technical" issue in mobile search is interoperability. In fact, the interconnection and interoperability of technologies was considered a key factor for success; much more than developing specific "hard-core" mobile search technologies.

Based on this general framework, the panel of experts who took part in the workshop in Seville analysed the relevance for search and the time of market appearance for the technologies discussed in the previous chapter. Figure 188 plots the eight aforementioned topics with respect to these both criteria; those on the upper left corner are more important that those on the bottom right. Figure 18 highlights the importance of mobile broadband connectivity, and the availability (and adoption) of smartphone devices. These two factors are necessary pre-conditions to boost other technological implementations.

A good deal of context-aware (#7) and cognitive technologies (#6) are already available (or in an advanced prototype stage to be operational in the near future), but yet show little presence in commercial services and applications. Once the connectivity (#1) is broadly assured and smartphones (#3) are deployed at large scale, it is expected that the technology relevance drawn would be re-adjusted after 3-4 years, considering that the identified preconditions would have achieved at that time a sufficient level of mass adoption that foster context-aware systems, services and applications usage.

4.2. Mobile market trends: baseline scenario

The same assumptions, notation and definitions made in the introduction to section 2.1 are used in this section of the report.

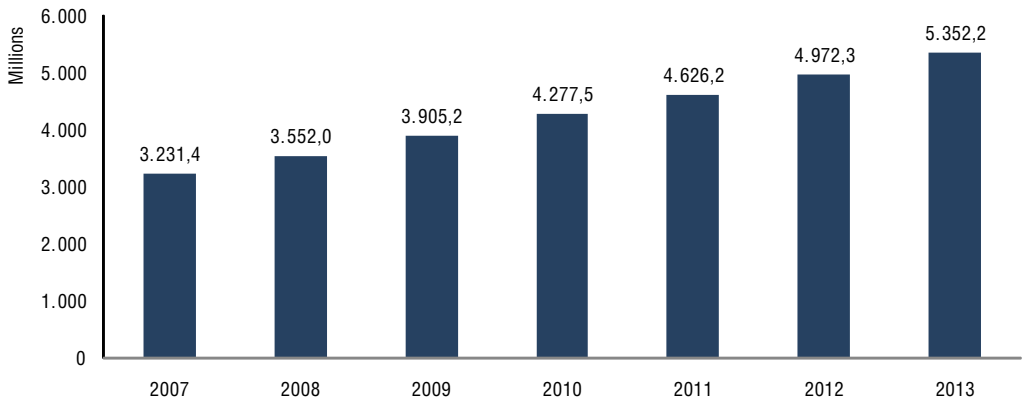
4.2.1. Subscribers

4.2.1.1. Mobile worldwide subscriber base

The subscriber base experienced a fast growth during the last years and is expected to continue to grow (Figure 19) with nearly 5,000 million subscribers worldwide in 2012.

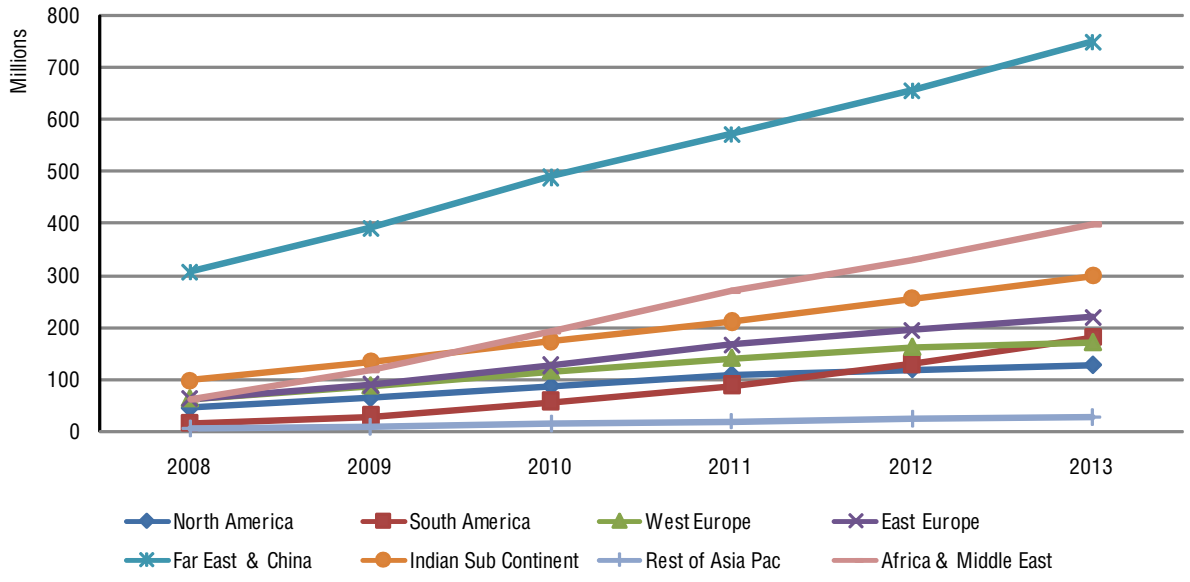
This strong growth is expected to be driven by the major emerging economies of Asia (particularly in China, India, Indonesia, Pakistan), Latin America (Brazil, Colombia), Europe (Russia, Ukraine, Turkey) and Africa (South Africa, Algeria, Nigeria). Regional growth is presented in Figure 20.

Figure 19. Mobile subscriber base worldwide (2007 – 2013).



Source: own elaboration based on data taken from Enter – IDATE (2009), from ITU (2009) and from Lane (2008)

Figure 20. Mobile subscriber base by region (2008 – 2013)

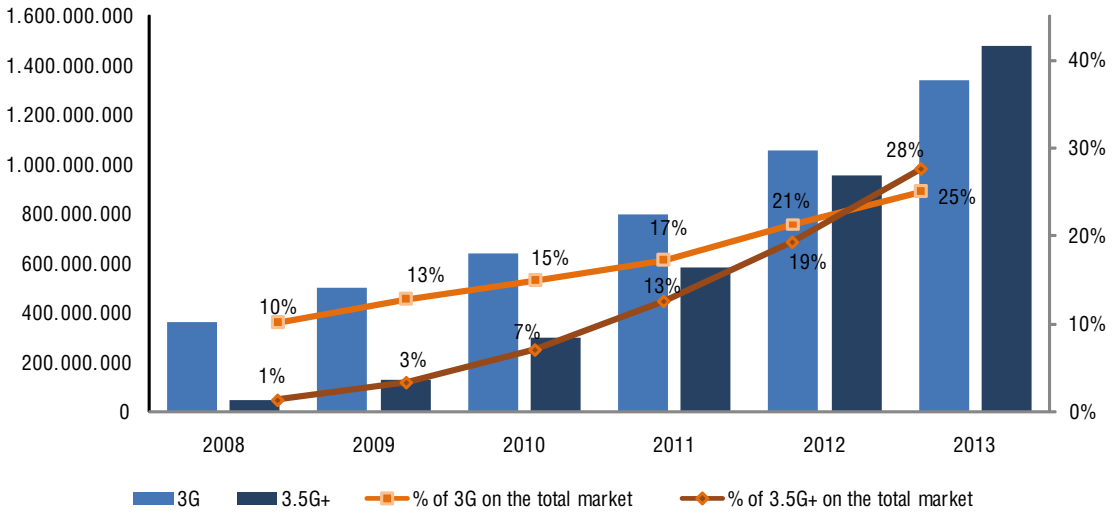


Source: own elaboration based on data taken from Enter – IDATE (2009), from ITU (2009) and from Lane (2008)

4.2.1.2. Mobile broadband

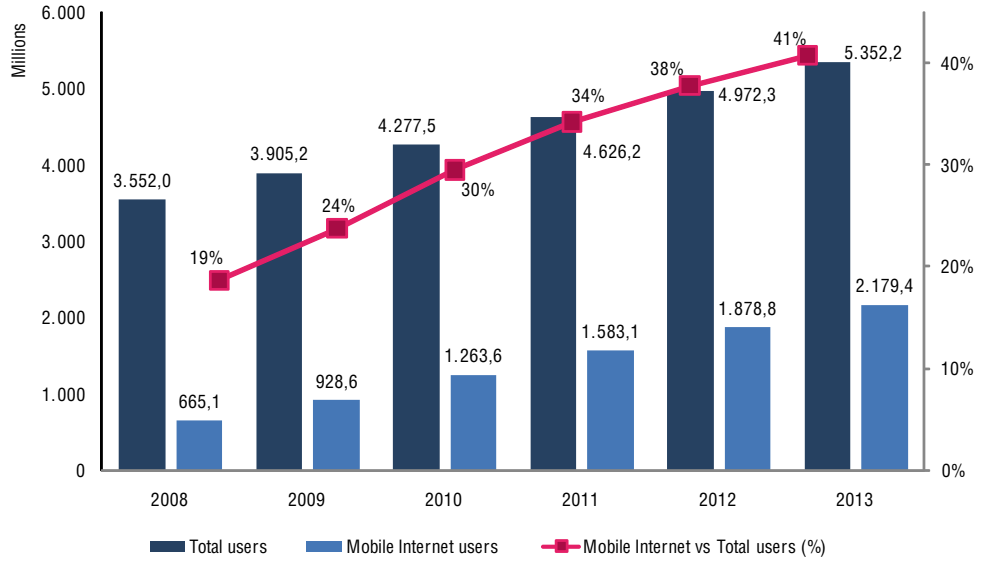
By the end of 2008, over 362 million 3G subscriptions were estimated globally, representing around 10% of the 3,686 million users worldwide. The forecasts is that broadband mobile connections (3G, 3.5G+) will grow significantly during the following years, representing more than 50% of total connections by the end of 2013 (Figure 21). This is a major factor for mobile internet and mobile 2.0 services development, and hence also for mobile search.

Figure 21. Forecasts for 3G and 3.5G access worldwide (2008 – 2013)



The figure reports the absolute value (in millions) and the share (in percentages) for 3G and 3.5 G
Source: own elaboration based on data taken from Enter – IDATE (2009), from ITU (2009) and from Lane (2008)

Figure 22. Mobile internet users vs total internet users (2008 - 2013).



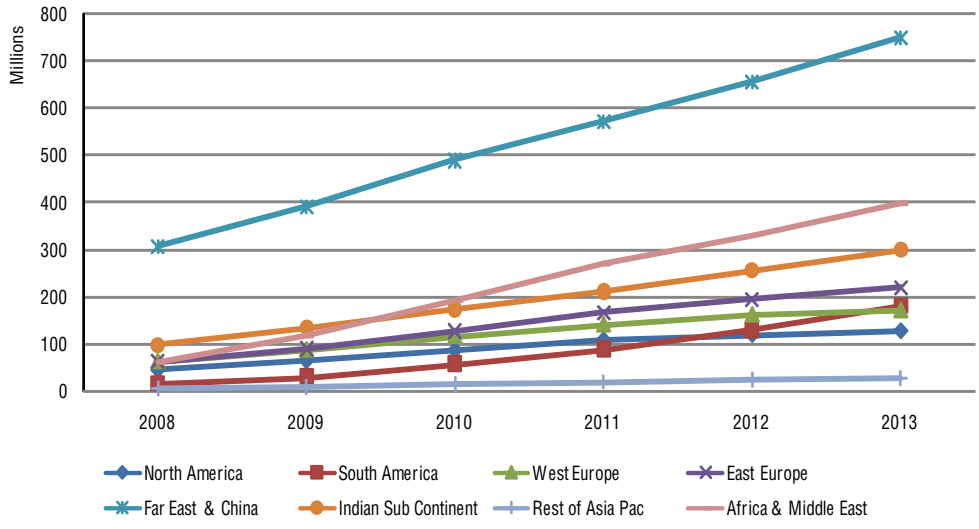
Source: own elaboration based on data provided by Chard (2008)

4.2.1.3. Mobile internet

Mobile internet adoption is expected to exhibit a fast growth in the following years, achieving up to 40% of total subscribers in 2013 (Figure 22).

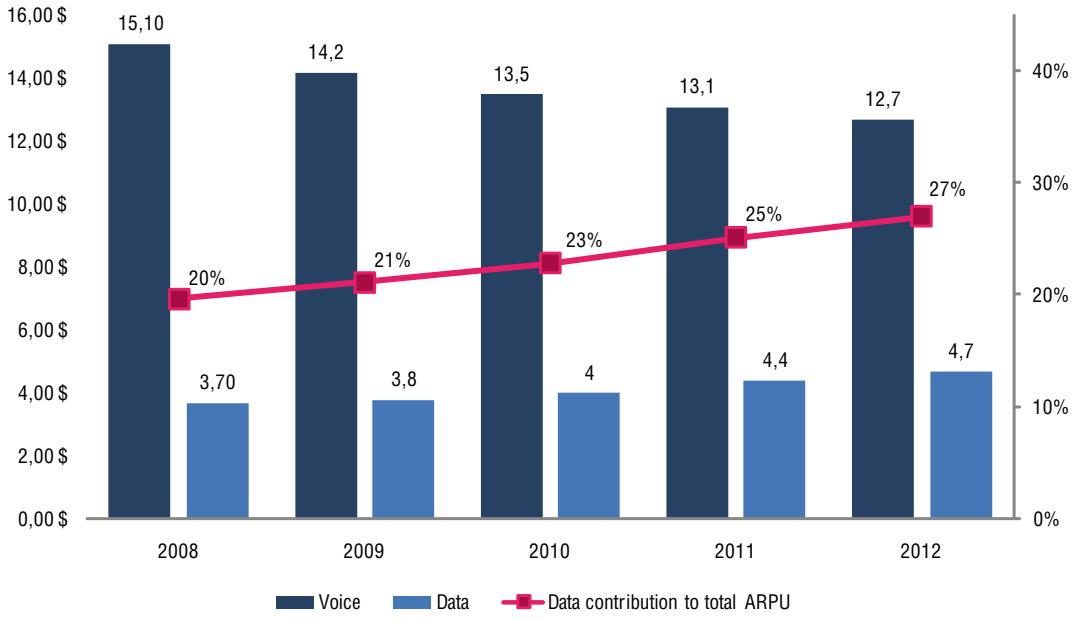
Figure 23 presents regional differences in mobile internet users. The Far East and China region will continue to be the largest mobile internet regional market. Mobile internet usage is already high in pioneering countries such as

Figure 23. Mobile internet users by region (2008 – 2013).



Source: own elaboration based on data taken from ITU (2009)

Figure 24. Mobile operators' average revenue per user (2008 – 2012).



The data shows the worldwide average ARPU by voice and data services. The data are in USD
Source: own elaboration based on data taken from Lane (2008)

Japan and Korea, and China continues to show strong growth in subscriber numbers. Africa and Middle East, and the Indian Sub Continent, will also experience strong growth, as the mobile phone provides the most viable medium for obtaining internet access (due to lack of fixed-line infrastructure). Growth will be moderate in more saturated markets such as North America, and Eastern and Western Europe, although it is expected that mobile 2.0 will boost the mobile internet services take up.

4.2.2. Industry revenues

4.2.2.1.1. Average revenue per user

Charging for increasing data traffic has long been sought by mobile operators as the long term solution to declining total average revenue per user (ARPU), mostly voice. However, existing consumption of mobile data services is failing to offset the decline in total ARPU, and despite its growing contribution, this tendency will be maintained during the following years.

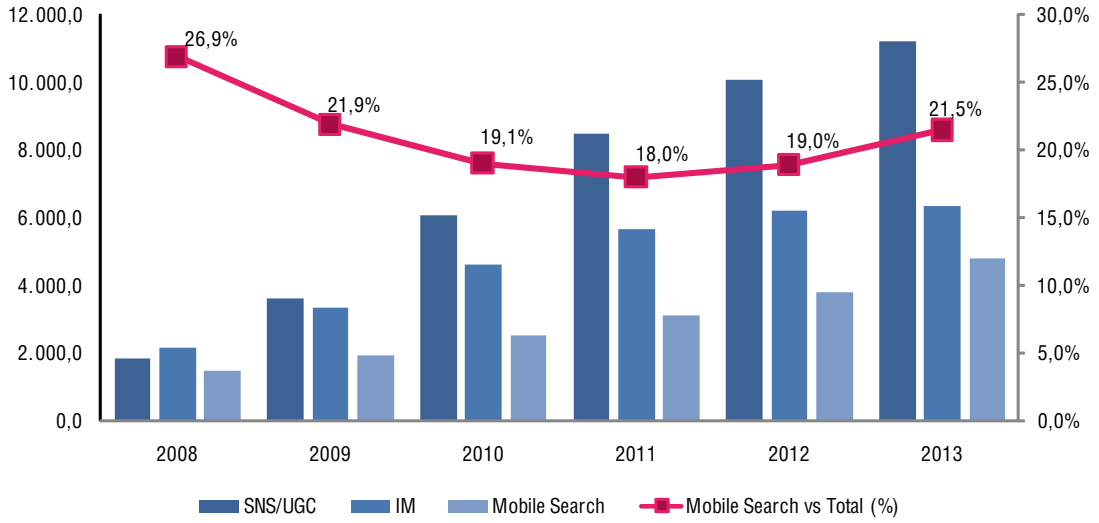
Figure 24 shows the forecast that total ARPU will decline, although data will increase its importance, until reaching almost 30% of total by 2012.

4.2.2.1.2. Mobile 2.0

Out of the 30% of operator's total revenues that data represent, mobile 2.0 applications will become a primary source of revenues, reaching up to 50% of data revenues. Currently main income generators are messaging (SMS, MMS), mobile email, basic contents (like ringtones or wallpapers) and information services. By contrast, nascent mobile 2.0 will be based on social networking and user-generated contents, instant messaging and mobile search.

As Figure 25 shows, although instant messaging currently is the primary source of mobile 2.0 incomes, social network services / user generated content (SNS/UGC) will become the leading mobile 2.0 application. The main assumption considered is that mobile search is expected to be widely adopted from 2010/2011

Figure 25. Global revenues for mobile web 2.0 by application (2008 – 2013).



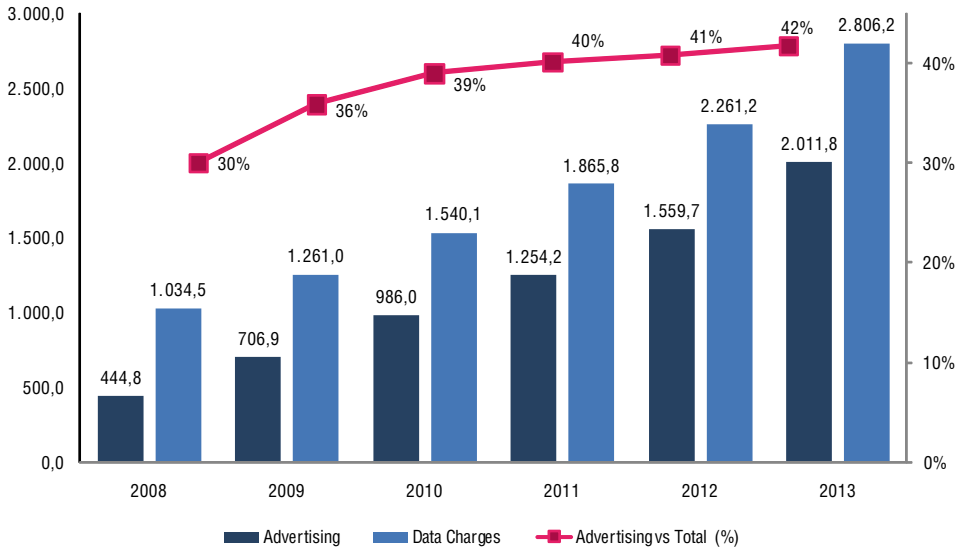
Data in USD. Source: own elaboration based on data provided by Chard (2008)

on, as context-aware technologies improve mobile search engines and results delivery and accuracy.

4.2.2.1.3. Mobile search

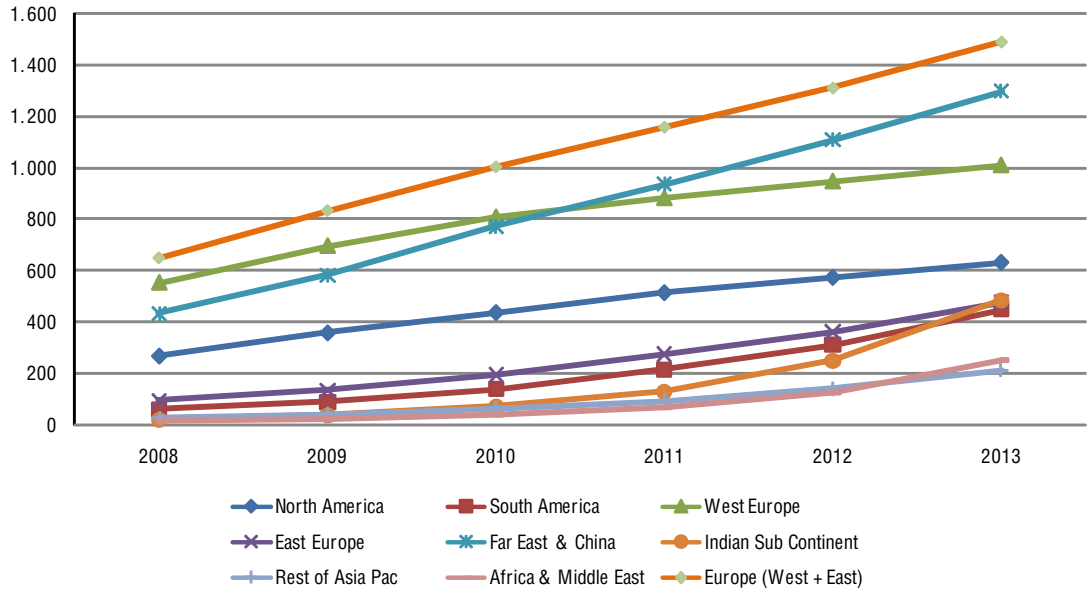
As presented in Section 2.2.2 and specifically referring to mobile search, Chard (2008) expects the advertising and user profiling contribution to the total mobile search revenues to grow from 30% in 2008 to around 40% in 2013, being the total mobile search revenues aggregate growth (CAGR) of 27% for the same period (Figure 26).

Figure 26. Mobile search revenues by advertising and data charges (2008 – 2013).



Data in million USD. Source: own elaboration based on data provided by Chard (2008)

Figure 27. Mobile search revenues by region (2008 – 2013).



Data in million USD. Source: own elaboration based on data provided by Chard (2008)

According to the Mobile Entertainment Forum (MEF), advertising revenue split ratios will likely be similar to internet ones with about one third for the search solution provider and about two thirds for the publisher, including as a main difference with the web a residual percentage up to 10% for other players in the mobile value network.

According to Chard (2008), Far East and China, Western Europe and North America represent the largest markets for mobile search in terms of total revenues, representing 27%, 21% and 13% of the overall market, respectively, in 2013 (Figure 27). It is important to highlight the leading position of Europe within global market, as the combination of Western and Eastern Europe forecasted revenues surpasses the leading single region, Far East and China. For this forecast to come true, total revenue in Eastern Europe in 2013 should be about five times higher than the 2008 value, reaching a level not far from that of North America.

Chapter 5. Projecting further into the future

5.1. The framework for the analysis

Due to the general lack of (reliable) data on the future prospects of mobile search evolution, a Delphi-type survey was carried out with some of the main experts in the domain. The first round of the survey was done using an online questionnaire in March 2009, and the second and final round took place in a face-to-face workshop in April 2009 (see Annex I for more details about the questionnaire and Annex II for the workshop).

The objective of the questionnaire was threefold: first, to ease forward thinking and reflection on current trends and developments; second, to stimulate debate during the validation workshop associated to the project; and finally, to harness experts' opinion along the key dimensions of the study (technological evolution, emergence of innovative business models and user acceptance) so as to cover the main issues that affects mobile search future development, its understanding and its drivers and barriers.

The questionnaire was based on distinct scenarios to contrast possible mobile search futures and to simulate possible uses and applications. The classical approach (Schoemaker, 1995) was followed to select them, and in particular, the two main dimensions of uncertainty in mobile search: the intensity of use of personal data in the application and the techno-economic developments required. The latter represents the techology push of an emerging domain and the former is arguably the summary of the users' balance between usefulness and perceived risks.

Seven scenarios were finally retained for a forward-looking exercise with experts in the field. They are summarized in the Table 11 with their main characteristics and depicted in Figure 28 along the two dimensions mentioned. These seven scenarios were designed in such a way as to cover all of the technological and socio-economic relevant aspects discussed in previous sections of this report. From a technological point of view they cover the conventional (but highly relevant) search paradigm plus the most important trends likely to boost mobile search (see Section 4.1), namely context-aware applications, the internet of things and emerging cognitive technologies. They are reviewed in the next paragraph following this "roadmap" order.

The "dating agency" scenario (#7) deals with trust issues and the possibility of a third party handling them. It is one of the most obvious niche extensions of search into the mobile domain, where geo-location and personal profile are used to improve the usefulness of search. The "Playground mates" scenario (#6) is proposed to understand the social and economic limits of mobile search. In this scenario parents subscribe to a search application for the welfare of their offspring. The "wellness" scenario (#3) is a health-based scenario that takes into account the difficulties in aligning the diversity of interests of stakeholders, including users. Focusing on health data is a way to explore both possible business models and privacy implications. In the "Serendipity mode" scenario (#1), users activate a "discovery" function whereby unexpected but relevant information is pushed to them as a prime example of techno-economic driven evolution. It is also one of the most obvious applications of mobile search: context information. "Recipe search" (#2) is a scenario demanding a complex business model with very accurate information and a very high level of standardisation and interoperability. As another typical potential application of mobile search it uses the idea of "reality mining" where information is searched

from physical objects. The "tourist mode" scenario (#5) is an application based on tagged content within a networked sensor infrastructure. It uses the concept of "augmented reality" to provide an improved user experience in another obvious setting: tourism. Finally, "the Truman Show" (#4) is a "black" scenario exploring the limits of privacy and commercialisation in mobile search. It uses the "big brother" concept through a mobile device where the viewers have full control. The detailed descriptions of the scenarios (#1 to #7) could be found in Annex I.

Table 11 places the seven scenarios with respect to these four dimensions. It gives also an overview of some critical elements in terms of technologies, user's adoption and business.

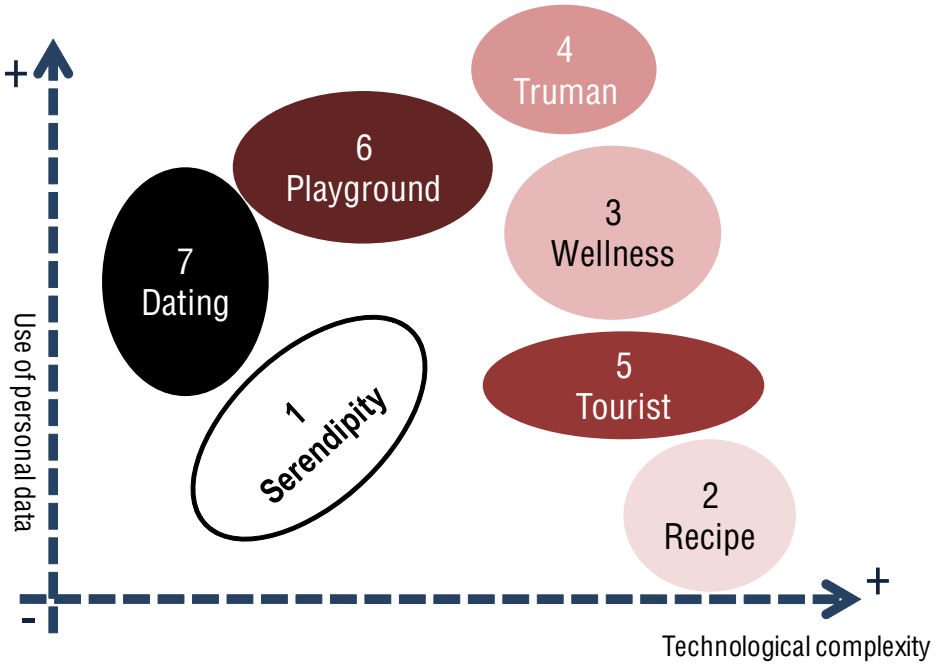
As stated before, Figure 28 positions the scenarios with respect to the intensity of use of personal data (whose misuse is a proxy for potential privacy concerns) and embedded technological complexity, a proxy for technological maturity.

Based on the scenarios presented in the previous section, a questionnaire was distributed

Table 11. Main characteristics of the prospective scenarios

EVOLUTION OF MOBILE SEARCH	Web search adapted to the mobile environment	Context-aware mobile search	Context-aware mobile search + cognitive technologies
Data types	Internet data + Location + Personal/social profile	Internet data Location Personal/social profile + Multimedia queries + Information from environment	Internet data Location Personal/social profile Multimedia queries Information from environment + Bio-parameters + Behavioural information
Critical technologies	Usability of mobile browsing Availability of mobile broadband connections	Usability of mobile browsing Availability of mobile broadband connections + Mobile social computing + Audiovisual search + Context information integration + Near-field communications infrastructures and sensors	Usability of mobile browsing Availability of mobile broadband connections Mobile social computing Audiovisual search Context information integration Near-field communications infrastructures and sensors + Bio-sensors information integration + Cognitive technologies
Additional enablers	Improvements in search technologies (semantic, etc) Improvements in geo-location	Improvements in search technologies (semantic, etc) Improvements in geo-location + Availability of geo-located content + Availability of context-aware content + Wearable computing + Internet of things	Improvements in search technologies (semantic, etc) Improvements in geo-location Availability of geo-located content Availability of context-aware content Wearable computing Internet of things + Improvements in artificial intelligence
Business model	Mainly advertising	Undefined	Undefined
Critical elements from user's perspective	Use of personal profile Some privacy issues Extension of eID to mobile environment	Use of personal profile + Multiple privacy issues + Management of mobile eID + Usefulness / perceived value	Use of personal profile Multiple privacy issues Management of mobile eID Usefulness / perceived value + Trust
Narrative scenarios	"Dating agency" (#7)	"Serendipity mode" (#1) "Playground mates" (#6) "Recipe search" (#2) "Tourist mode" (#5)	"Wellness mode" (#3) "Truman show" (#4)

Figure 28. Scenarios: positioning with regard to their technological complexity and use of personal data



to 240 experts in the mobile and search fields. The number of respondents for this first round was 61. For the second round, 23 of these experts were gathered in a workshop to discuss the results and modify them accordingly.

The profiles of the respondents show a reasonable balance. Finally, there were 442 valid responses across the seven scenarios. Industry (205) and academia (184) were equally represented, while 53 responses were from experts engaged in legal aspects and in research and development promotion from public administration. Years of expertise were similarly spread, with 180 responses from experts' with less than 5 years of experience in the domain, 140 from 5 to 10 years, and 122 answers from experts with more than 10 years of experience. Regarding the main area of experience, 41 experts mentioned business and market, compared to 37 with user experience, 28 in technology development and 12 in legal affairs.

5.2. Main results of the experts' survey and discussion

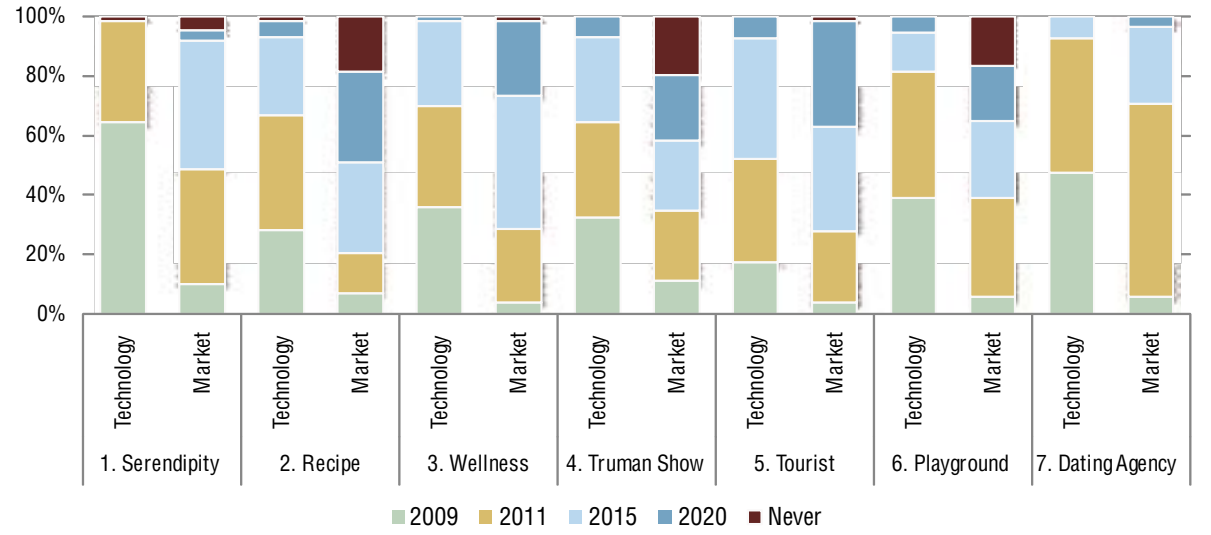
The results emerging from the first round of (answers to) the questionnaire are presented in detail in Annex I. The following sections of report summarise the main findings and the agreements reached during the face-to-face workshop.

5.2.1. Time horizon

The first analysis of the survey referred to the timeline along which the different scenarios are expected to be feasible from a technological point of view and when they will be adopted in the market. The objective was not to define an exact roadmap, but rather to gather expert forecast about the potential stopovers on the route of development of the mobile search environment, as depicted in the seven scenarios. Two questions were used across the seven scenarios:

- When will the underlying technology be available?

Figure 29. Scenarios: technological availability and time-to-market



Data shows % of experts' opinion for each of the 7 scenarios

- When might this application reach the mass market?

Figure 29 shows the distribution of answers. Experts consider that –in most cases– the technology is either available (2009) or will be available soon (2011 to 2015) except for effective audiovisual search ("tourist"), integration with other services ("wellness"), semantic search and deployment of sensors ("recipe"), and cognitive technologies ("Truman show"). We conclude that technology is not the (major) barrier for the deployment of the mobile search applications depicted in the scenarios. Note also that experts confirmed that technology is expected to come ahead of the market. A time lag is expected between the actual possibility of having a scenario enabled from a technological perspective and its reach to the mass market. This time lag is bigger in more complex scenarios where aligning the interests of many stakeholders like scenarios 2 ("recipe") and 3 ("wellness") is key.

Ordering the scenarios, it could be interpreted that a shorter time to market is more likely to occur first in the take-up of conventional search adapted to the mobile environment in niche markets (scenario 7), followed by applications making a more intensive use of personal and social data to improve user experience (scenarios 1, 3, and 5) in increasingly wider markets. Scenarios requiring more complex services (like scenario 2) will arrive last given the effort needed for the integration of technologies, the interoperability of content and applications, and advanced interconnected services. The experts considered the "black" scenario (#4) not likely to occur, thus, placing it long away in the future.

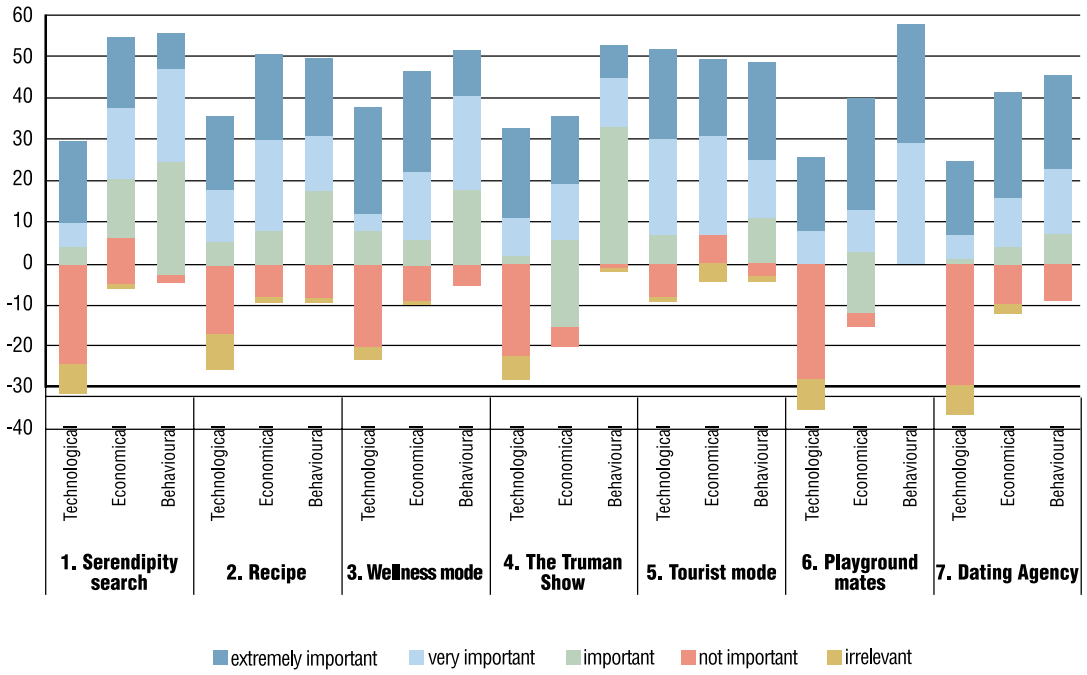
As a whole most experts seem to consider all scenarios likely to happen in the next 10-15 years.

5.2.2. Major bottlenecks

Experts were also asked about the type of bottlenecks that could hinder the success of mobile search applications as envisaged in the scenarios. Figure 30 illustrates the questionnaire results.

In accordance with the previous sub-section, technology is not considered the most relevant limiting factor; Figure 30 indicates that economic

Figure 30. Technological, economic and behavioural bottlenecks



Data shows % of experts' opinions for each of the 7 scenarios

and behavioural aspects are regarded more important.

Further, it appears that scenarios can be grouped into three different clusters:

- A first group where technology is not so important, economics are important, but behavioural aspects are extremely important ("wellness", "playground", "dating", "Truman show"). These scenarios make intensive use of very personal data.

- A second one, where both the economic and the behavioural aspects are important with regard to relatively unimportant technology aspects ("serendipity"). A balance between use of personal data and business model is required.

- Finally, those scenarios where economics are more important than the relatively less important technological and behavioural aspects ("recipe", "tourist"). They require finding out a suitable business model to be successfully deployed.

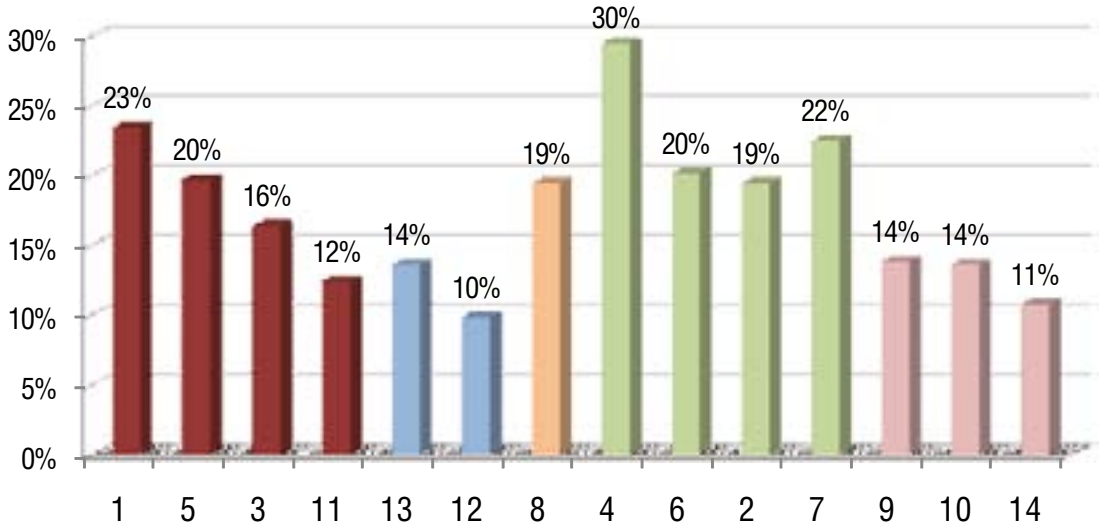
5.2.3. Business models

To examine techno-economic aspects, the experts were also asked to choose up to four business models as suitable for each scenario.[22] The questions introduced the business models already summarised in previous sections. The overall results of experts' responses are shown in Figure 31 with relative percentages.

The first four columns (I, V, III, XI) are related to advertising (advertising similar to the web, advertising linked with some product placement, merchandising/affiliation and user profiling, respectively). They seem to confirm the hypothesis of advertising, in its multiple varieties, being a

22 On average they chose 2.4 business models per scenario.

Figure 31. Preferred mobile search business models



The data shows the percentage of experts' respondance for the ensemble of the 7 scenarios. The numbers refer to the 14 different business models mentioned below.

(I) Advertising in general (i.e. like in today's internet search)
(II) Pay-as-you-go (impulse purchase)
(III) Merchandising (i.e., as a way to sell some other product or service) or affiliation (i.e., to create opportunities of business for some other site)
(IV) Premium services (i.e., the basic functionality is free, but the advanced options not)
(V) Advertising but based on some product placement (i.e., linked with another product: a TV show, a cinema premiere...)
(VI) Value-added services (i.e., a contract for a pack of services on top of usual ones)
(VII) Subscription (monthly/annual fee, etc)
(VIII) Packaged with some other product or service not related to ICTs (a flight ticket, a hotel accommodation, a tourist pack, insurance...)
(IX) Business model to be defined at a very late stage when a critical mass of users is achieved (like Twitter today, for example)
(X) User community maintained by user contributions (like Wikipedia, for example)
(XI) User profiling (i.e., selling the user profiles for commercial purposes)
(XII) Packaged with the (voice, data) services of the mobile operator
(XIII) Packaged with the mobile handset
(XIV) Not a commercial service (i.e., a public service)

fundamental business models in mobile search. A second group of business models (XIII, XII) are based on packaging mobile search with some other good or service (the mobile device, the voice or data services of the mobile operator and some other good or service which is non-ICT related, respectively). The experts' consider packaging options (VIII) more likely than traditional "walled garden" approach. Here, they consider mobile search as a tool within a number of products or services not related to communication as such. The third block of business models (IV, VI, II, VII) considers mobile search as a premium service, as a value added service, as an impulse purchase or as a subscription service. Although seldom present in current mobile search market, this is the experts' preferred category of business model for mobile search, in particular in the direction of premium services. It is also worth to note the relevance of the other service categories, all connected with the particular circumstances of usage: a moment in time, a place, or a specific need. The final three columns (IX, X, XIV) group other models. Number IX is about the likelihood of mobile search applications looking for a critical mass of users to later become a de facto standard; then expanding to an actual business model. Experts seem relatively sceptical about this possibility. The second explores the development of mobile search applications through community open-source-software. The experts are also sceptical of this case, but less so than of the

mobile operators role, for instance. Finally, the last column demonstrates that public provision of some type of mobile search, although a less prominent choice among experts is nevertheless a possibility to be considered.

The survey responses show a rather consistent picture of the preferred business models. The "dating agency" scenario (#7), a case for an improved web search applied to the mobile environment, and the "tourist mode" (#5), the most obvious example of mobile search utility, are prototypical of the average result. Premium services were considered the business model with a higher potential, but it was very closely followed by pay-as-you-go and packaged with a non-ICT service models. Advertising has a secondary role in both cases. Both of them probably show one of the most evident ways forward for mobile search. A similar result was obtained for the "wellness" (#3) scenario, where subscription service now dominates. From the report perspective, this block of results contributes to the possibility of building appealing applications for niche markets. In this last scenario, packaging the mobile search application is preferred to advertising as a secondary option, in the report opinion an indication of a potential preference for a third party streamlining the difficulties in the provision of complex services and managing it satisfactorily. Reading the result somewhat openly, it could be interpreted as mobile operator and device suppliers as the only players able to contribute to the provision of a value added service when there are many different (commercial) interests at stake.

For the "serendipity mode" scenario (#1) experts prefer conventional advertising as the leading business model. They also considered the possibility of "push advertising" and user profiling. This scenario seems to underline that the range of advertising schemes are larger in the mobile domain increases than its web counterpart. Again, experts see a role for mobile device suppliers and mobile operators as providers of the service. In this scenario it is worth mentioning the relevance given to the "undefined" type of business model just looking for a critical mass of users. This could suggest the emergence of new de-facto standards related with the mobile search applications domain. "Recipe search" (#2) adds to the increased scope of advertising models in the mobile domain and interestingly also includes the "impulse purchase" model due, probably, to its relationship with a very demanding situation, therefore, a prototypical case of the aforementioned connection of mobile search application with the particular circumstances of usage.

In the "playground mates" (#6), a grey scenario in which children and parents are the protagonists, the highest ranked business model was the user community, followed at a distance by subscription and premium services. This scenario also has a high profile for the public provision of this type of mobile search. In our view, both results (user community and public provision) could be interpreted as some of the niches in mobile search domain sharing some public goods characteristics and therefore they are regarded as non-profitable from a private company perspective. As a consequence, there is, therefore, some role for public administrations in their provision. Finally, the "Truman Show" (#4) as a "black" scenario that should be avoided, highlights the dangers of over-exposure to commercial interests, and the experts have noted the potential connection with the type of advertising-related business models.

5.3. Enablers, drivers and barriers

In this section, the key enablers, drivers, barriers and potentially disruptive trends in the future evolution of mobile search are briefly presented and discussed. The section is a summary of the main ideas discussed through the document and it is also an overview of the discussion with the experts during the workshop conducted in April 2009 in Seville (see Annex II for details).

5.3.1. Key enablers for mobile search adoption

Enablers are necessary but not sufficient conditions for a successful development of mobile search. They belong fundamentally to three types: those related to the availability of technical infrastructure, those linked with the framework of viable business models and those based on the perception of the user about mobile applications.

On the technical side, enablers are related to the availability of new devices and technologies based on them: interfaces like touch screens, 3D, or the capability of devices to capture information from sensors, about the environment and the person. From a mobile point of view, next generation mobile networks, 4G-type and beyond, are arguably the most relevant enabler of mobile search. 3.5 G technologies are enablers to improve download and upload speeds as well as latency to enable an adequate experience for users. Mobile networks shall be complemented increasingly by other types of wireless networks such as near field communications for interaction with sensors. In particular, the success of an open and interoperable Internet of things is a main enabler of context-aware mobile applications like mobile search. In addition, there are also technical enablers distributed across the mobile ecosystem: the existence of open standards and solutions (the overall role of IMS being controversial), mobile widgets, mobile "glue" technologies (for instance, javascript enhancements), SIM/smart card web servers, APIs (GSMA, OpenAjax, Bondi, Gears, RCS…), browser plugins (MS Silverlight, Mozilla, W3C…), and social network APIs.

Two elements appear particularly important to the business environment. First the adaptation of advertising formats to the mobile environment, recognizing the fact that advertising is de-facto the only business model for web search and likely to play a dominant role in mobile search. Second the drive towards more personalised and context-aware applications, whereby mobile devices hold a unique competitive advantage.

As an overall enabler, advertising is shifting from mass advertising (television, newspapers etc), to a more targeted, personalised and engaged format. This benefits search in general (both web and mobile) at the expense of traditional media. Note, thus, that mobile advertising is scalable to the extent of a significant amount of substitution with traditional media, but –in order to become more effective– advertising needs to become platform specific (but globally harmonised like Nokia ad service, Android or iPhone), as opposed to current platform agnostic, and at the same time more granular.

The availability of information adapted to improve the mobile search experience is another main business framework element. Interoperable and standardized location information seems to be a necessary precondition, followed by a more ambitious similar initiative regarding context-based information in general.

The creation and storage of digital content doubles roughly every three years. There is a proliferation of formats and a major shift of content from text-based information to multimedia. This abundance of digital content creates at least three major challenges. First, although crawlers are increasingly better performing to gather information on the web, the size of the hidden web remains immense and outside the reach of conventional searches engines. Specific for the mobile environment is that highly valuable information for real-time context-aware applications is located in proprietary databases. The success of these mobile search applications is based on the one hand on technological improvements to make use of data needed for context-aware applications and, on the other hand, to ensure that access to such data is available. The second challenge with regards to the abundance of content is how to structure and index increasing amount of "raw" audio-visual content with little or no metadata attached to it. This is a general issue for search engines; specific for mobiles is that the shift towards more audio-

visual retrieval poses far larger technological challenges for mobile devices than for PCs. Finally, a competitive advantage of search engines would be to filter, prepare and package content suitable for mobile applications, rather than only facilitating access to this content.

Social computing lends itself well to mobile search since it involves creating and organizing information which communities can do in a more extensive way. The difference with the fixed counterpart lies in the mobile device opening up the possibility of sharing 90% of the daily pattern, in comparison with a mere 10% in a fixed access web model.[23] Finally, a positive perception about usefulness (value for users), ease of use and user in control will contribute to create the conditions for the success of context-aware mobile search as previously discussed based on the results of the experts' survey.

5.3.2. Key drivers and barriers for mobile search adoption

Drivers are variables affecting future mobile search developments, supposing that required pre-existing conditions (enablers) are met. Barriers are factors impeding development in the short term or, more worryingly, in the medium to long term. Drivers and barriers are obviously related and, in this section, they are going to be jointly introduced and discussed.

From a techno-economic perspective, the one driver that matters most is the availability of context-based metadata-enabled content. The use of context will make the difference in mobile search. Without it, it will be highly unlikely to be able to provide a differential value to users of mobile search as compared with conventional search. The success of the internet of things and its usability and interoperability are the base of the context-awareness as mentioned previously.

Related to metadata enabled content is the users' involvement in the creation of tagged mobile user generated content. Here the role of reputation dynamics and the potential of the mobile as a unique device that can automatically add relevant data to content captured on the phone (i.e., metadata enabled content captured from mobile devices at the point of inspiration, for instance geo-tagging images) are particularly relevant. Regarding reputation, the more content volume increases and more people go online from a mobile device, the more there will be a drive for seeking out content which is relevant and has been provided by 'trusted sources'. Therefore, mobile search will be tied to reputation and trust. In this regard, algorithms, engines and tools for user-in-control are still needed to associate trust and reputation to content in a mobile environment. Search applied to citizen journalism, where users collect, report and distribute information about events, is arguably a major example of this necessity. With respect to tagging, the recent example (it was made available during the summer of 2009) of Twitter including geo-information is very relevant. Users of this service not only can search the information posted by their network of contacts but simply that "tweet" which is related to a location. Note that using the mobile device as a camera is the most common form of content capture, followed closely by video clips recording (Ofcom, 2008). As another example of automatic tagging, digital mobile footprints, where the user's position in time and space and activities are exposed, bring a new dimension to social computing. In fact, knowing when your friends are around and meeting people sharing the same interests is expected to drive the adoption by users of mobile social computing. The capabilities of mobile devices as environment sensors add to these digital footprints and make possible the contribution of users to "reality mining" where all types of information are placed on top of physical entities. Therefore, as a

23 Tony Fish on "Bothered by 2.0" at http://opengardensblog.futuretext.com/archives/2007/05/bothered_20_by_tony_fish.html

summary of these drivers, social search and real-time augmented reality search are the two other elements that complement context and create the distinctive user experience in mobile search.

In connection with the preceding driver, there is an increasing consensus that such a complex ecosystem for mobile search (and other types of mobile applications) can only be tackled with some degree of cooperation among players and openness in the platforms they use. This process can take shape in many different forms and several main players are exploring such possibilities. Google's Android is maybe the most paradigmatic example of creating an open platform to develop any kind of application. However note that even such an open approach requires both the collaboration of device suppliers (for the fabrication of the hardware) and mobile operators (approval and subsidisation of the device). On the other end, Apple's "app store" creates a "closed" environment where all the interested parties can work with a high level of certainty. It could be said that the heterogeneity of the ecosystem and the same "long tail" effect that attracts innovation (see below) are responsible for the difficulties in achieving the appropriate economies of scale that render investments profitable.

The main driver on the user-demand side is linked to the new perception of users of the usefulness of social, real-time mobile applications. Online stores offering mobile-tailored content following the long-tail business model will increase the opportunities to innovate, create niche markets (many types of mobile enterprise search-related applications are possible, for example) and, in general, monetise on-the-go consumption. As a consequence, it is likely that business will evolve around value-added services supplied through mobile search applications that the user has previously downloaded. The possible list of mobile search applications is endless: search within a specific domain of information (tourist, travel, work, navigation…) sometimes also named vertical search; context-aware search – discovery mode where the user only sets some preferences and receives relevant information in an appropriate time and situation; real-time search - where the immediacy of information is the relevant parameter; multimedia search or audiovisual search; search for an object or physical parameter (internet of things); on-device search combined with conventional search; mobile social computing search; etc.

Summarizing the business perspective on mobile search, the big providers of internet search and social applications (Google, Yahoo!, Facebook, Twitter, etc) are trying to shape mobile search as an extension of their current activities. The extent to which this will happen is not obvious. The authors of the report believe that mobile search has many distinctive features that might allow for new innovative players to gain market share and become influential. This is also creating new partnerships that will aim at mobile search applications in some way. There are many examples of new alliances: content providers who become API enabled (like the Guardian newspaper in the UK), deeper integration between the network, device and the service (Nokia N97 – Skype phone), partnerships between non phone players like Amazon Kindle with network and content providers, new players who manage internet of things (no main examples yet as of time of writing), content players with devices including content stored in extended memory cards (like Sandisk), social networks and devices partnerships (INQ1 phone with Facebook and Operator 3 in the UK), and, last but not least, device stack consolidation (LIMO, Android) which unify the device software platform and lead to a simpler and standardised access to APIs.

For the user, privacy and management of mobile digital identity can be both a driver and a barrier. In order to enjoy mobile search personalised services, the user will have to reveal some personal information to players across the mobile ecosystem. To many observers *the success of advanced mobile search applications*

will require a higher degree of acceptance of profiling and behavioural tracking as we are currently accustomed.[24] As a consequence, the different approaches to privacy (privacy by design, privacy by law, etc.) will have a critical impact on the evolution of mobile search. In particular, looking at the regulatory part, this will define the potential of the framework for mobile search applications. Note that there have been already a number of complaints both in the EU[25] and USA[26] about abuses in mobile marketing. As a summary, although personalisation can create better mobile search services, there is an increasing concern as more data is available both in the public domain and in the hands of private players. A privacy backlash could deeply affect further developments in advanced mobile search.

A final driver/barrier is the user's latent (e.g. non-expressed) request for content discovery and learning, which goes beyond just wanting to be entertained. This poses a challenge for the design of mobile search applications, since results (and applications) need to embed a "surprise" factor while being useful and usable at the same time. Such application must have a minimum level of "quality" to be adopted by potentially interested consumers. Also the search process will be "hidden" from the user in many of these applications or reversed (from existing real-life content the source of original or additional information is supplied). In the authors' view, the aforementioned issues are signs of a larger trend to shift from mere "search engines" to "recommendation engines", able to include in real time the user's preferences, social network and contextual information in the search results.

24 As a main example of the current conceptions in this domain, Google allowed users to accept advertising based on their behavioural profiles but also allowed more control over what they could see. See http://googleblog.blogspot.com/2009/03/making-ads-more-interesting.html

25 A 2008 EU-wide investigation into websites offering mobile phone services such as ring-tones and wallpapers resulted in 80% of the sites checked need to be further investigated for suspected breaches of EU consumer rules.

26 http://opengardensblog.futuretext.com/archives/2009/01/ftc_complaint_a.html

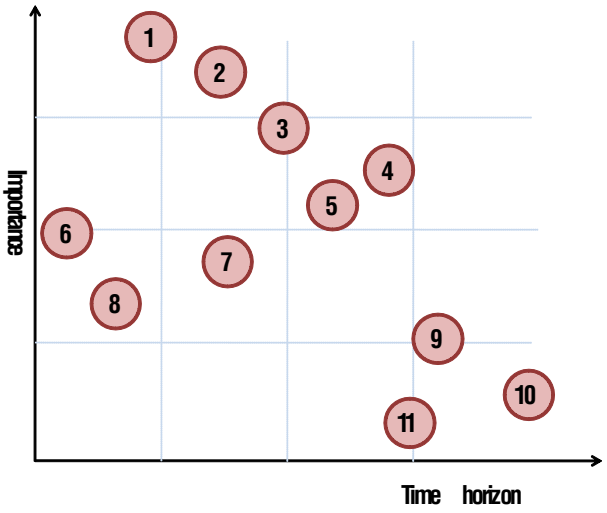
5.3.3. Disruptive trends

A foresight exercise on disruptive trends likely to affect the sector was also conducted. The aim was to identify disruptive trends in the mobile search domain. Eleven clusters of technologies were identified likely to influence the mobile search market of the future: 1) 4G and beyond mobile communications, 2) the ensemble of cognitive technologies, 3) artificial intelligence, 4) the internet of things (object-based networks on RFID or other equivalent technologies), 5) new user interfaces (touch-based screens, natural language interfaces, etc), 6) location awareness of presence (satellite or wireless sensor based), 7) semantically structured information and knowledge, 8) cloud computing, 9) augmented reality (including technologies for perceived immersiveness, like 3D), 10) peer-to-peer networks and applications, and 11) mesh networks.

The technology clusters were analysed from the point of view of impact for the mobile search area. The results of the survey were discussed by the expert group. Given the maturity of the clusters vary to a large extend, there was a need to order also the impact of the technologies with their emergence on the market. This is particularly an issue for those technologies that build upon each other and whose deployment triggers the development of other technologies. Figure 32 plots the eleven clusters of technologies with regards to their timeframe and potential to disrupt the market. The time relevant for this analysis is the moment when they are mature enough to impact mobile search.

The circles show the relative position of technologies as perceived by the experts. The numbers refer to the following list: 1. 4G and beyond mobile communications, 2. Cognitive technologies, 3. Artificial intelligence, 4. Internet of things, 5. New user interfaces, 6. Location awareness of presence, 7. Semantic structured

Figure 32. Domains of technologies of relevance for mobile search by their importance and likelihood to appear in the market



knowledge, 8. Cloud computing, 9. Augmented reality – 3D, 10. P2P, 11. Mesh networks)

The impacts of these technological trends have already been discussed throughout the report. Here they have been complemented by cloud computing and P2P because they have relevant implications in other public policy domains.

Cloud computing can represent a driver for the search engine world. However, a visible is the lack of standards and interoperability, implying that data portability will be the great challenge for searching in the cloud (for instance, portability of geo-coded information). Public procurement has been mentioned as a possible lever to foster data portability and the promotion of standards. Further, data portability is identified as a guarantee for user autonomy and freedom from lock-in effects. The experts promoted the idea of fostering discussion among interested actors (industry, governments and users) on data portability issues.

With respect to P2P, the experts agreed that the current regulatory framework for digital rights management is representing a barrier for the exploration of the potential of P2P search. P2P search in the mobile domain is connected with mesh networks and, therefore, requires some new methods for dynamic spectrum allocation. This fully falls in the category of potential policy interventions.

Chapter 6. Implications of mobile search for Europe

6.1. SWOT analysis

One of the main objectives of the workshop and this study was to analyse strengths, weaknesses, opportunities and threats (SWOT) for the future success of the mobile search domain. SWOT analysis was originally designed as a tool to position a specific company with regards to its competitive environment. The results are typically inputs to the company's creative generation of potential future strategies. Ideally, it should be carried out by a multidisciplinary team that represents the broadest range of perspectives. SWOT analysis can also be used any decision-making situation when a desired objective has been defined, in our case successful development of the mobile search domain. In this report we focus specifically on Europe.

Results from the SWOT analysis are presented and discussed. They are compared with similar findings from the overall search domain. For additional reference, some items that were more controversial or which were considered of secondary relevance, are briefly presented in a separate sub-section.

6.1.1. Main results from the SWOT analysis and discussion

The methodology for the SWOT analysis was the following. First, experts were asked individually to write down points they considered the most important one for each of the four aspects of the analysis (strengths, weaknesses, opportunities and threats). Then they were asked to present them and to justify their choice. Once the round of the individual contributions was concluded, the panel set up a first list of topics comprising all items. Then, similar items were grouped using a commonly agreed nomenclature. This new list, served further discussion. Table 12 summarises the results of the SWOT that were agreed upon by the panel. Items not having full consensus, or reflecting only minority views are not included, but are briefly discussed in Section 6.1.3.

The SWOT analysis leaves a number of clear-cut conclusions.

On the demand side, Europe enjoys a large base of early adopters of mobile search and a huge mass of mobile users with the economic strength to demand and pay for advanced mobile internet services that satisfy their expectations and requirements. On the supply side, Europe's industry is able to provide users with all the required technology. The industrial tissue is strong and readily available in all required sections of the mobile search ecosystem and particularly strong in some parts of it (telecommunications, handset producers and software and application providers). European companies have significant experience in past success stories (and failures) and, more important, they are increasingly pushed by the market, to simplify mobile tariffs and make them more affordable. Thus, a very positive conclusion is that Europe has both a strong supply and demand side in mobile search. Moreover, European industry is also actively involved in developing countries where mobile devices will become prime means to access the internet. This shared experience could become beneficial in both ways: spreading European innovations and learning from massive usage of mobile internet access.

One specific European asset is that Europe possesses a large collection of high quality information that may trigger advanced mobile search applications at the service of the citizens.

Table 12. SWOT analysis main results

EU Strengths	EU Opportunities
• Extremely high penetration of mobile technologies and critical mass of advanced mobile users • Industrial landscape strong (operators, suppliers…) and past success stories of co-operation • Main technological puzzle pieces in place (devices, networks, applications…) • Good research standards • Increasingly available and affordable mobile broadband connections • Increasingly available, affordable and usable mobile devices • Availability of content of higher quality for mobile use (geo, land-property registry, …) • Availability of public funded content (broadcasting…) • Multicultural background • Public awareness of privacy issues and increasingly focused laws and regulation	• Improving the integration between web/mobile/PC platform for a richer user experience • Existence of niche markets/services related to mobile search • Mobile search linked with local content (multicultural) • Partner with the experiences of mobile internet usage in developing countries • Be the first to put in place a new (regulatory) framework for API's-interoperability, privacy… • Create an open ecosystem for data portability among players and applications based on mobile search • Liberation of European public data for the creation of new services and applications • Use forthcoming disruptions (cloud computing, internet of things…) • Empowerment of the user for granular privacy and identity control internet of things debate.
EU Weaknesses	**EU Threats**
• Techno-economic and market fragmentation (data roaming, standards, application stores, convergent regulation, cultural diversity…) • Need for better / understandable / more secure pricing models and roaming charges in mobile broadband connections • Lack of interoperability and (open) standards • Uncertain strategies for revenue generation. Early state of development of business models • Strategic decisions on innovation and investments in (mobile) search are outside the EU • Search mostly dominated by global companies • Lack of entrepreneurship culture and framework for continuing venture capital action	• Delay of enabling technology developments • Increasingly fragmented market (silos, platforms, app stores…) and closed ecosystem (mobile search needs links and references with other domains) • Companies outside EU will control the developments in mobile search • Asymmetry of regulation among electronic communications, internet services and content regimes • Regulatory lag (spectrum management…) • Privacy and data protection issues not acknowledged and solved

Geo-data (e.g. cadastre), images and pictures (e.g. national libraries), or video (e.g. public broadcasters) are examples of data collections in the hands of public authorities, which have already been digitised to a very large extent, that could add significant value to new categories of mobile search. Note that most of this content comes from public sources and/or has been subsidised in the past by public institutions. It seems therefore that public administrations have not yet fully understood how they can exploit in the best possible way this value and how to get into various partnerships and collaborations to unlock its potential. The prospect of "liberation" of public data could also put governments into a favourable position to enforce an open and "loose interoperability" model to allow data portability across applications and players. Forthcoming disruptions in technology could help to deploy such models.

Finally, the many times used but also many times empty-of-practical application motto of "reaping the benefits of Europe's cultural diversity" could become true in the mobile search domain. Some of the most promising applications of mobile search pivot around local information, local culture and specific languages, which is supposed to be complemented by the emergence of many niche markets and services. Civil society is increasingly aware of the need to establish digital identities, which in turn sets the conditions for a stable and firm framework to develop mobile (search) applications, both

appealing to users and respectful with them and their preferences and motivations. Europe could be the first to put in place such a light-handed and user-empowered regime that could shift the interest of global innovators in mobile search.

Still there are many challenges and barriers to be overcome. The current mobile ecosystem is largely fragmented in terms of both techno-economic models and markets. On the techno-economic side, there are multiple layers (devices hardware and software, applications, networks, development platforms, content platforms, etc) composed of competing, closed and non-interoperable standards. On the market side, the European internal market is far from being established (think on roaming charges, for example) and recent practices (applications stores) keep the tradition of silo incompatible models. Mobile broadband connections are still expensive, particularly in many situations where mobile search would have an extreme value for users (such as finding places in foreign countries), high roaming charges dissuade users from even attempting to connect to the internet. Monetizing mobile search is also still a pending issue. Many business models are possible as discussed through the document (see Section 2.2), but none of them has yet crystallized as the winning one.

The mobile search market will remain to be heavily influenced by the web search engines. Given that the most influential ones have all their headquarters abroad, many of the strategic decisions that would influence the evolution of the domain are going to be taken outside Europe's frontiers. To compensate such an effect, a more supportive framework (cultural, institutional and business-like) for entrepreneurs and innovators in Europe would be needed.

The potential delay in the adoption of appropriate regulation regimes (electronic communications, spectrum management, content, consumer protection, etc) will slow the adoption of mobile search. In this sense, a stable, clear and forward-looking framework is desirable which would address the new issues coming from advanced mobile applications.

Finally, there is a risk of a mobile digital divide. Next generation mobile infrastructures may not reach some geographical areas in the short to middle term and the prices both of devices and mobile connections are not affordable for many citizens. Also the skills and physical capabilities to use a mobile device in a search scenario need to be further addressed.

In summary, the main messages raised from the SWOT analysis are:

- Availability and affordability of mobile broadband connections is the main enabler of mobile search. Europe has a good position in this emerging market and several key industry players are well prepared, but a number of issues remain to be solved to this regard: market fragmentation, roaming charges, mobile digital divide, interoperability and institutional and regulatory framework.

- An open ecosystem for mobile search is desirable for innovation to thrive. This openness refers to the adoption of open standards and to putting in place a "loose interoperability" concept similar to that of Web 2.0 solutions.

- There is an ample role for public action in the mobile search domain. Potential actions refer to the "conventional" regulatory approach but also, and maybe more relevantly, to the use of the wealth of public data with potential high added value in various mobile search scenarios. The role of public administrations as deployers of applications could be the key, since they are the natural playfield for the convergence of the many stakeholders involved in mobile search applications.

- Users have a definitive role to play in the success of mobile search applications. They ought to contribute to innovations but they also need a granular and easy control of their mobile digital identities and personal data.

6.1.2. A contrast with findings in the generic search domain

It is interesting to contrast these findings with similar ones from the evolution of the generic search domain:[27]

- The availability and affordability of connections to broadband infrastructures is not seen as an issue in the general search perspective.

- There is an agreement of the necessity for a high degree of interoperability that would increase the rate of deployment of applications and the user acceptability. In the general search domain, the desirable degree of interoperability is unclear, from experts arguing that loosely coupled heterogeneous systems are sufficient to those saying that tightly coupled fully standardised systems will be necessary. The experts in the Chorus project thought that, in general, at this stage it appears that the risk of damage, in term of killing innovation and creativity, through too early introduction of mandatory standards, is higher than potential lost opportunities by lacking standardisation. Note that this could be compatible with the movement towards open standards where possible.

- On the public side, it was identified that there is room for international cooperation and possibilities for common platforms to exchange data and content. It was also suggested, given that some datasets are scarce, that a special effort could be devoted to expand and share (minority) language resources. On the regulatory side, it was thought that it would be desirable to advance to find best practices of implementation of rules related to privacy.

- The users role is regarded as (arguably the main) important upcoming trend, in particular for recommendation, ratings mechanisms, folksonomies and user-generated content. However, it seems that this user role will be more relevant in the mobile search domain due to the personal and pervasive relationship between the user and their mobile device.

6.1.3. Additional results of the SWOT analysis

Table 13 summarises some additional results of the SWOT analysis. These particular results were either highlighted by some of the experts, in spite of not reaching a complete consensus, or were thought of secondary relevance but somewhat important.

The vision that emerges from these additional results is the early stage of development (technical, market, regulatory) of the domain, the controversy about the role of the existing industries in the new mobile applications domain and the huge barriers for use of data belonging to different domains (user, public, internet) in a seamless experience.

6.2. Policy options

The methodology followed for the policy recommendation has been the following. The authors of this report explored possible policy

27 To find out more about it, refer to the Chorus project final conference that took place in Brussels, 26th and 27th May 2009, http://www.ist-chorus.org/conference.asp

Table 13. SWOT analysis additional results

EU Strengths	EU Opportunities
• Internal market provides a coherent information space • Comparatively high ICT adoption and literacy in general with comparatively high income levels • Availability of new devices with new interfaces. • Young people use new mobile services extensively, and have strong virtual community feelings	• New ways of advertising (non intrusive, highly targeted) • European champions • Telecommunications industry (operators and suppliers) abilities and position. • Leap frog evolution from online internet thinking to mobile services thinking
EU Weaknesses	**EU Threats**
• Some technologies (i.e., NFC) are not reaching the market • Lack of trusted third party metrics for interested players in mobile search (advertisers, service providers, …) • Lack of critical mass in mobile search, low penetration of advanced mobile devices and low usability of them • Low capacity of marketing innovation and market developments slower than US/Asia • Context-aware technologies not developed • Weak innovation track of mobile operators • Lack of consideration of user value, no seamless user experience and little user need in mobile search • No tools for user management of personal data • Social expectations – technology provision imbalance • Weak regulatory regime for (mobile) content • Asymmetrical regulation operators – search providers • Context aware technologies not fully developed • Closed markets for technology and business development	• Reduced consumer spending in economic crisis • Intergenerational digital divide (intergenerational) • Security of new mobile applications • Risks of data theft • Data ownership/data portability issues • Difficulties for data aggregation • Fear of mobile network operators of being relegated to "dumb pipes" • Slow pace of progress/execution

actions at the EU level. This list of actions was appropriately introduced in the questionnaire to receive feedback from the respondents. The proposed actions were discussed with the experts in the Mobile Search Workshop (Seville, April 2009), with the aim to arrive at a minimum consensus on the policies more feasible and with a higher positive impact in the mobile search domain ("prioritisation"). A methodology for "convergence" of the discussion was used. The policy recommendations were re-elaborated following the workshop results and additional consultation with experts by authors of the report. The main potential policy actions are presented and discussed.

6.2.1. Potential policy actions

The list of potential policy options that were considered in the prioritisation exercise is presented below, grouped in relevant areas of action:

- **User-oriented policies aimed at the demand side** of mobile search (policy options U):
  - Enhance user-awareness of opportunities and risks (policy option **U.1**)
  - Create (policy-push) tools for user empowerment, i.e., for granular management of privacy or electronic identities (policy option **U.2**)
- **Innovation-support policies** (policy options S):
  - Supporting innovators and entrepreneurs through an improvement of the institutional framework, i.e., access to venture capital, taxes, education, etc (policy option **S.1**)

  - Promoting living labs, in particular, for mobile applications and open access to them (policy option **S.2**)

  - Promoting research projects focused one missing technologies and enablers, i.e., FP-type (policy option **S.3**)

- **Regulatory policies** (policy options R):

  - Reforming the mobile search regulatory framework, i.e., in electronic communications, e-commerce, privacy, consumer rights, etc (policy option **R.1**)

  - Promoting self regulation of the mobile search industry, i.e., codes of conduct (policy option **R.2**)

  - Harmonisation and enforcement of EU internal market (policy option **R.3**)

  - Mandate data portability suitable for mobile search applications (policy option **R.4**)

  - Creating and enforcing an independent agency, i.e., a watchdog for mobile data usage (policy option **R.5**)

- **Industrial-type policies** (policy options J):

  - Promoting standards and interoperability (policy option **J.1**)

  - Promoting content production suitable for mobile search (policy option **J.2**)

  - Supporting a European champion in mobile search (policy option **J.3**)

  - Setting up a multi-stakeholder platform (policy option **J.4**)

  - Helping accelerate the deployment of 4G mobile broadband infrastructures (policy option **J.5**)

- **Public involvement in the supply side** of mobile search (policy options P):

  - Development of mobile search public services, i.e., for cultural purposes in cities (policy option P.1)

  - Public procurement, i.e., public administration as buyers and users of mobile search applications (policy option P.2)

- **No public involvement at all**

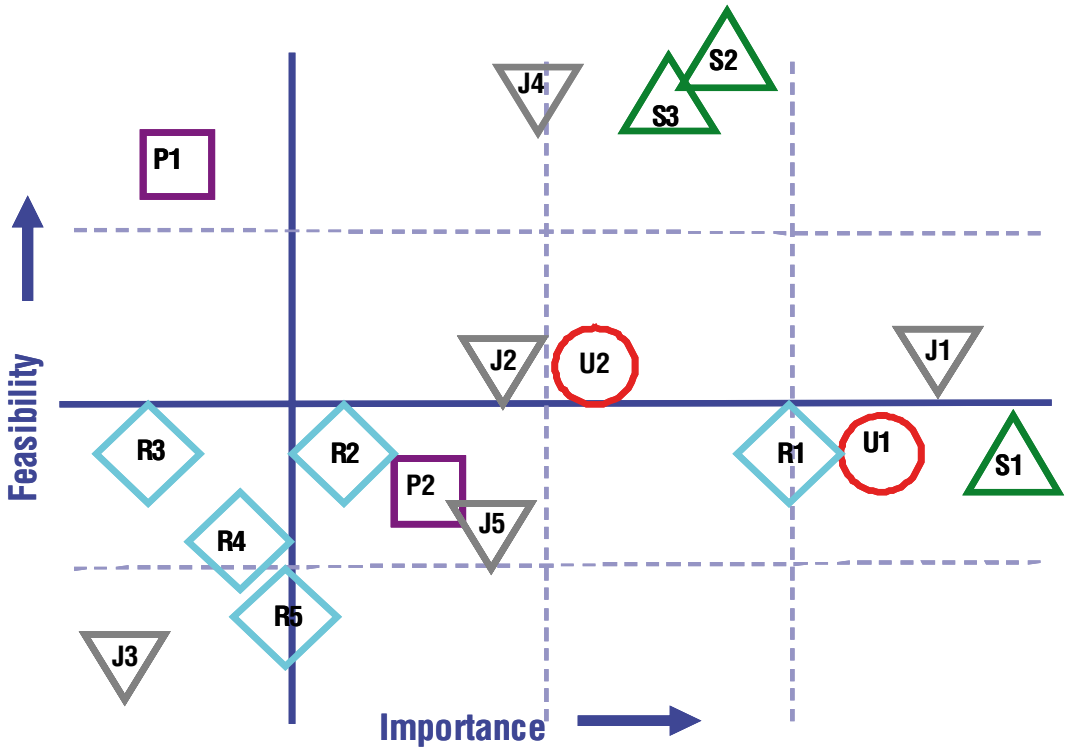
Figure 33 shows the result of the discussion to prioritise potential policy intervention. It positions the policy options with respect to their relative importance to the mobile search domain in Europe and the feasibility to put them into practice. Policies in the upper-right quadrant are considered candidates to be implemented.

The options are presented with respect to their relative importance to the domain and the feasibility to put it into practice. The nomenclature used is described in the text.

The overall vision on policy action is very balanced among the different possible options or, in other words, it is regarded that the mobile search domain requires a combination of different types of policy actions to thrive and succeed and the experts do not think that a sole type of policy will suffice to achieve this aim.

Looking in detail into each of the potential policy measures, in the first place, there is a need to impel the demand side of mobile search, raising the awareness of users and then empowering them with the tools to manage their data.

Figure 33. Policy options for the mobile search domain



This should be complemented with reinforcing all polices aimed at innovation: from the support to innovators and entrepreneurs, to the use of living labs and the more traditional research programs.

On the regulation side, it is considered that the existing frameworks should be quickly reviewed and adapted to the new needs of advanced mobile applications. However, there is no much faith amongst experts in the self-regulation of the industry or in other actions beyond the regulatory framework like specific agencies or decisions.

From the industrial policy perspective, the idea of promoting the use and adoption of open standards and the achievement of a reasonable level of interoperability, including, if needed, a platform to gather all the stakeholders involved has considerable support by the experts. Helping to develop content for added value mobile search is also highly regarded. However, it is thought that neither supporting a European champion in the mobile search domain nor forcing a swifter deployment of 4G-type mobile communications infrastructures would be helpful.

Finally, it is thought that for some niche mobile search applications public administrations can have a leading role, setting the conditions for their deployment or even becoming their providers.

References

- Altheide, D.L. and Snow, R.P. (1979). Media logic. Sage Publications. Beverly Hills.

- Álvarez, F.; Martin, C.A.; Alliez, D.; Roc, P.T.; Steckel, P.; Menéndez, J.M.; Cisneros, G. and Jones, S.T. (2009). "Audience measurement modeling for convergent broadcasting and IPTV networks", IEEE Transactions on Broadcasting, vol. 55, no. 2, pp. 502-515.

- Arter, D.; Buchanan, G.; Jones, M. and Harper, R. (2007). "Incidental information and mobile search", in Proceedings of the 9th international conference on human computer interaction with mobile devices and services (Mobile HCI'07), pp. 413-420. Singapore, 9-12 September. Available at: www.cs.swan.ac.uk/~csmatt/qna/QnA%20Resources/47CE6897-3DFD-4FF4-AD91-93CDA0D23C8D_files/QnAMobileHCI.pdf

- Baeza-Yates, R.; Dupret, G. and Velasco, J. (2007). "A study of mobile search queries in Japan", in Proceedings of the 17th international conference on World Wide Web (WWW 2007), pp. 257-266. Beijing, 8–12 May. Available at: www2007.org/workshops/paper_50.pdf

- Ballon, P. (2009). Control and value in mobile communications: a political economy of the reconfiguration of business models in the European mobile industry. Vrije Universiteit Brussel. PhD Thesis. Available at: http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID1331439_code1034017.pdf?abstractid=1331439&mirid=3

- Ballon, P. (2007). "Business modelling revisited: the configuration of control and value", Info, vol. 9, no. 5, pp. 6-19.

- Ballon, P. and Walravens, N. (2008). Competing platform models for mobile service delivery: the importance of gatekeeper roles. Paper presented at the International Conference on Mobile Business 2008. Barcelona, 7-8 July.

- Barnes, J.S. and Huff, L.S. (2003). "Rising sun: iMode and the wireless internet", Communications of the ACM, vol. 46, no. 11, pp. 78-84.

- Bauer, H.H.; Reichardt, T.; Barnes, S.J. and Neumann, M.M. (2005). "Driving consumer acceptance of mobile marketing: a theoretical framework and empirical study", Journal of Electronic Commerce Research, vol. 6, no. 3, pp. 181-192.

- Bohlin, E.; Olsson, T. and Westlund, O. (2007). Mobile barometer 2007 – An analysis of the Swedish mobile society. Mobile Society Research Institute Report, NttDoCoMo, Tokyo (Japan). Accessible at http://www.moba-ken.jp/wp-content/pdf/research07-01.pdf

- Bohlin, E. and Westlund, O. (2008). Mobile internet adoption and use: Results from a national survey in Sweden. Paper presented at the 17th Biennial ITS Conference. Montreal, 24-27 June.

- Bolin, G. (2008). "Mobilgenerationer i skilda världar" ("Mobile generations in separate worlds"), in Holmberg, S. and Weibull, L. (Eds), Skilda världar (Separate worlds), pp. 335-444. SOM-Institutet – Göteborgs Universitet. Gothenburg.

- Bolin, G. and Westlund, O. (2009). "Mobile generations: The role of mobile technology in the shaping of Swedish media generations", International Journal of Communication, vol. 3, pp. 108-124.

- Boutemedjet, D. and Ziou S. (2008). "A graphical model for context-aware visual content recommendation", IEEE Transactions on Multimedia, vol. 10, no. 1, pp. 52-62.

- Bouwman, H. (2003). State of the art on business models. Telematica Instituut Freeband B4U D3.2 Report. Enschede. Available at http://www.scribd.com/doc/14666/Bouwman-H-2003-State-of-the-art-business-models

- Campbell, W.S. (2007). "A cross-cultural comparison of perceptions and uses of mobile telephony", New Media Society, vol. 9, no. 2, pp. 343-363.

- Carey, M.J.; Tattersall, G.D.; Lloyd-Thomas, H. and Russell, M.J. (2003). "Inferring identity from user behaviour", IEE Proceedings - Vision, Image and Signal Processing, vol. 150, no. 6, pp. 383-387.

- Chard, I. (2008). Mobile web 2.0. Leveraging location, IM, social web and search. 2008-2013. Juniper Research. Tadley.

- Cheong, J. H. and Park, M. C. (2005). "Mobile internet acceptance in Korea", Internet Research, vol. 15, no. 2, pp. 125-140.

- Church, K.; Keane, M.T. and Smyth, B. (2005). "Towards more intelligent mobile search", in Proceedings of the 19th international joint conference on artificial intelligence (IJCAI '05), pp. 1675-1676. Edinburgh, 30 July – 5 August. Available at http://www.ijcai.org/papers/post-0135.pdf

- Church, K.; Smyth, B. and Mark, T.K. (2006). "Evaluating interfaces for intelligent mobile search", in Proceedings of the 2006 international cross-disciplinary workshop on web accessibility (W4A): Building the mobile web: rediscovering accessibility?, pp. 69-78. Edinburgh, 23-26 May.

- Church, K.; Smyth, B.; Cotter, P. and Bradley, K. (2007). "Mobile information access: a study of emerging search behaviour on the mobile Internet", ACM Transactions on the Web, vol. 1, no. 1, article no. 4.

- Church, K. and Smyth, B. (2007a). "Understanding mobile information needs", in Proceedings of the 10th international conference on human computer interaction with mobile devices and services, pp. 493-494. Amsterdam, 2-5 September.

- Church, K. and Smyth, B. (2007b). "Mobile content enrichment", in Proceedings of the 12th international conference on intelligent user interfaces (IUI'07), pp. 112-121. Honolulu, 28-31 January.

- Church, K. and Smyth, B. (2007c). "Improving mobile search using content enrichment", Artificial Intelligence Review, vol. 28, no. 1, pp. 87-102.

- Church, K. and Smyth, B. (2008). "Who, what, where and when: a new approach to mobile search", in Proceedings of the 13th international conference on intelligent user interfaces (IUI'08), pp. 309-312. Maspalomas, 13-16 January.

- Church, K.; Smyth, B.; Bradley, K. and Cotter, P. (2008). "A large scale study of European mobile search behaviour", in Proceedings of the 10th international conference on human computer interaction with mobile devices and services, pp. 13-22. Amsterdam, 2-5 September.

- Compañó, R. (2008). "Techno-economic challenges of audiovisual search engines" in Nikoltchev, S. (ed.), Searching for Audiovisual Content, Chapter 2. Print Publications of the European Audiovisual Observatory. Strasbourg.

- ComScore M:Metrics (2008a). Mobile search grew 68 percent in the U.S. and 38 percent in Western Europe during past year. Press Release, 15 September. Available at http://www.comscore.com/Press_Events/Press_Releases/2008/09/US_and_Western_Europe_Mobile_Search_Increases

- ComScore M:Metrics (2008b). Mobile social networking driving growth of the mobile internet in Europe. Press Release, 29 January. Available at: http://www.comscore.com/Press_Events/Press_Releases/2009/1/Mobile_Social_Networking_Europe

- Cui, Y. and Roto, V. (2008). "How people use the web on mobile devices" in Proceeding of the 17th international conference on World Wide Web, pp. 905-914. Beijing, 21-25 April.

- Davies, M. (2008). "Designing a new mobile search service – A user-centred approach", in Proceedings of the 10th international conference on human computer interaction with mobile devices and services, pp. 445-447. Amsterdam, 2-5 September.

- De Moor, K.; Berte, K.; De Marez, L.; Joseph, W.; Deryckere, T. and Martens, L. (2008). User involvement in living lab research, experiences from an interdisciplinary study on future mobile applications. Paper presented at the Third international Seville seminar on future-oriented technology analysis: Impacts and implications for policy and decision-making. Seville, 16-17 October.

- De Vos, H.; Haaker, T. and Teerling, M. (2008). Consumer value of context aware and location based mobile services. Paper presented at the 21st Bled eConference eCollaboration: Overcoming boundaries through multi-channel interaction. Bled, 15-18 June.

- Enter – IDATE (2009). Mobile 2009. Markets & trends – Facts & figures. Enter – IDATE. Available at http://www.enter.ie.edu/enter/mybox/cms/9812.pdf

- European Commission (2009). Progress report on the single European electronic communications market 2008 (14th report). Communication from the Commission COM(2009) 140 final. Brussels, 24.3.2009.

- European Commission – EPoSS (2008). Internet of Things in 2020: a roadmap for the future. INFSO D.4 Networked Enterprise in cooperation with the RFID Working Group of the European Technology Platform on Smart Systems Integration. Available at http://www.iot-visitthefuture.eu/fileadmin/documents/researchforeurope/270808_IoT_in_2020_Workshop_Report_V1-1.pdf

- Evans, J. (2008). Google confirms huge search traffic from iPhones. Press Release, 14 February. Available at: http://www.macworld.co.uk/ipod-itunes/news/index.cfm?rss&newsid=20446

- Feijóo, C.; Maghiros, I.; Bacigalupo, M.; Abadie, F.; Compañó, R. and Pascu, C. (2009a). Content and applications in the mobile platform: on the verge of an explosion. Institute for Prospective Technological Studies. Forthcoming.

- Feijóo, C.; Maghiros, I.; Abadie, F. and Gómez-Barroso, JL. (2009b). "Exploring a heterogeneous and fragmented digital ecosystem: mobile content". Telematics & Informatics, vol. 26, no. 3, pp. 282-292.

- Feijóo, C.; Maghiros, I. and Gómez-Barroso, J.L. (2008). A survey of mobile content ecosystem. Paper presented at the 19th European regional ITS conference. Rome, 18-20 September.

- Forge, S.; Blackman, C. and Bohlin, E. (2005). The demand for future mobile communications markets and services in Europe. Institute for Prospective Technological Studies, JRC Scientific and Technical report, EUR 21673 EN. Available at: http://fms.jrc.ec.europa.eu/documents/FMS%20FINAL%20REPORT.pdf

- Fransman, M. (2007). The new ICT ecosystem. Implications for Europe. Kokoro. Edinburgh.

- Gartner (2008). Mobile devices forecast worldwide, 2003-2012. Gartner Dataquest Market Statistics.

- Giesecke, S.; Klerx, J.; Pascu, C.; Abadie, F. and Maghiros, I. (2008). Privacy in the Knowledge Society – the case of search engines. Report without reference. Institute for Prospective Technological Studies. Available at: http://www.ist-chorus.org/documents/SEandPrivacyforChorusNewslettersETU5a.pdf

- Gorder, P.F. (2007). "Building better search engines", Computing in Science and Engineering, vol. 9, no. 4, pp. 7-11.

- Gustafsson, F. and Gunnarsson, F. (2005). "Mobile positioning using wireless networks: possibilities and fundamental limitations based on available wireless network measurements", IEEE Signal Processing Magazine, vol. 22, no. 4, pp. 41-53.

- Haddon, L. (Ed.) (2005). International collaborative research. Cross-cultural differences and cultures of research. COST Action 269. COST. Brussels.

- Haddon, L. and Vincent, J. (2008). "Children's broadening use of mobile phones", in Goggin, G. and Hjorth, L. (eds), Mobile technologies: from telecommunications to media, pp. 37-49. Routledge. Abingdon.

- Heres, J.; Mante, E. and Pires, D. (2002). Factors influencing the adoption of broadband mobile internet. Report from the Capabilities Working Group of COST Action 269. Available at http://www.cost269.org/working%20group/DocCapabilities/Ch_8.doc

- ITU (2009). World telecommunication/ICT indicators database 2008 (12th Edition). International Telecommunication Union. Geneva.

- ITU (2005). Ubiquitous network societies and their impact on the telecommunication industry. International Telecommunication Union. Geneva. Available at http://www.itu.int/ubiquitous

- Jaokar, A. and Fish, T. (2006). Mobile web 2.0. Futuretext. London.

- Jupiter Research (2008). Mobile search. Unlocking the potential for advertisers. Forrester Research.

- Jupiter Research (2007). European mobile youth consumer survey 2007: targeting digital natives and keeping them loyal. Forrester Research.

- Kamvar, M. and Baluja, S. (2007). "Deciphering trends in mobile search", Computer, vol. 40, no. 8, pp. 58-62.

- Kamvar, M. and Baluja, S. (2006). "A large scale study of wireless search behavior: Google mobile search", in Proceedings of the SIGCHI conference on human factors in computing systems, pp. 701-709. Montreal, 22-27 April. Available at : http://www.esprockets.com/papers/kamvar-baluja.chi06.pdf

- Katz, J.E. and Aakhus M.A. (eds) (2002). Perpetual contact: Mobile communication, private talk, public performance. Cambridge University Press. Cambridge.

- Karlson, A.K.; Robertson, G.; Robbins, D.C.; Czerwinski, M. and Smith, G. (2006). "FaThumb: A facet-based interface for mobile search", in Proceedings of the SIGCHI conference on human factors in computing systems, pp. 711-720. Montreal, 22-27 April.

- Karlsson, J. (2008). Mobila webbsidor med inriktning mot IT-nyheter – Möjligheter, begränsningar och efterfrågan utifrån ett användarperspektiv (Mobile webpages focusing IT-news – Opportunities, limitations and demand from a user perspective). Master Thesis at the Royal Institute of Technology – Department for Computer Science and Communication (Stockholm).

- Kennedy, C.J. (2009). Wireless search engines: bigger isn't better. Wireless developer network web page. Available at : http://www.wirelessdevnet.com/channels/wireless/features/wireless_search.phtml

- Kolmonen, L. (2008). Mobile search engine survey. Paper Presented at the Research Seminar on Telecommunications Business, Helsinki University of Technology, 14 April. Available at http://www.tml.tkk.fi/Opinnot/T-109.7510/2008/Eng1.pdf

- Kompatsiaris, Y. (unknown date). Semantic multimedia analysis and retrieval. Available at http://www.ist-chorus.org/telechargement/1195808363.pdf

- Lancieri, L. and Durand, N. (2006). "Internet user behavior: compared study of the access traces and application to the discovery of communities", IEEE Transactions on Systems, Man, and Cybernetics – Part A: Systems and Humans, vol. 36, no. 1, pp. 208-219.

- Lane, N. (2008). Mobile advertising: cutting through the hype. Informa Telecoms & Media.

- Ling, R. (2004). The mobile connection: The cell phone's impact on society. Morgan Kaufman Publishers. San Francisco.

- Ling, R. and Sundsøy, P.R. (2009). The iPhone and mobile access to the internet. Paper presented at the ICA pre-conference on mobile communication. Chicago, 20 May. Available at: http://lirneasia.net/wp-content/uploads/2009/05/final-paper_ling_et_al.pdf

- Livingstone, S. (2003). "On the challenges of cross-national comparative media research", European Journal of Communication, vol. 18, no. 4, pp. 477-500.

- Lie, L. and Seide, F. (2008). "Mobile ringtone search through query by humming in IEEE International Conference on acoustics, speech and signal processing (ICASSP 2008), pp. 2157-2160. Las Vegas, 31 March - 4 April.

- Melville, P.; Mooney, R.J. and Nagarajan, R. (2002). "Content-boosted collaborative filtering for improved recommendations", in Proceedings of the 18th National Conference on Artificial Intelligence, pp. 187–192. Edmonton, 28 July – 1 August. Available at http://www.cs.utexas.edu/~ml/papers/cbcf-aaai-02.pdf

- Microsoft (2009). Verizon wireless selects Microsoft for mobile search and advertising. Press Release. Available at http://www.microsoft.com/presspass/press/2009/jan09/01-07VerizonSearchPR.mspx

- Morris, R.M. (2008). "A survey of collaborative web search practices", in Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems, pp. 1657-1660. Florence, 5-10 April.

- Murata, T. and Saito, K. (2006b). "Extracting users' interests from web log data", in Proceedings of the 2006 IEEE/WIC/ACM International Conference on Web Intelligence, pp. 343-346. Hong Kong, 18-22 December.

- Murata, T. and Saito, K. (2006a). "Extracting keywords of web users' interests and visualizing their routine visits", in 9th International Conference on Control, Automation, Robotics and Vision, 2006. ICARCV'06 pp. 1-6. Singapore, 5-8 December.

- Murata, T. (2004). "Discovery of user communities from web audience measurement data", in Proceedings of the IEEE/WIC/ACM International Conference on Web Intelligence, pp. 673-676. Beijing, 20-24 September.

- Myvoice (2009). 2007 internet survey. Available at http://www.myvoice.co.jp/index.html

- Newman, M. (2008). Future mobile operator business models: broadband, partnerships and mobile 2.0 – Worldwide market analysis, strategic outlook & forecasts to 2012. Informa Telecoms & Media.

- Ngai, E.W.T. and Gunasekaran, A. (2007). "A review for mobile commerce research and applications", Decision Support Systems, vol. 43, no. 1, pp. 3-15.

- Nysveen, H.; Pedersen E.P. and Thorbjornsen, H. (2005). "Intentions to use mobile services: antecedents and cross-service comparisons", Journal of the Academy of Martketing Science, vol. 33, no. 3, pp 330-346.

- NTT DoCoMo (2007). Comparison of general outlook for mobile societies in China and Japan (Global questionnaire). Mobile Society Research Institute. Tokyo.

- OECD (2007). OECD communications outlook 2007. OECD. Paris. Available at http://213.253.134.43/oecd/pdfs/browseit/9307021E.PDF

- Ofcom (2008). The international communications market 2008. Ofcom. London. Available at http://www.ofcom.org.uk/research/cm/icmr08/icmr08.pdf

- Oksman, V. and Rautiainen, P. (2003). " 'Perhaps it is a body part': how the mobile phone became an organic part of the everyday lives of Finnish children and teenagers", in Katz, J.E. (ed.), Machines that become us: the social context of communication technology, pp. 293-308. Transaction Publishers. New Brunswick.

- Pascu, C. (2008a). An empirical analysis of the creation, use and adoption of social computing applications. Institute for Prospective Technological Studies, JRC Scientific and Technical report, EUR 23415 EN. Available at: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1684

- Pascu, C. (2008b). Towards convergence of social computing with mobile – A "thought" piece on mobile trends and futures, Paper presented at the 19th European Regional ITS Conference. Rome, 18-20 September.

- Paulson, D.L. (2005). "Search technology goes mobile", Computer, vol. 38, no. 8, pp 19-22

- Pedersen, P.E. and Thorbjørnsen, H. (2003). Adoption of mobile services. Model development and cross-service study. Norwegian School of Economics and Business Administration. Available at http://ikt.hia.no/perep/cross_service_jams.pdf

- Pedersen, P.E. (2005). "Adoption of mobile internet services: an exploratory study of mobile commerce early adopters", Journal of Organizational Computing and ElectronicCommerce, vol. 15, no. 3, pp. 203-222.

- Ramos, S.; Feijóo, C. and Gómez-Barroso, J.L. (2009). "Next generation mobile network deployment strategies", Journal of the Institute of Telecommunications Professionals, vol. 3, no.1, pp. 13-19.

- Ramos, S.; Feijóo, C.; González, A.; Rojo, D. and Gómez-Barroso, J. (2004). "Barriers to widespread use of mobile Internet in Europe. An overview of the new regulatory framework market competition analysis", The Journal of the Communications Networks, vol. 3, no. 3, pp. 76-83.

- Ramos, S.; Feijóo, C.; Castejón, L.; Pérez, J. and Segura, I. (2002). "Mobile Internet evolution models. Implications on European mobile operators", The Journal of the Institution of British Telecommunications Engineers, vol. 1, no. 2, pp. 171-176.

- Ramos, S.; Feijóo, C.; Pérez, J. and Castejón, L. (2001). Implications of the i-mode business model on the framework for European 3G mobile communications. Paper presented at the 12th European Regional ITS Conference. Dublin, 2-3 September.

- Rappa, M. (2007). Business models on the web. Managing the digital enterprise course. Available at http://digitalenterprise.org/models/models.html

- Reding, V. (2008). Digital Europe: the Internet mega-trends that will shape tomorrow's Europe. Speech at the European Internet Foundation Special Event "A view of the Digital World in 2025". Brussels, 13 November. Available at http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/08/616&format=PDF&aged=0&language=EN&guiLanguage=en

- Rotenberg, B. (2007). "Towards personalised search: EU data protection law and its implications for media pluralism", in Machill, M. and Beiler, M. (eds.), Die Macht der Suchmaschinen / The Power of Search Engines, pp. 87-104. Herbert von Halem. Cologne.

- Rotenberg, B. and Compañó, R. (2007). Search engines for audio-visual content: Copyright Law and its policy relevance. Paper presented at the 18th European Regional ITS Conference. Istanbul, 2-5 September.

- RTL Group (2008). Television 2008 – International key facts. RTL. Luxembourg.

- Schoemaker, P. (1995). "Scenario planning: a tool for strategic thinking", Sloan Management Review, no. winter, pp. 25-40.

- Schwarz-da-Silva, J. (2008). Mobile research at the crossroads. Paper presented at the ICT Mobile Summit 2008. Stockholm, 10-12 June.

- Sell, A. and Walden, P. (2006). "Mobile digital calendars: an interview study", in Proceedings of the 39th Annual Hawaii International Conference on System Sciences, HICSS'06, pp. 23b. Kauai, 4-7 January.

- Schusteritsch, R.; Shailendra, R. and Kerry, R. (2005). "Mobile search with text messages: designing the user experience for Google SMS", in Conference on Human Factors in Computing Systems CHI'05, pp. 1777-1780. Portland, 2-7 April.

- Sidduri, R.S. (2008). An architecture for mobile local information search: focusing on wireless LAN and cellular integration. Master Thesis in Computer Science. Department of Software Engineering and Computer Science, School of Engineering, Blekinge Institute of Technology, Ronneby (Sweden).

- Uglow, S. (2007). The race for mobile content revenues. Juniper Research. Tadley.

- Verkasalo, H. (2008). From intentions to active usage: a study on mobile services in Finland. Paper presented at the 19th European regional ITS conference. Rome, 18-20 September.

- Westlund, O. (2008b). "From mobile phone to mobile device: news consumption on the go", Canadian Journal of Communication, vol. 33, no. 3, pp. 443-463.

- Westlund, O. (2008a). "Diffusion of Internet for mobile devices in Sweden", Nordic and Baltic Journal of Information and Communications Technologies (nb!ict), vol. 2, no. 1, pp. 39-47.

- Westlund, O. (2007b). "The adoption of mobile media by young adults in Sweden", in Goggin, G. and Hjorth, L. (eds.), Proceedings of Mobile Media 2007, chapter 12, Sydney, 2-4 July.

- Westlund, O. (2007a). Mobiltelefonanvändning – en forskningsöversikt (How people use mobile devices – a research overview). JMG Report series number 47. University of Gothenburg.

- Williams, F. (2008). eMobility – 2020 vision. aper presented at the ICT Mobile Summit 2008. Stockholm, 10-12 June.

- Xie, X.; Lu, L.; Jia, M.; Li, H.; Seide, F. and Ma, W.Y. (2008). "Mobile search with multimodal queries", Proceedings of the IEEE, vol. 96, no. 4, pp. 589-601.

- Yu, K.; Schwaighofer, A.; Tresp, V.; Xu, X. and Kriegel, H.P. (2004). "Probabilistic memory-based collaborative filtering", IEEE Transactions on Knowledge and Data Engineering, vol. 16, no. 1, pp. 56-69.

- Yu, Z. and Wong, H.S. (2007). "A rule based technique for extraction of visual regions based on real-time clustering", IEEE Transactions on Multimedia, vol. 9, no. 4, pp. 766-784.

- Zoller, E. (2007). *Mobile search comes of age: opportunities and challenges*. Ovum/MEF Mobile Search Initiative white paper. Available at http://www.m-e-f.org/fileadmin/user/Suhail/Search_and_Discovery/MEF_Ovum_mobile_search_white_paper.pdf

Annex I: Scenarios and questionnaire

Seven prospective scenarios were developed as discussion basis for workshop. They are presented together with the questionnaire.

Prospective scenarios

1 – Serendipity search

Baiba recently joined Baltic Wings as air hostess, enjoying her new life travelling around the world as she always dreamt of. Now she earns some money, but has little time to spend during their stop-overs. She likes fashion and vegetarian food, is always at the hunt of special deals and interested in foreign culture. As a curiosity-driven person she is always open to explore new experiences. Luckily, her new mobile handset can be switched on a "discovery" mode that includes a "surprise factor" when searching amongst her preferences. She configured her preferences quickly on the web page of the supplier. This operation needs to be introduced only once; then her profile is automatically updated based on her choices, including the reactions to the unexpected responses proposed.

Whenever Baiba feels like wandering around a city, she sets the discovery mode on her handset and starts receiving appealing information regarding her preferences, including also some nice surprises. She does not feel disturbed by publicity, and the information gets increasingly better suited to her tastes. Last time in London she learned about Latvians in exile and was told about a nearby Armani jeans bargain just her size, all in the same afternoon. But she was truly amazed when the "discovery mode" suggested her to go to a gig to her favourite Latvian rock band that very same evening. She never filled any information about music, nor did she know that they were playing in London.

2 – Searching for a recipe

"Guess who was on the phone?" said Inese to her husband. "Your father just announced himself for dinner. He will be here in less than one hour". Under normal circumstances, stress would now begin. Inese's ticky-picky father-in-law is not an easy visitor and he always had to suffer his hidden criticism for being a bad cook. But things have change thanks to state-of-the-art technology. Inese picks her mobile device which has a RFID reader embedded. With this device, she scans the barcodes of the food in the fridge and in the cupboard. The systems detects jam, steak, tomatoes and cucumber from Murcia, French red onion, olives, salt, black pepper, oregano, basil, olive oil, …

Now Inese presses the "recipe search" button. Some seconds later, the system proposes an Andalusian-style *gazpacho* (cold vegetables soup) as a side dish to a plain steak. Furthermore, it proposes to buy some cheddar and feta cheese in the night shop 500m down the street to prepare an exquisite Cordon-Bleu with a Greek salad. Inese sends her husband to the shop, while she prepares the dishes, and all three have a pleasant evening.

3 – Wellness mode

As an intensive runner wishing to break her already impressive personal records, Gitta needs to control training sessions, food, hours sleeping, etc. She might follow one of the standard programs but her work as consultant for one of the "Big 3" leaves no room for ordinary routine; she needs something completely adapted to her personal lifestyle and she found it! Gitta is crazy about her new Runfit-kit. This is an add-on device embedded into a running bra and a daywear bra that monitors essential body signals (blood pressure, pulse, breath, temperature, etc) and a

software application to run on her smart mobile she can wear with an arm belt (to record distance and speed). The kit guides her on how to keep an appropriate rhythm depending on the type of training similar to a standard cardio-kit. As a bonus, after training it advises her also on nutrition (amount of food and drink to take) or habits. For instance, it keeps track of how long you stand on your feet –one of the worst positions for a running addict– or it calculates additional exercises to be carried out, such as recommending walking from or to work while optimizing the travel time. It is really great. It has also an optional security system warning in case of an excess of exercise or any health problem; which in case a dangerous pattern or accident calls automatically the emergency service indicating the patient location and transmits vital data to the hospital. "I do not really need that", she thinks.

4 – Truman show mode

Many youngsters are in search for fame. So was Lavinia, when she applied to become one of the protagonists for the brand-new "Big Brother XL" series. Contrary to previous editions in closed environments and cameras everywhere to be watched in TV, this time people would be observed in an open space and "voyeurs" could monitor them on the internet. She gladly gave out her privacy rights and allowed being traced 24 hours a day and 7 days per week, in exchange of a prospective carrier in the show business. Lavinia's got an ultra-broadband mobile communications system; a hell of a device: this mobile included camera that could be remotely switched on by the TV producer, conversations were recorded, her mood could be identified observing her bio parameters (heartbeat rate, blood pressure). Processing these data, the TV producer knew about her love affairs, when she was saying the truth or lying, if she was happy or angry…

At the beginning, success was beyond expectations. Lavinia became a rising star on the internet: she was subject of discussion in social network sites, people approached her on the street (given that they knew where she was) and she got some smaller contracts for making advertisements. Slowly, however, things started to change and turned into a personal nightmare…

5 – Tourist mode

Karmele is a PhD student at the University College London, where she is involved in an EU-funded project on the Future of the Internet. Thanks to the project she has the opportunity to travel across Europe, though she regrets she never has the time to prepare her travels as much as she would like. Usually during her journey to a new destination Karmele spends some time browsing pictures of the city she is heading to that people have uploaded on FlickrMobile. She adds to her favourites the pictures she likes and then asks her journey planner application to define itineraries for her. The planner, considering the location of the places she has highlighted by selecting pictures, their opening hours, her agenda and knowing that she prefers walking than using public transport presents her with an set of tours through the city. Karmele has just arrived in Seville where she'll have the afternoon free. She drops her suitcase at the Hotel, wears her Augmented Reality sunglasses and presses the "Let's go" button on her mobile. She is proposed with two options. A walk along the river, a photo exhibition entitled *Flamenco and Photography* at the Centro Andaluz de Arte Contemporáneo, and a drink at the Embarcadero - a charming *chiringuito* on the famous calle Betis - facing the Cathedral and the Torre de Oro. The second option consists of a walk in the narrow streets of Santa Cruz, a visit at the Museo del Baile Flamenco and a *tinto de verano* on the roof-terrace of the Hotel Doña María, just under the Giralda Tower. Without any doubt and just with a glimpse Karmeles selects the first option. A small pointing arrow on her lens guides her around. While walking she can choose to view the pictures she saved on Flickr. When she arrives at the Museum she receives an mp3 flamenco soundtrack to accompany her

during the exhibition. She enjoys it so much than she buys it. Later, at the Embarcadero she takes some time to annotate her diary. Karmele puts her mobile on the table and projects a map of City where her path is highlighted. She uses a smart pen to note down her memories along her walk and then saves them. The phone rings, it's Pekka, a Finnish researcher working on the same project. He has just arrived at the Hotel. Karmele invites him to reach her and sends him her location so that his mobile AR navigator can lead him to the Embarcadero.

6 – Playground mates mode

Dace is mother of a 6-year old boy, George. They have recently moved to a new city, where they have few social connections for the time being. Dace enjoys bringing her son to the park where there is a nice playground full of children of his age. It is a nice opportunity to get to know people. The playground area provides a local social networking application aimed at facilitating interactions among parents and enhancing children's safety. Parents fill in a their own and their children's profile introducing information about the area they live, the activities their children like doing, the school their children attend, birthday parties they plan to go and alike. The service provider matches user's profiles and proposes / alerts parents of possible companions.

It is Saturday afternoon and the playground is crowded. Dace activates the service. She knows that her information is used only locally at the park and no sensitive details are disclosed. Few seconds later, the device visualises two families on the playground with compatible patterns: first, the mother of two girls attending the same school as her son and, second, the father of a boy who is already playing with George. Apparently he is crazy about the zoo, just like George. Dace is planning a trip to the zoo the next day. She approaches the young man, if he seems all right she might propose that the two families go together.

7 – Professional appointments – dating agency

Elita is visiting CeBIT in Hannover for the first time. As a newcomer she is excited about the huge exhibition in front of her: operators, manufacturers, software providers, augmented reality, artificial intelligence demos, robots, etc. Sounds great if you are a curious engineer but is it also for making business for a small Riga-based advertising agency? As newly appointed Director, she is looking for options to improve data mining management at her company, and decrease time–to–market by re–using as much as possible from their inventory of past campaigns. Where to start? Elita did send an email to a selection of LinkedIn contacts but she did not receive any response. While queuing for her badge, she fulfils a thorough mobile questionnaire with her company data and her specific objectives for CeBIT. Minutes later she receives a complete list of marketing representatives from data mining specialised companies on her mobile, including details of their location at the fair (in real time!), their pictures (easier to recognise them) and even the languages they speak (there are two Latvians!). There is even a red–yellow–green light to indicate if the person is around and available for some business talk.

Questionnaire

Data on expertise

Experts need to complete a number of background questions before entering into the scenarios questionnaire. This will have two purposes: to ensure that the questionnaire is not filled twice by the same persona and to correlate some of the responses with the expert's profiles. Personal data will be immediately discarded after the processing of the responses (only grouped statistics will be provided) and will not be further used.

The experts will be kindly asked to provide:

- Name (*voluntary*)
- An email address (*voluntary*)
- Main background (*tick as many as apply*):
  - Academia
  - Industry
  - Public Administration
  - Other (specify, please)
- Number of years of expertise in Mobile ICTs
  - 5 or less
  - From 5 to 10
  - More than 10
- Main areas of expertise in connection to mobile search (*tick as many as apply*)
  - Technologies
  - Business and market development
  - User experience
  - Legal
  - Other (specify, please)

Questions common to all scenarios

1. Time Horizon

When do you expect this scenario to happen?

- already available (in 2009)
- by 2011
- by 2015
- by 2020
- Never (in this case, please explain briefly why)

2. Bottlenecks

Which are the most important bottlenecks for this scenario to happen? (Rank each the following categories using a scale from 5-extremely important to 0-irrelevant).

The major challenges of for the scenario to happen are…

- of technological nature
- of economical nature
- of behavioural, related to user experience or of ethical nature
- any other, please specify

3. Technology

The most relevant developments in technology for this scenario to happen are… (tick up to four options)

- "general" search technology: indexing, matching algorithms, page ranking, etc
- semantic web/search
- audio/image search
- interfaces to location-based services
- interfaces to mobile social networking
- augmented reality technologies (i.e., information embedded in physical objects)
- wireless sensors (smart environment, RFID, NFC, etc)
- cognitive technologies (behavioural patterns, artificial intelligence, etc)
- bio-sensors technologies
- usability/interfaces
- technologies regarding user profiling
- privacy control on the user side
- any other, please specify

4. Business model

The most likely business model for this scenario to happen might be… (tick up to three options)

- pay-as-you-go (impulse purchase)
- premium services (i.e., the basic functionality is free, but the advanced options not)
- value-added services (i.e., a contract for a pack of services on top of usual ones)
- subscription (monthly/annual fee, etc)
- packaged with the mobile handset
- packaged with the (voice, data) services of the mobile operator
- packaged with some other product or service not related with ICTs (a flight ticket, a hotel accommodation, a tourist pack, an insurance, …)
- advertising in general (i.e. like in today Internet search)
- advertising but based on some product placement (i.e., linked with another product: a TV show, a cinema premiere, …)
- merchandising (i.e., as a way to sell some other product or service) or affiliation (i.e., to create opportunities of business for some other site)
- user profiling (i.e., selling the user profiles for commercial purposes)
- user community maintained by user contributions (like Wikipedia, for example)
- business model to be defined at a very late stage when a critical mass of users is achieved (like Twitter today, for example)
- not a commercial service (i.e., a public service)
- any other, please specify

5. User experience

The biggest challenges to enable a satisfactory user experience for this scenario to happen are… (tick up to four options)

- availability of detailed user profile
- well-defined privacy (i.e., which data are private and which not)
- tools to conveniently manage eID (digital identity)
- established market for economy of identity (i.e., with which personal data is possible to commerce and which is the value of each of these data)
- security against all types of malware
- trust in application providers
- trust in third-parties that manage and use personal data
- specific cultural values and lifestyle particularities
- overall interest in technology
- perceived ease of use
- perceived usefulness / quality of the services and content offered
- existence of alternative means to access the same (or as close as possible) experience (for instance, use of a PC connected to internet)
- pricing
- any other, please specify

6. Policy support

The most successful supporting policies for this scenario to happen are… (tick up to three options)

- conventional research and development programmes (like the 7th FP) for the required emerging technologies
- promoting (open) standards and interoperability
- promoting living labs for these advanced mobile applications
- helping innovators and entrepreneurs in this area
- pushing some European "champion" (i.e. a European mobile operator or a European mobile handset supplier, for instance) into this domain
- reforming the legal framework (electronic communications, ecommerce, privacy, consumers' rights, …)
- promoting the internal market in the EU, eliminating barriers to economies of scale for this type of applications
- increasing user-awareness (i.e., so users know about the advantages, opportunities and risks of these mobile applications)
- creating tools for user-empowerment in this area (control of privacy, managing of eID, …)
- promoting self-regulation of the industry
- developing (or subsidizing the development of) content to be searchable in this scenario
- public procurement, i.e., the public administrations are the first buyers and users of this mobile application
- development of a public service for this type of mobile search
- no policy support is required in this scenario, market developments will suffice
- any other, please specify

Questions specific to individual scenarios

Maximum three additional questions per scenario

1. Serendipity

Please, rank the following views in a scale from 5-completely agree/extremely important to 0-completely disagree/irrelevant.

- serendipity search –i.e. finding relevant information by an unexpected, curiosity-driven path– will be a major determinant in the success of mobile search
- the market –through price, different players, different segments– will distinguish between search in the push mode and search in the pull mode
- users will never trust application providers to let them view their complete personal profile, unless they have extremely usable and powerful tools to control their privacy
- add any other comment you think it will be interesting about this scenario

2. Searching for a recipe

Please, rank the following views from 5-completely agree/extremely important to 0-completely disagree/ irrelevant.

- information will be never accurate enough for this scenario to become real –i.e. RFID tags should provide the right information, every ingredient should have its tag and this should be matched with missing ingredients and its availability in nearby supermarkets–
- the level of standards and interoperability needed to comply with satisfy user expectations about advanced applications like these is beyond willingness of stakeholders to cooperate
- this scenario will only happen if open standards and loose interoperability (web 2.0 style) is in place
- add any other comment you think it will be interesting about this scenario

3. Wellness mode

Please, rank the following views from 5-completely agree/extremely important to 0-completely disagree/ irrelevant.

- information about health status, even for leisure purposes only, belongs exclusively to the personal sphere and should never be exchanged over a commercial network
- personal health systems will increase dramatically the sense of self-control of consumers and, therefore, applications related with them will be, in general, a market success
- the success any application requiring the agreement of many stakeholders –with distinct (and often opposing) interests– (in this example: suppliers of running gear, emergency services, city planners, clothes manufacturers, mobile operators, mobile device suppliers, insurance companies, etc), is unlikely
- add any other comment you think it will be interesting about this scenario

4. Truman show mode

Please, rank the following views from 5-completely agree/extremely important to 0-completely disagree/ irrelevant.

- the use of informed consent should be limited by law, for particular cases. Some decisions about privacy should not be left to individuals, i.e., there should be an absolute limit to the use of personal data and it should be impossible to go beyond it
- the exploitation of personal data for commercial purposes should be limited, subject to a strict scrutiny by regulators. It shall be allowed only where there are not signs of potential conflicts including a future perspective on the individual
- the ubiquitous nature of mobile technologies will cause our social perception of privacy to change (reducing the traditional concept of "personal sphere") and few can be done about it
- add any other comment you think it will be interesting about this scenario

5. Tourist mode

Please, rank the following views from 5-completely agree/extremely important to 0-completely disagree/ irrelevant

- there are so many barriers for the deployment of augmented reality infrastructures (wireless sensors and the networks that link them to mobile devices) that only the public administrations (i.e. a city council) will be able to do it
- the risks associated with wireless sensors technologies (lack of privacy, irresponsible use of them, …) outweighs potential benefits
- user-generated content will be enough to create an augmented-reality-wikipedia able to provide users will all the relevant information in an scenario like this
- add any other comment you think it will be interesting about this scenario

6. Playground mates mode

Please, rank the following views from 5-*completely agree/extremely important* to 0-*completely disagree/irrelevant*.

- mobile search will not be just an extension internet search of practices to the mobile domain. The mobile dimension will add new added-value possibilities to internet search. As a consequence new players will appear different from those existing today
- exchanging socially sensitive information through mobile technologies will soon become common practice
- personal privacy is not at risk in controlled environments –i.e., linked to a particular location and only to some partial data about the persons–
- add any other comment you think it will be interesting about this scenario

7. Professional appointment – dating agency

Please, rank the following views from 5-completely agree/extremely important to 0-completely disagree/ irrelevant.

- the establishment trusted-third-parties will be necessary pre-requisite for the emergence of applications –and businesses– linked with the use of very personal data
- applications as the one described in this scenario will be highly profitable. They will be amongst the first to appear in the market segment of "advanced mobile search" combining elements of many other different technologies and solutions
- "adult" content and applications were amongst the first and most profitable businesses over internet. This is likely to happen on the mobile sphere
- add any other comment you think it will be interesting about this scenario

General questions about privacy

Please, rank the following views from 5-completely agree/extremely important to 0-completely disagree/irrelevant

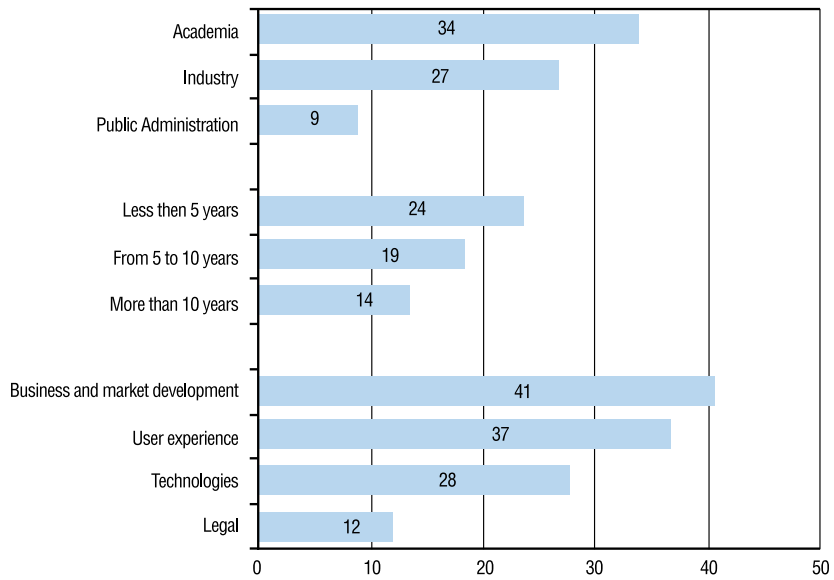
- privacy will irrevocably be eroded by the take up of mobile search services
- users are willing to exchange personal data for customized services
- profiling by search engines (e.g. cookies, log-files, IP-addresses, etc.) is fundamentally not different to tracking via other digital footprints (e.g. credit card records, cell phone calls, ATM machine use, etc)
- privacy by design (e.g. privacy-enhancing, transparency-enhancing technologies) is not viable (e.g. hacking, costs, etc)
- approaches requiring user consent for processing their data will kill innovation (e.g. as opt-in options difficult to implement, as use of data for the development of future applications unclear, etc)
- profiling of small groups (or individuals) is indispensable to generate customized services
- privacy by law will be absolutely require to avoid abuses

Distribution of the questionnaire

The questionnaire was distributed to a network of approximately 240 international experts in the mobile and search fields, including workshop participants. At the cut-off date, the number of the total respondents raised to 61.

The profiles of the respondents are summarised in Figure 34 (affiliation, years of experience in the mobile search field and specific background). They show a good balance between industry and academia and between different backgrounds (business/market development, user experience, technology, and legal). Respondents from public administration and those having a legal background were slightly less numerous compared to the others.

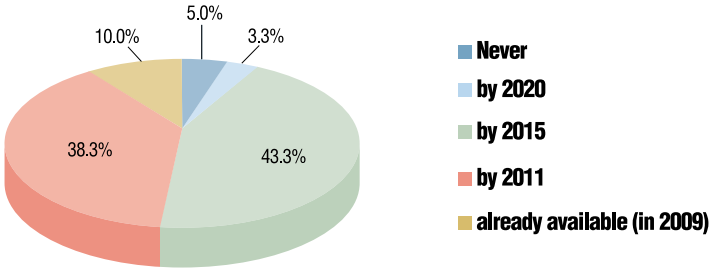
Figure 34. Profiles of the experts who participated in the survey



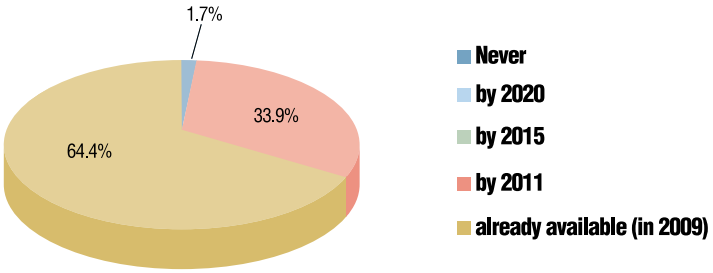
Results of the questionnaire

Scenario 1 – Serendipity search

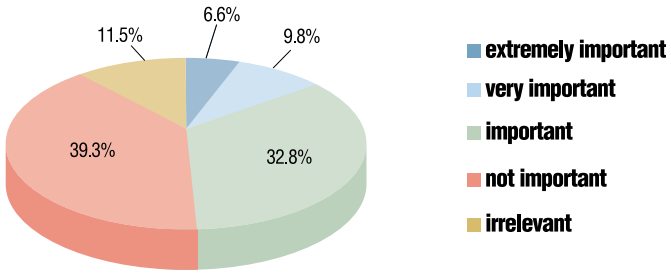
Q1a. Time Horizon (mass market)



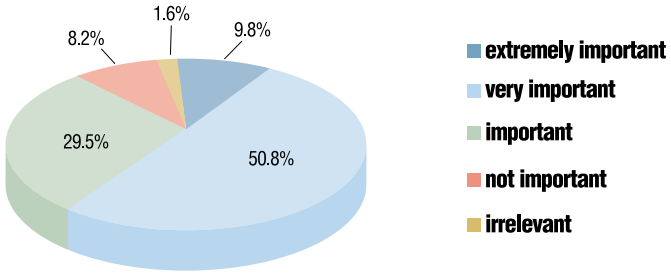
Q1b. Time Horizon (underlying technology available)



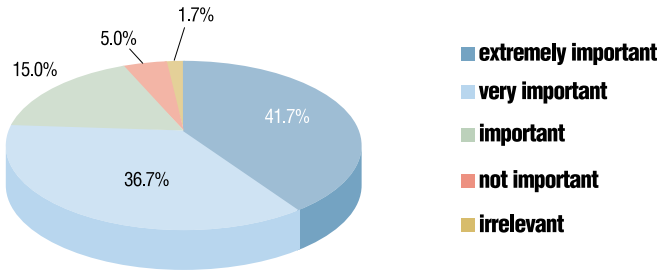
Q2a. Bottlenecks of technological nature



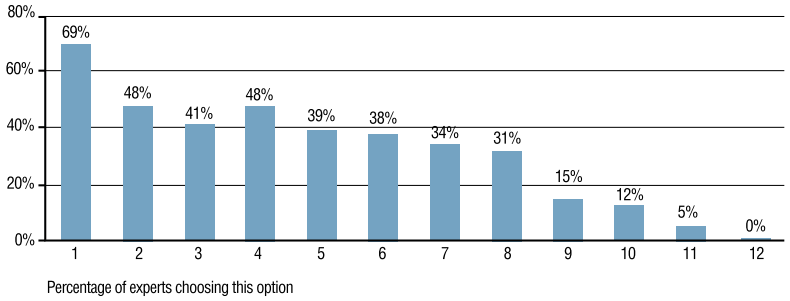
Q2b. Bottlenecks of economical nature



Q2c. Bottlenecks of behavioural nature

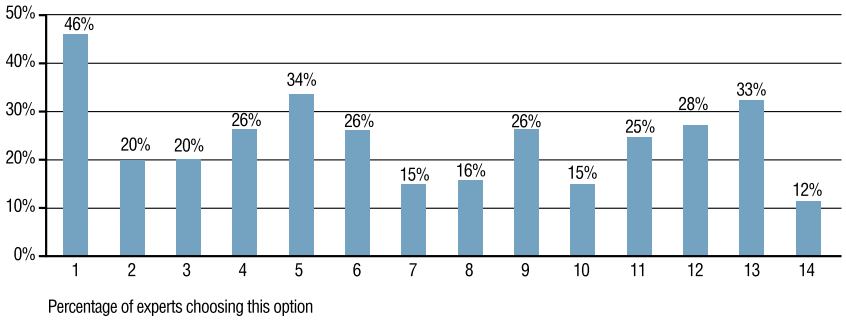


Q3. Technology



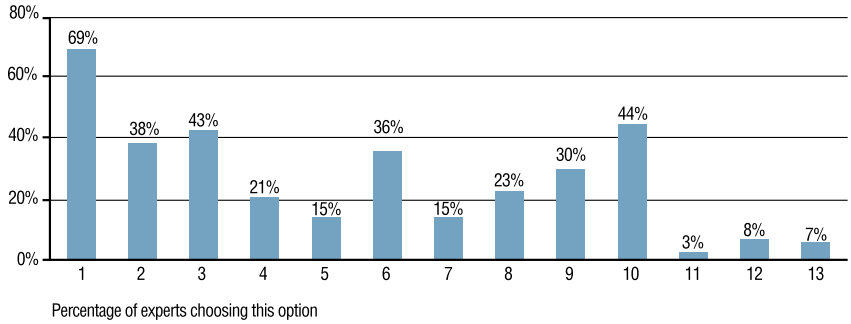
1. *Interfaces to location-based services*
2. *Technologies regarding user profiling r side*
3. *Privacy control on the use*
4. *Usability/interfaces*
5. *Cognitive technologies (behavioural patterns, artificial intelligence, etc)*
6. *General search (better indexing, matching algorithms, ranking, etc)*
7. *Semantic web/search*
8. *Interfaces to mobile social networking*
9. *Wireless sensors (smart environment, RFID, NFC, etc)*
10. *Including augmented reality features (i.e., information embedded in physical objects)*
11. *Audio/image search*
12. *Bio-sensors technologies*

Q4. Business Model



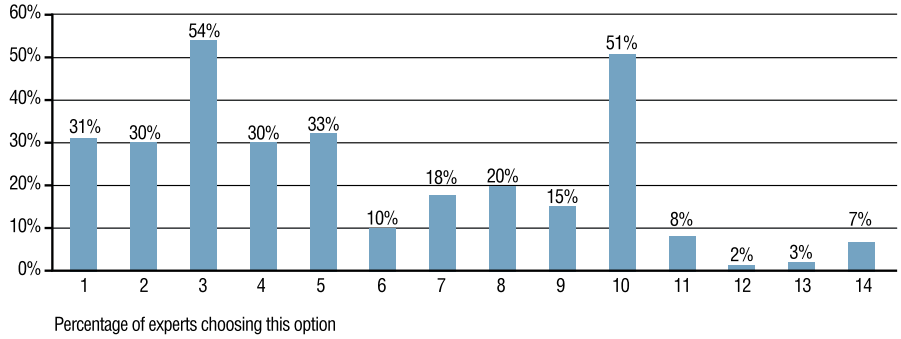
1. *Advertising in general*
2. *Pay-as-you-go (impulse purchase)*
3. *Merchandising or affiliation*
4. *Premium services*
5. *Advertising but based on some product placement*
6. *Value-added services (i.e., a contract for a pack of services on top of usual ones)*
7. *Subscription (monthly/annual fee, etc)*
8. *Packaged with some other product or service not related with ICTs*
9. *Business model to be defined at a very late stage when a critical mass of users is achieved*
10. *User community maintained by user contributions*
11. *User profiling (i.e., selling the user profiles for commercial purposes)*
12. *Packaged with the (voice, data) services of the mobile operator*
13. *Packaged with the mobile handset*
14. *Not a commercial service (i.e., a public service)*

Q5. User experience



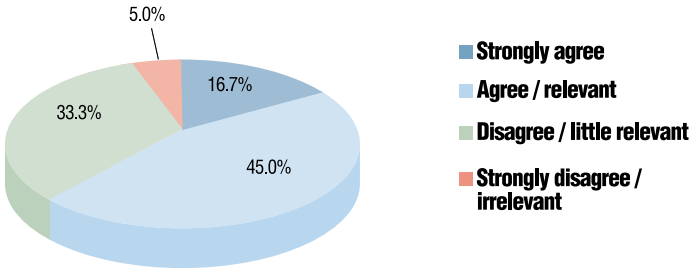
1. *Perceived usefulness / quality of the services and content offered*
2. *Trust in third-parties that manage and use personal data*
3. *Well-defined privacy*
4. *Trust in application providers*
5. *Specific cultural values and lifestyle particularities*
6. *Perceived ease of use*
7. *Security against all types of malware*
8. *Tools to conveniently manage digital identity*
9. *Availability of detailed user profile*
10. *Pricing*
11. *Overall interest in technology*
12. *Established market for economy of identity*
13. *Having a choice to same or similar experience*

Q6. Policy support

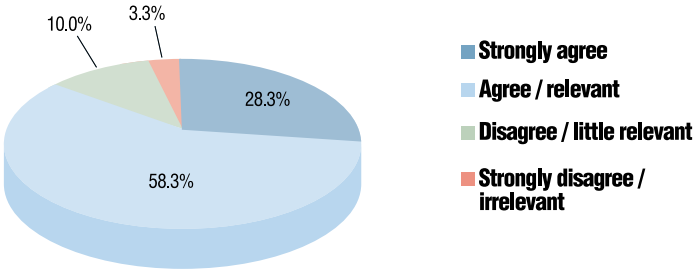


1. *Enhance user-awareness on opportunities and risks*
2. *Creating tools for user-empowerment*
3. *Supporting innovators and entrepreneurs*
4. *Promoting living labs*
5. *Reforming the regulatory framework*
6. *Development of a public service for this type of mobile search*
7. *Research projects for the required technologies*
8. *Promoting self-regulation of the industry*
9. *Promoting the internal EU market for economies of scale*
10. *Promoting standards and interoperability*
11. *Developing (or subsidising) content production*
12. *Supporting some European champion*
13. *Public procurement, (administrations are the first buyers and users)*
14. *No policy support required*

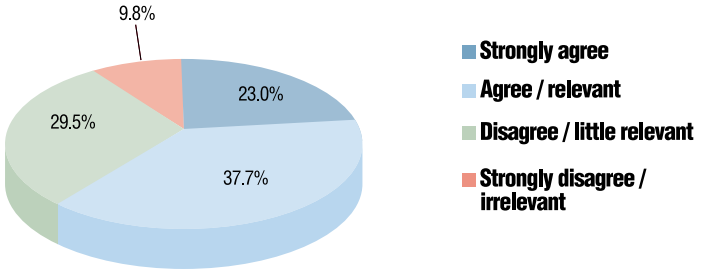
QA. Serendipity search –i.e. finding relevant information by an unexpected, curiosity-driven path– will be a major determinant in the success of mobile search



QB. The market –through price, different players, different segments– will distinguish between search in the push mode and search in the pull mode

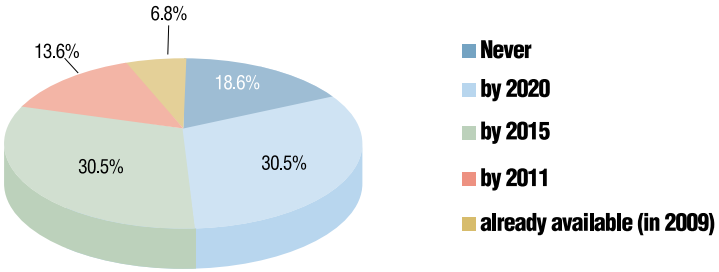


QC. Users will never trust application providers to let them view their complete personal profile, unless they have extremely usable and powerful tools to control their privacy

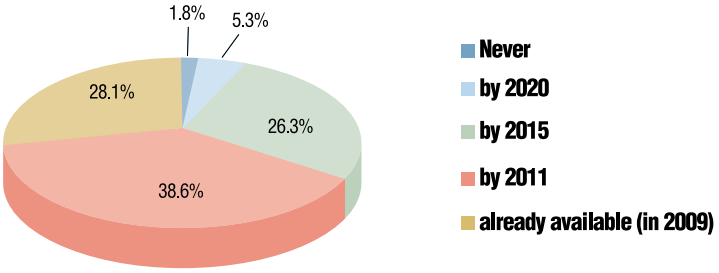


Scenario 2 – Searching for a recipe

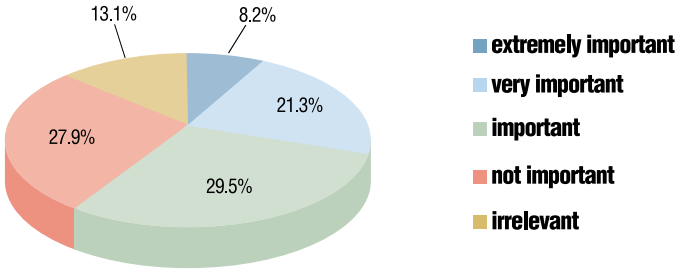
Q1a. Time Horizon (mass market)



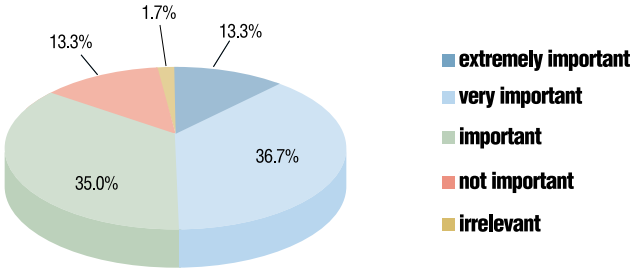
Q1b. Time Horizon (underlying technology available)



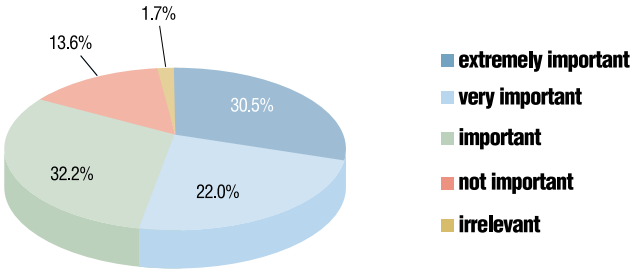
Q2a. Bottlenecks of technological nature



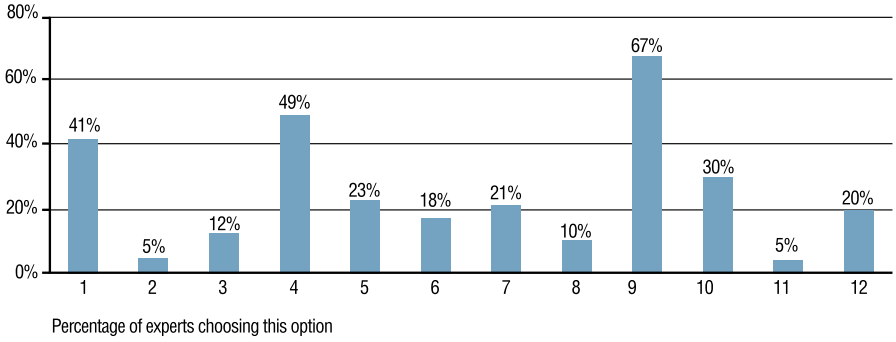
Q2b. Bottlenecks of economical nature



Q2c. Bottlenecks of behavioural nature



Q3. Technology



1. *Interfaces to location-based services*
2. *Technologies regarding user profiling*
3. *Privacy control on the user side*
4. *Usability/interfaces*
5. *Cognitive technologies (behavioural patterns, artificial intelligence, etc)*
6. *General search (better indexing, matching algorithms, ranking, etc)*
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9. *Wireless sensors (smart environment, RFID, NFC, etc.)*
10. *Including augmented reality features (i.e., information embedded in physical objects)*
11. *Audio/image search*
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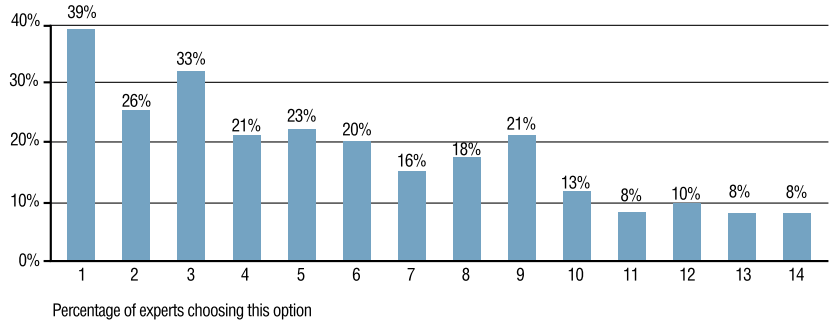
Q4. Business Model



1. *Advertising in general*
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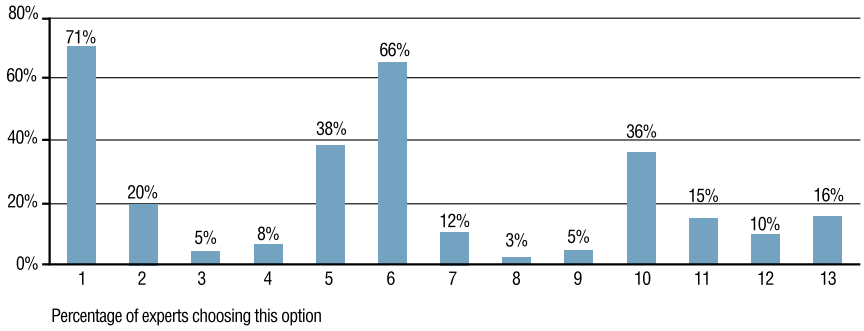
10. *User community maintained by user contributions*
11. *User profiling (i.e., selling the user profiles for commercial purposes)*
12. *Packaged with the (voice, data) services of the mobile operator*
13. *Packaged with the mobile handset*
14. *Not a commercial service (i.e., a public service)*

Q5. User experience



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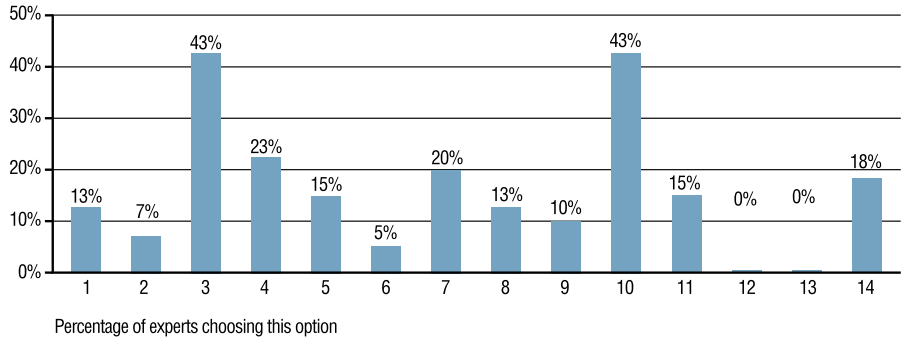
9. *Availability of detailed user profile*
10. *Pricing*
11. *Overall interest in technology*
12. *Established market for economy of identity*
13. *Having a choice to same or similar experience*

Q6. Policy support



1. *Enhance user-awareness on opportunities and risks*
2. *Creating tools for user-empowerment*
3. *Supporting innovators and entrepreneurs*
4. *Promoting living labs*
5. *Reforming the regulatory framework*
6. *Development of a public service for this type of mobile search*
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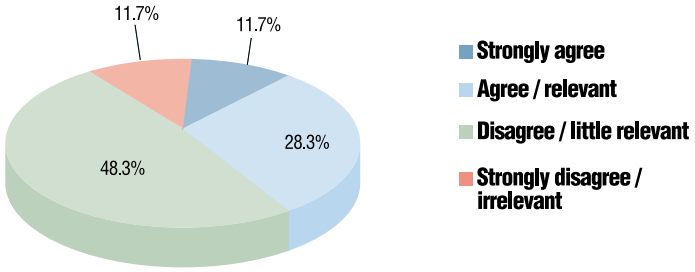
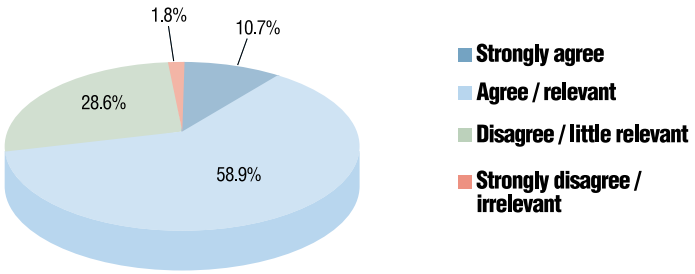
9. *Promoting the internal EU market for economies of scale*
10. *Promoting standards and interoperability*
11. *Developing (or subsidising) content production*
12. *Supporting some European champion*
13. *Public procurement, (administrations are the first buyers and users)*
14. *No policy support required*

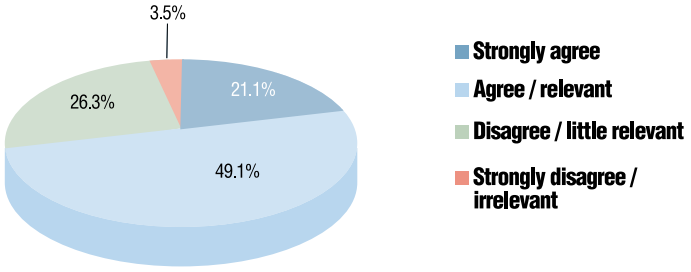
QA. Information will be never accurate enough for this scenario to become real –i.e. RFID tags should provide the right information, every ingredient should have its tag and this should be matched with missing ingredients and its availability in nearby supermarkets–



QB. The level of standards and interoperability needed to comply with satisfy user expectations about advanced applications like these is beyond willingness of stakeholders to cooperate

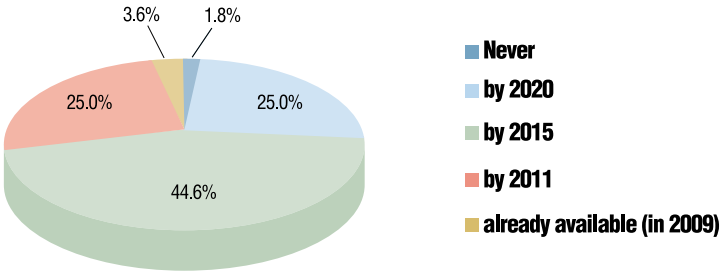


QC. This scenario will only happen if open standards and loose interoperability (web 2.0 style) is in place

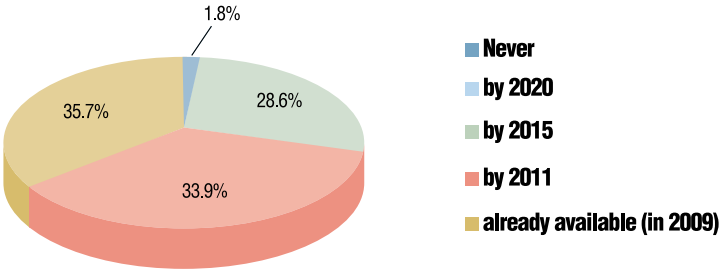


Scenario 3 – Wellness mode

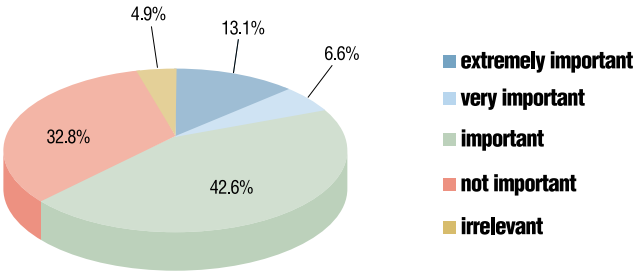
Q1a. Time Horizon (mass market)



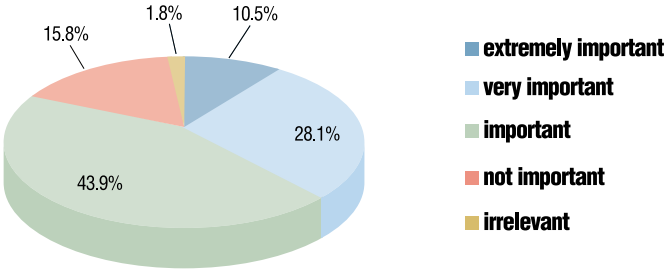
Q1b. Time Horizon (underlying technology available)



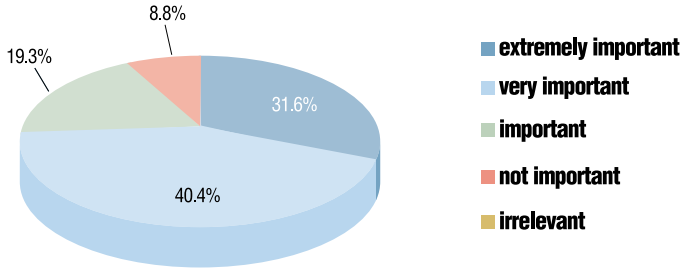
Q2a. Bottlenecks of technological nature



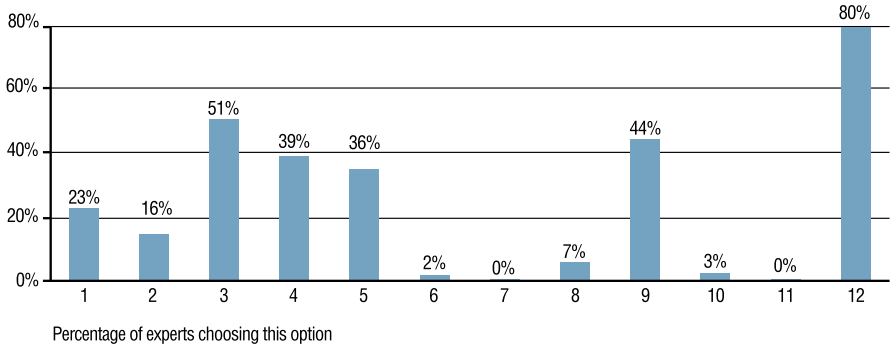
Q2b. Bottlenecks of economical nature



Q2c. Bottlenecks of behavioural nature

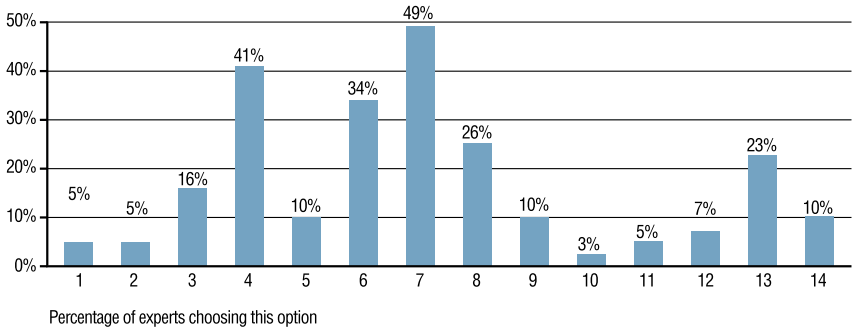


Q3. Technology



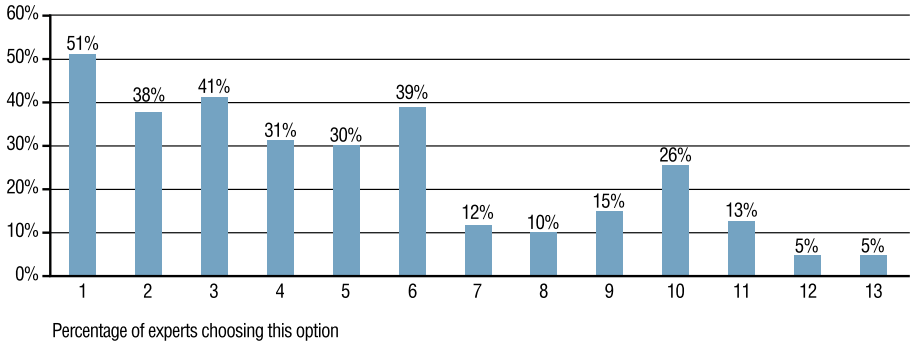
1. *Interfaces to location-based services*
2. *Technologies regarding user profiling*
3. *Privacy control on the user side*
4. *Usability/interfaces*
5. *Cognitive technologies (behavioural patterns, artificial intelligence, etc)*
6. *General search (better indexing, matching algorithms, ranking, etc)*
7. *Semantic web/search*
8. *Interfaces to mobile social networking*
9. *Wireless sensors (smart environment, RFID, NFC, etc.)*
10. *Including augmented reality features (i.e., information embedded in physical objects)*
11. *Audio/image search*
12. *Bio-sensors technologies*

Q4. Business Model



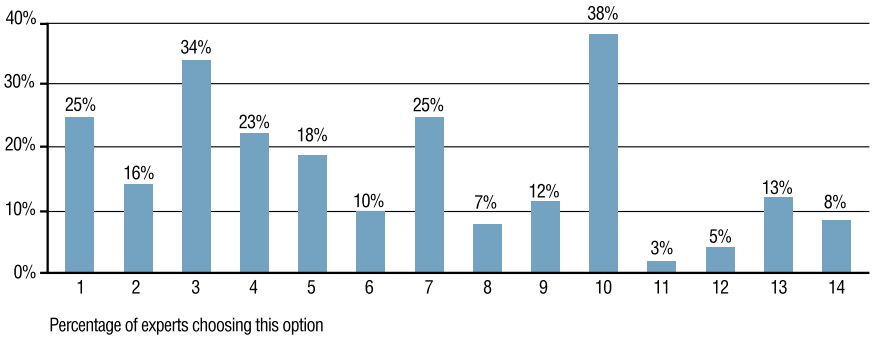
1. *Advertising in general*
2. *Pay-as-you-go (impulse purchase)*
3. *Merchandising or affiliation*
4. *Premium services*
5. *Advertising but based on some product placement*
6. *Value-added services (i.e., a contract for a pack of services on top of usual ones)*
7. *Subscription (monthly/annual fee, etc)*
8. *Packaged with some other product or service not related with ICTs*
9. *Business model to be defined at a very late stage when a critical mass of users is achieved*
10. *User community maintained by user contributions*
11. *User profiling (i.e., selling the user profiles for commercial purposes)*
12. *Packaged with the (voice, data) services of the mobile operator*
13. *Packaged with the mobile handset*
14. *Not a commercial service (i.e., a public service)*

Q5. User experience



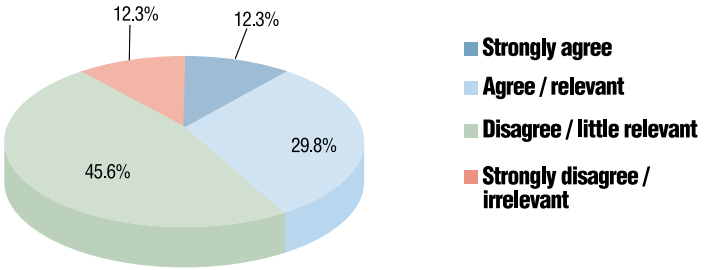
1. *Perceived usefulness / quality of the services and content offered*
2. *Trust in third-parties that manage and use personal data*
3. *Well-defined privacy*
4. *Trust in application providers*
5. *Specific cultural values and lifestyle particularities*
6. *Perceived ease of use*
7. *Security against all types of malware*
8. *Tools to conveniently manage digital identity*
9. *Availability of detailed user profile*
10. *Pricing*
11. *Overall interest in technology*
12. *Established market for economy of identity*
13. *Having a choice to same or similar experience*

Q6. Policy support

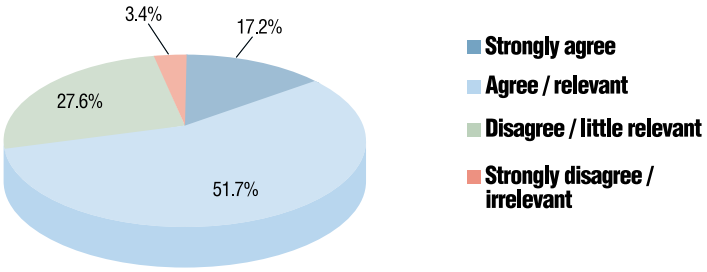


1. *Enhance user-awareness on opportunities and risks*
2. *Creating tools for user-empowerment*
3. *Supporting innovators and entrepreneurs*
4. *Promoting living labs*
5. *Reforming the regulatory framework*
6. *Development of a public service for this type of mobile search*
7. *Research projects for the required technologies*
8. *Promoting self-regulation of the industry*
9. *Promoting the internal EU market for economies of scale*
10. *Promoting standards and interoperability*
11. *Developing (or subsidising) content production*
12. *Supporting some European champion*
13. *Public procurement, (administrations are the first buyers and users)*
14. *No policy support required*

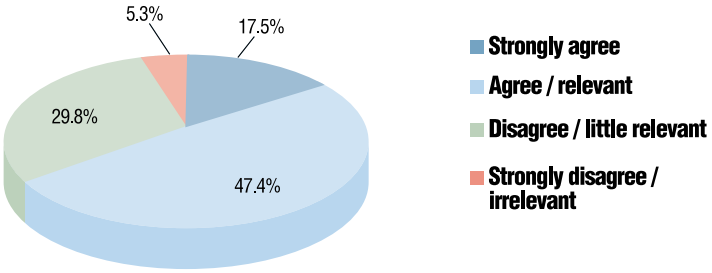
QA. Information about health status, even for leisure purposes only, belongs exclusively to the personal sphere and should never be exchanged over a commercial network



QB. Personal health systems will increase dramatically the sense of self-control of consumers and, therefore, applications related with them will be, in general, a market success

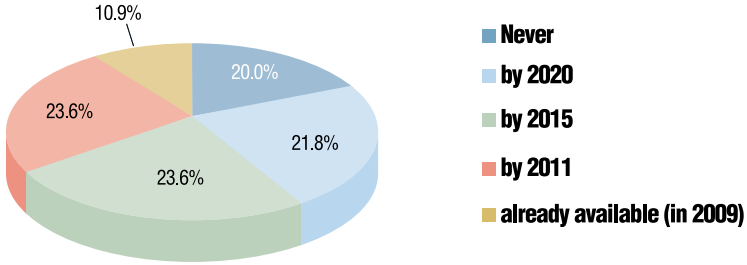


QC. The success any application requiring the agreement of many stakeholders –with distinct (and often opposing) interests– (in this example: suppliers of running gear, emergency services, city planners, clothes manufacturers, mobile operators, mobile device suppliers, insurance companies, etc), is unlikely

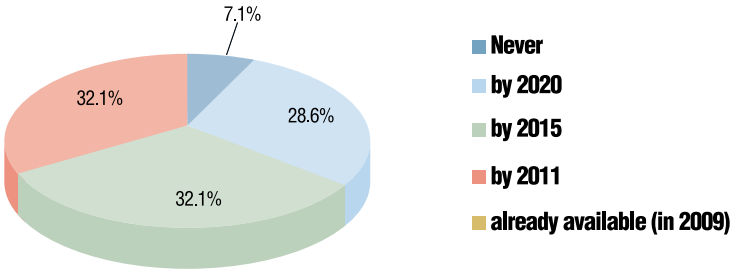


Scenario 4 – Truman show mode

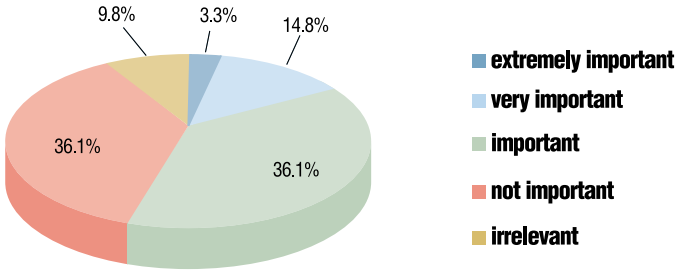
Q1a. Time Horizon (mass market)



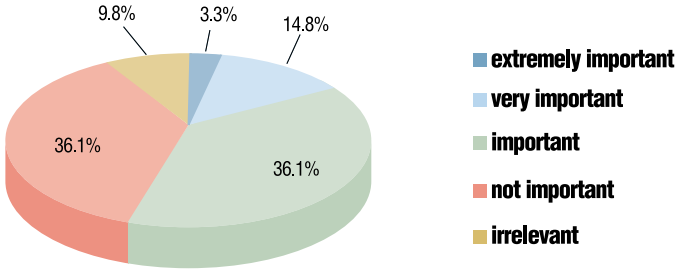
Q1b. Time Horizon (underlying technology available)



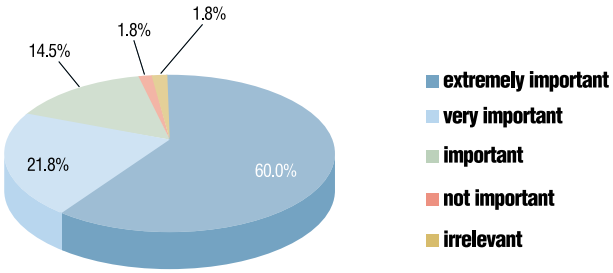
Q2a. Bottlenecks of technological nature



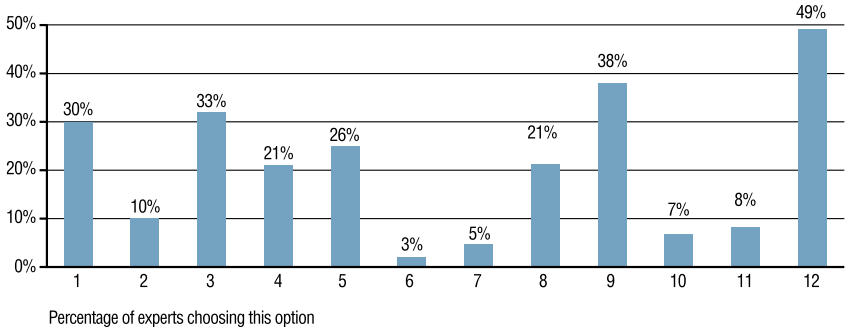
Q2b. Bottlenecks of economical nature



Q2c. Bottlenecks of behavioural nature

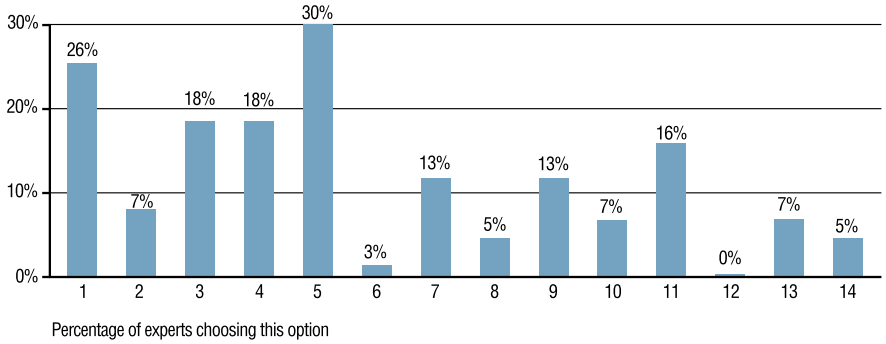


Q3. Technology



1. *Interfaces to location-based services*
2. *Technologies regarding user profiling*
3. *Privacy control on the user side*
4. *Usability/interfaces*
5. *Cognitive technologies (behavioural patterns, artificial intelligence, etc)*
6. *General search (better indexing, matching algorithms, ranking, etc)*
7. *Semantic web/search*
8. *Interfaces to mobile social networking*
9. *Wireless sensors (smart environment, RFID, NFC, etc.)*
10. *Including augmented reality features (i.e., information embedded in physical objects)*
11. *Audio/image search*
12. *Bio-sensors technologies*

Q4. Business Model



1. *Advertising in general*
2. *Pay-as-you-go (impulse purchase)*
3. *Merchandising or affiliation*
4. *Premium services*
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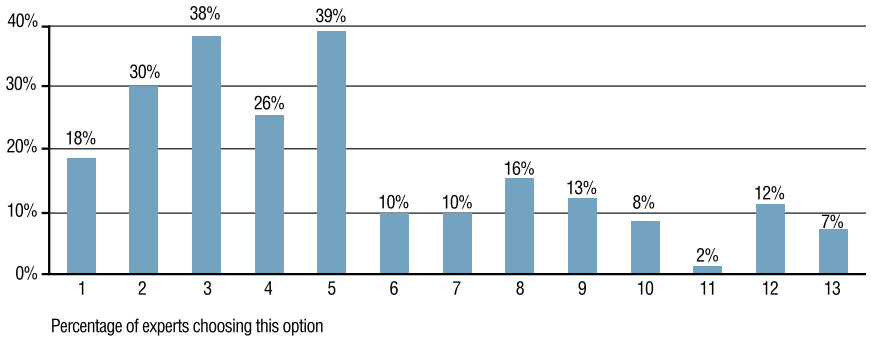
12. *Packaged with the (voice, data) services of the mobile operator*
13. *Packaged with the mobile handset*
14. *Not a commercial service (i.e., a public service)*

Q5. User experience



1. *Perceived usefulness / quality of the services and content offered*
2. *Trust in third-parties that manage and use personal data*
3. *Well-defined privacy*
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5. *Specific cultural values and lifestyle particularities*
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11. *Overall interest in technology*
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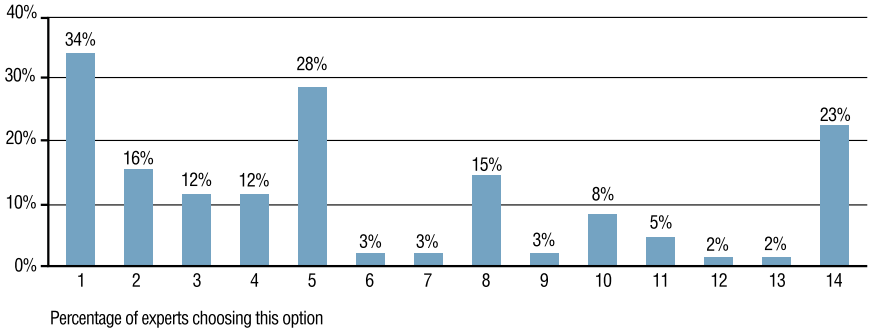
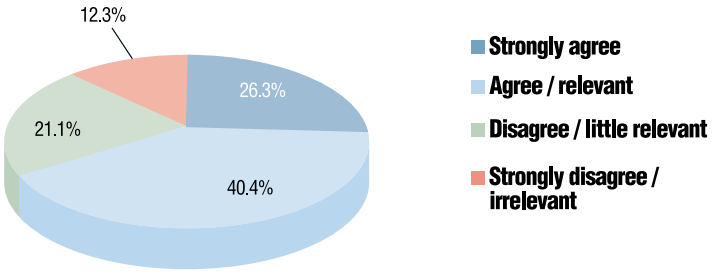
13. *Having a choice to same or similar experience*

Q6. Policy support

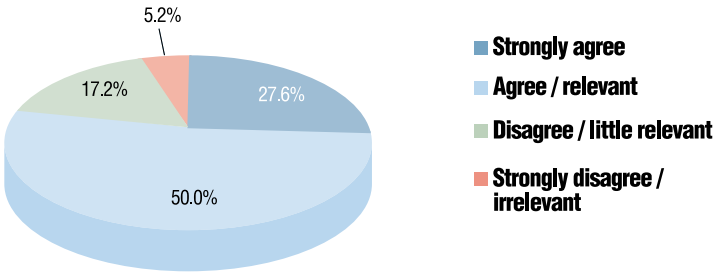


1. *Enhance user-awareness on opportunities and risks*
2. *Creating tools for user-empowerment*
3. *Supporting innovators and entrepreneurs*
4. *Promoting living labs*
5. *Reforming the regulatory framework*
6. *Development of a public service for this type of mobile search*
7. *Research projects for the required technologies*
8. *Promoting self-regulation of the industry*
9. *Promoting the internal EU market for economies of scale*
10. *Promoting standards and interoperability*
11. *Developing (or subsidising) content production*
12. *Supporting some European champion*
13. *Public procurement, (administrations are the first buyers and users)*
14. *No policy support required*

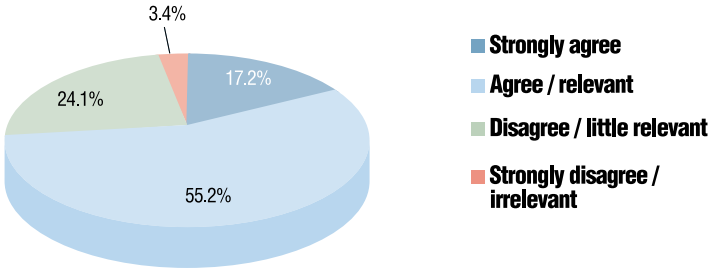
QA. The use of informed consent should be limited by law, for particular cases. Some decisions about privacy should not be left to individuals, i.e., there should be an absolute limit to the use of personal data and it should be impossible to go beyond it



QB. The exploitation of personal data for commercial purposes should be limited, subject to a strict scrutiny by regulators. It shall be allowed only where there are not signs of potential conflicts including a future perspective on the individual

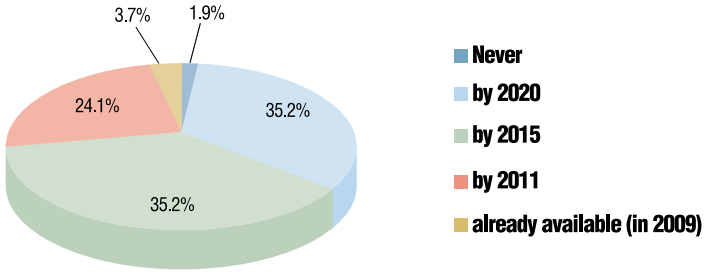


QC. The ubiquitous nature of mobile technologies will cause our social perception of privacy to change (reducing the traditional concept of "personal sphere") and few can be done about it

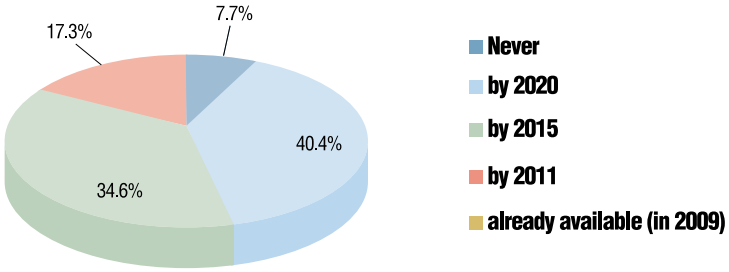


Scenario 5 – Tourist mode

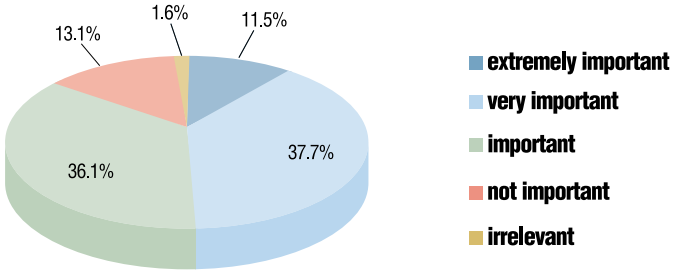
Q1a. Time Horizon (mass market)



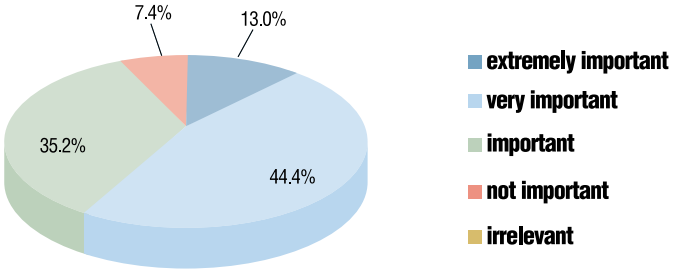
Q1b. Time Horizon (underlying technology available)



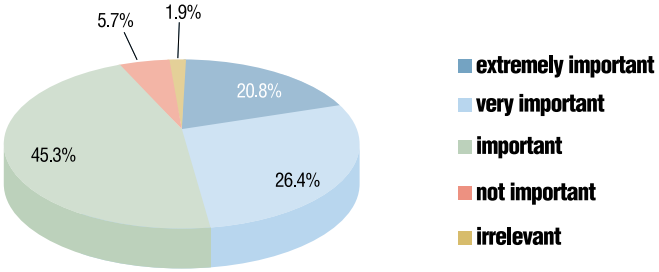
Q2a. Bottlenecks of technological nature



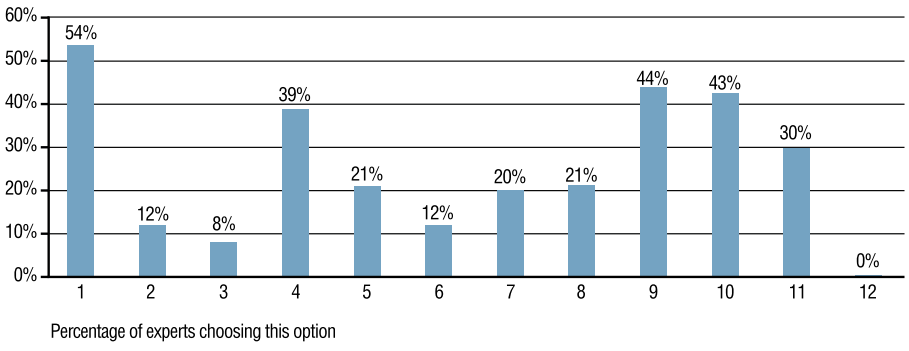
Q2b. Bottlenecks of economical nature



Q2c. Bottlenecks of behavioural nature



Q3. Technology



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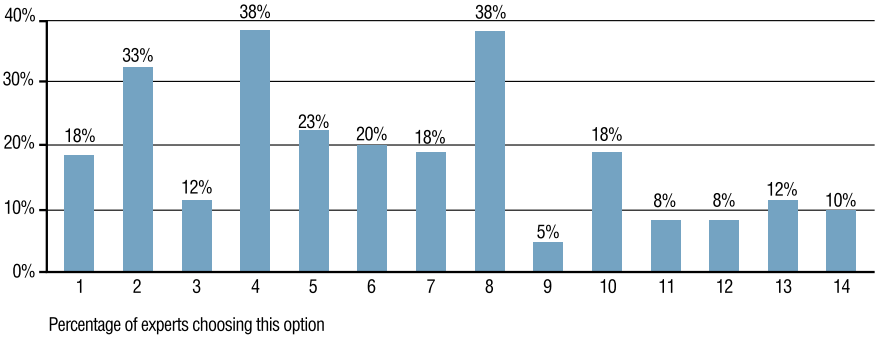
9. *Wireless sensors (smart environment, RFID, NFC, etc)*
10. *Including augmented reality features (i.e., information embedded in physical objects)*
11. *Audio/image search*
12. *Bio-sensors technologies*

Q4. Business Model



1. *Advertising in general*
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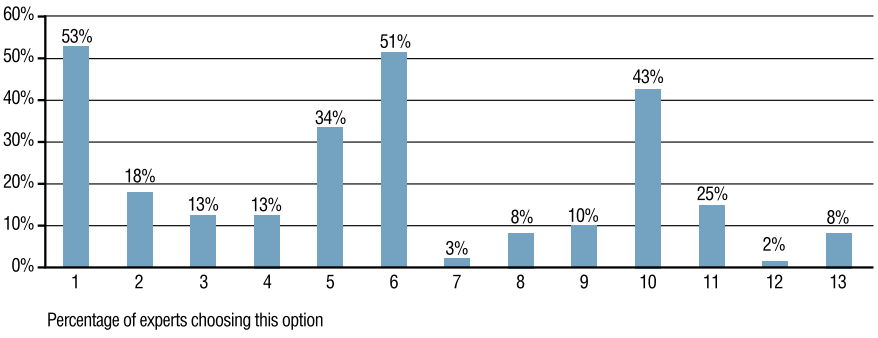
13. *Packaged with the mobile handset*
14. *Not a commercial service (i.e., a public service)*

Q5. User experience



1. *Perceived usefulness / quality of the services and content offered*
2. *Trust in third-parties that manage and use personal data*
3. *Well-defined privacy*
4. *Trust in application providers*
5. *Specific cultural values and lifestyle particularities*
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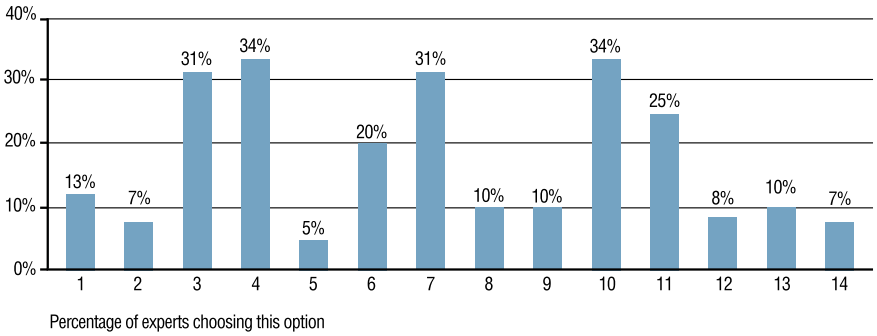
9. *Availability of detailed user profile*
10. *Pricing*
11. *Overall interest in technology*
12. *Established market for economy of identity*
13. *Having a choice to same or similar experience*

Q6. Policy support



1. *Enhance user-awareness on opportunities and risks*
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3. *Supporting innovators and entrepreneurs*
4. *Promoting living labs*
5. *Reforming the regulatory framework*
6. *Development of a public service for this type of mobile search*
7. *Research projects for the required technologies*
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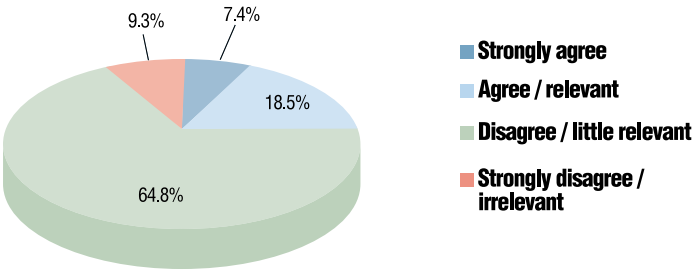
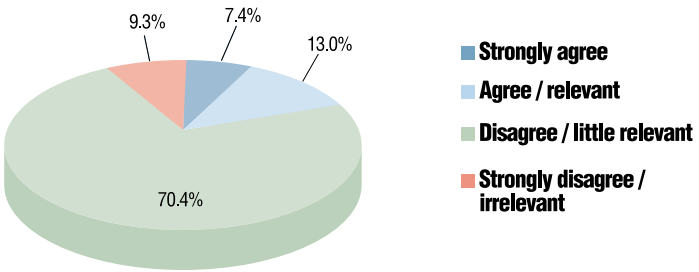
9. *Promoting the internal EU market for economies of scale*
10. *Promoting standards and interoperability*
11. *Developing (or subsidising) content production*
12. *Supporting some European champion*
13. *Public procurement, (administrations are the first buyers and users)*
14. *No policy support required*

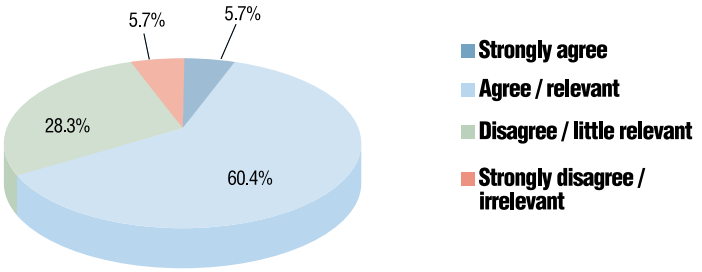
QA. There are so many barriers for the deployment of augmented reality infrastructures (wireless sensors and the networks that link them to mobile devices) that only the public administrations (i.e. a city council) will be able to do it



QB. The risks associated with wireless sensors technologies (lack of privacy, irresponsible use of them, …) outweighs potential benefits

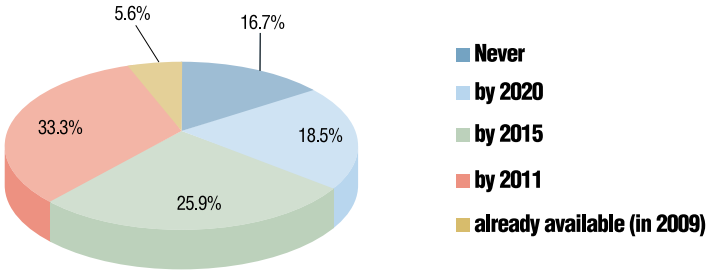


QC. User-generated content will be enough to create an augmented-reality-wikipedia able to provide users will all the relevant information in an scenario like this

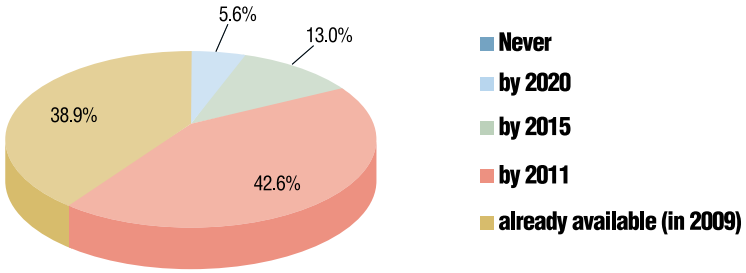


Scenario 6 – Playground mates mode

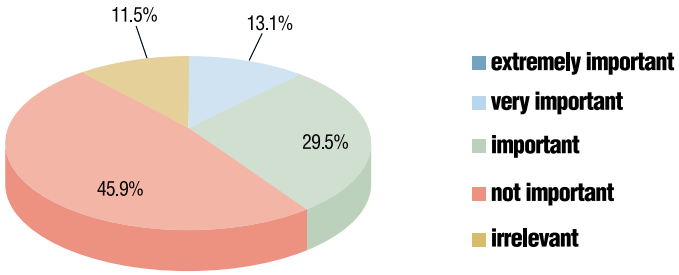
Q1a. Time Horizon (mass market)



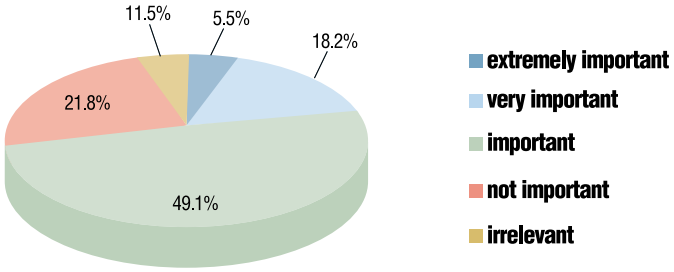
Q1b. Time Horizon (underlying technology available)



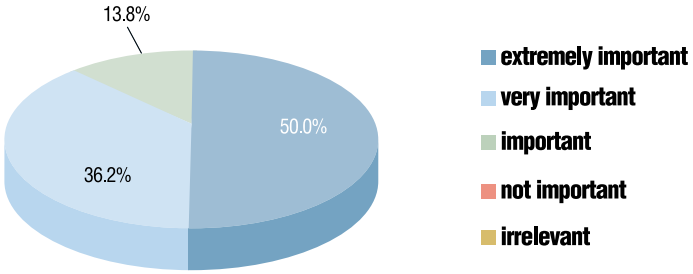
Q2a. Bottlenecks of technological nature



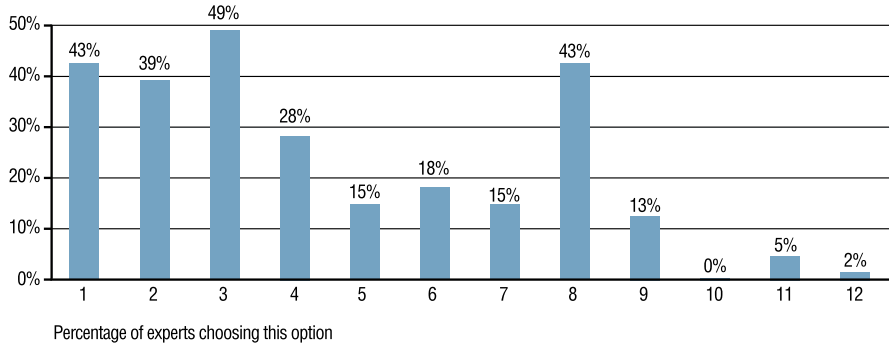
Q2b. Bottlenecks of economical nature



Q2c. Bottlenecks of behavioural nature

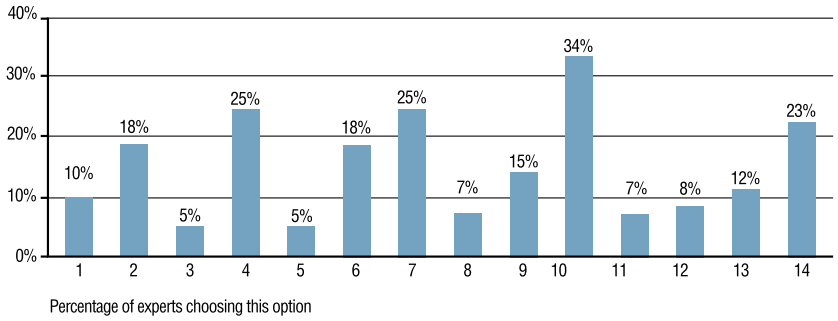


Q3. Technology



1. *Interfaces to location-based services*
2. *Technologies regarding user profiling*
3. *Privacy control on the user side*
4. *Usability/interfaces*
5. *Cognitive technologies (behavioural patterns, artificial intelligence, etc)*
6. *General search (better indexing, matching algorithms, ranking, etc)*
7. *Semantic web/search*
8. *Interfaces to mobile social networking*
9. *Wireless sensors (smart environment, RFID, NFC, etc.)*
10. *Including augmented reality features (i.e., information embedded in physical objects)*
11. *Audio/image search*
12. *Bio-sensors technologies*

Q4. Business Model



1. *Advertising in general*
2. *Pay-as-you-go (impulse purchase)*
3. *Merchandising or affiliation*
4. *Premium services*
5. *Advertising but based on some product placement*
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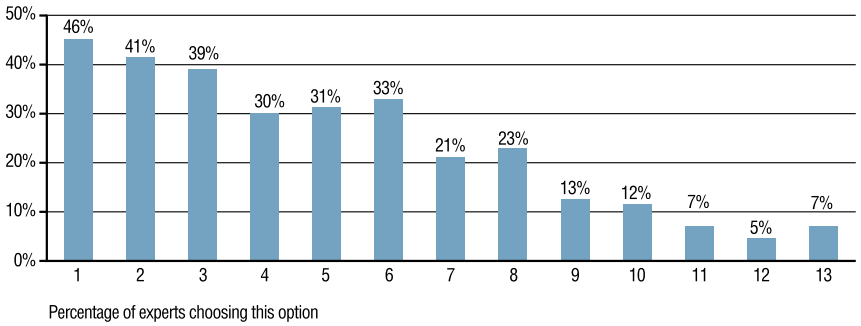
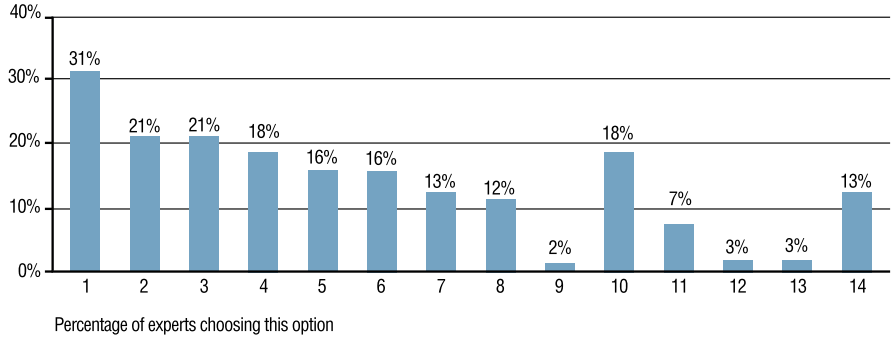
7. *Subscription (monthly/annual fee, etc)*
8. *Packaged with some other product or service not related with ICTs*
9. *Business model to be defined at a very late stage when a critical mass of users is achieved*
10. *User community maintained by user contributions*
11. *User profiling (i.e., selling the user profiles for commercial purposes)*
12. *Packaged with the (voice, data) services of the mobile operator*
13. *Packaged with the mobile handset*
14. *Not a commercial service (i.e., a public service)*

Q5. User experience



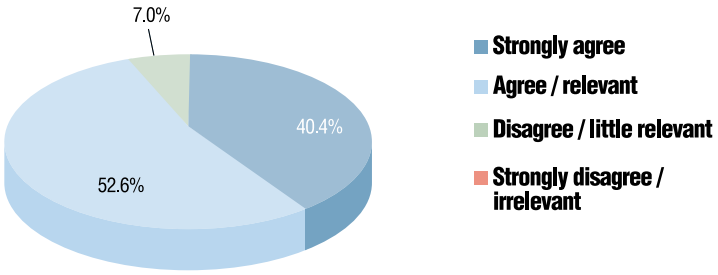
1. *Perceived usefulness / quality of the services and content offered*
2. *Trust in third-parties that manage and use personal data*
3. *Well-defined privacy*
4. *Trust in application providers*
5. *Specific cultural values and lifestyle particularities*
6. *Perceived ease of use*
7. *Security against all types of malware*
8. *Tools to conveniently manage digital identity*
9. *Availability of detailed user profile*
10. *Pricing*
11. *Overall interest in technology*
12. *Established market for economy of identity*
13. *Having a choice to same or similar experience*

Q6. Policy support

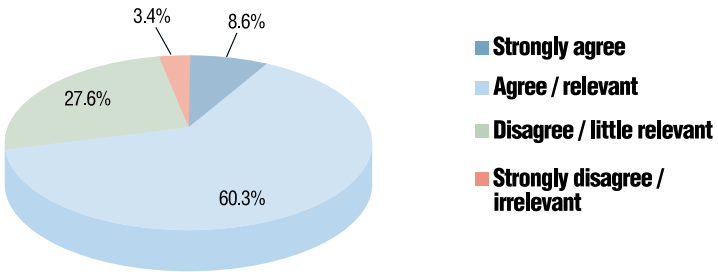


1. *Enhance user-awareness on opportunities and risks*
2. *Creating tools for user-empowerment*
3. *Supporting innovators and entrepreneurs*
4. *Promoting living labs*
5. *Reforming the regulatory framework*
6. *Development of a public service for this type of mobile search*
7. *Research projects for the required technologies*
8. *Promoting self-regulation of the industry*
9. *Promoting the internal EU market for economies of scale*
10. *Promoting standards and interoperability*
11. *Developing (or subsidising) content production*
12. *Supporting some European champion*
13. *Public procurement, (administrations are the first buyers and users)*
14. *No policy support required*

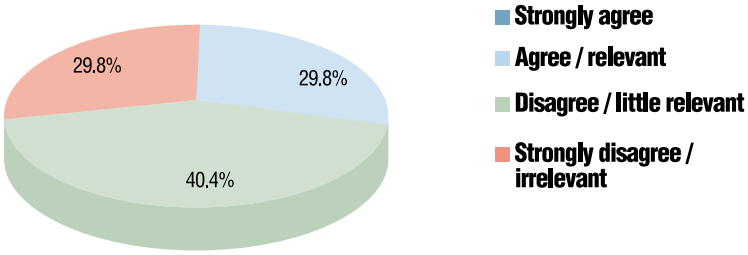
QA. Mobile search will not be just an extension internet search of practices to the mobile domain. The mobile dimension will add new added-value possibilities to internet search. As a consequence new players will appear different from those existing today



QB. Exchanging socially sensitive information through mobile technologies will soon become common practice

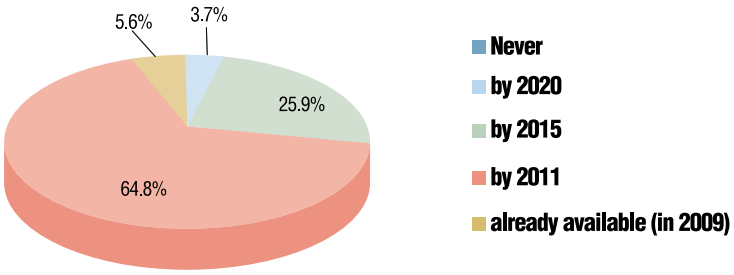


QC. Personal privacy is not at risk in controlled environments –i.e., linked to a particular location and only to some partial data about the persons–

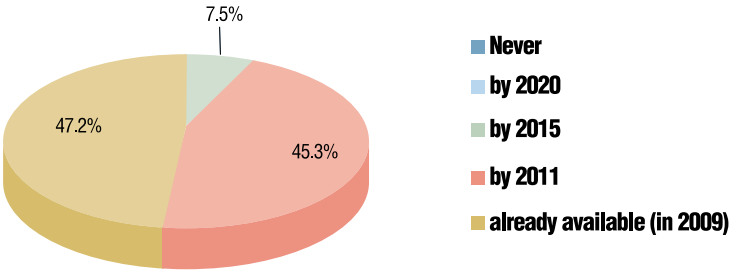


Scenario 7 – Professional appointments – Dating agency

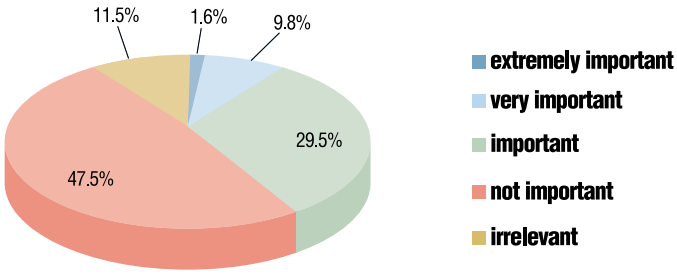
Q1a. Time Horizon (mass market)



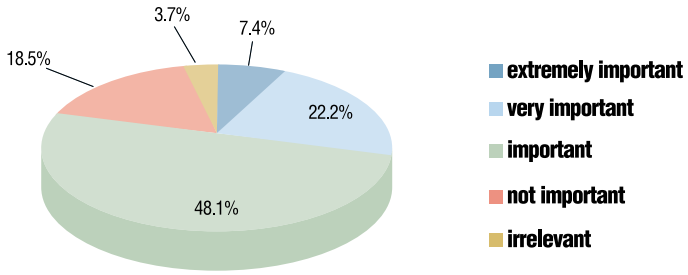
Q1b. Time Horizon (underlying technology available)



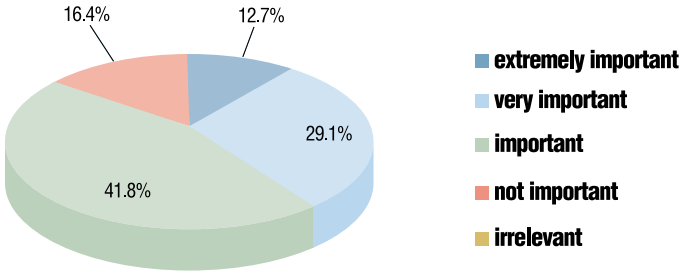
Q2a. Bottlenecks of technological nature



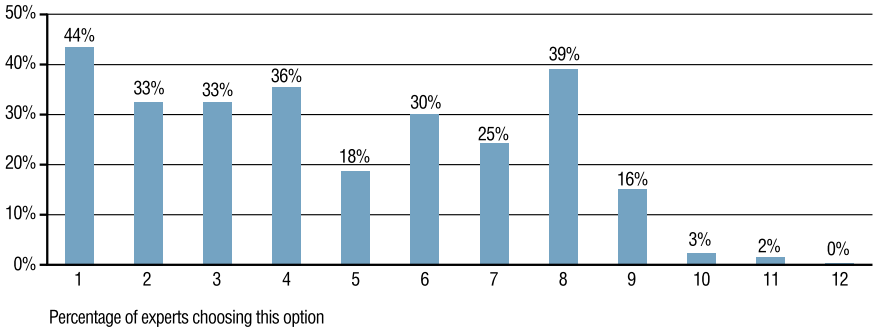
Q2b. Bottlenecks of economical nature



Q2c. Bottlenecks of behavioural nature



Q3. Technology



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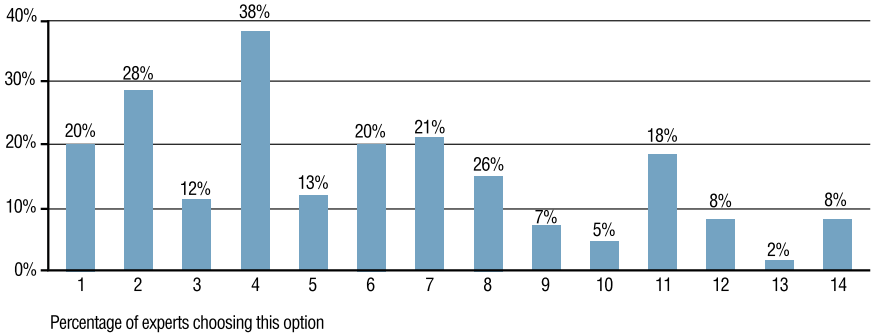
Q4. Business Model



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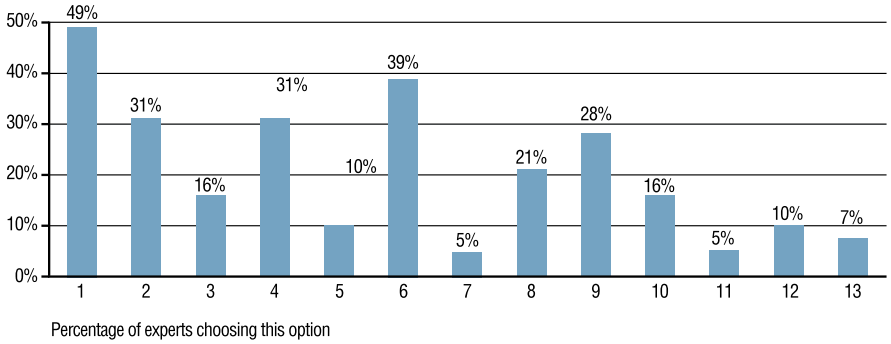

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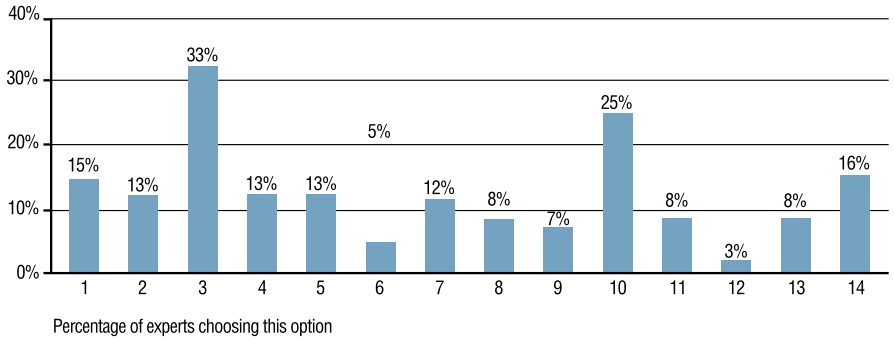
Q6. Policy support



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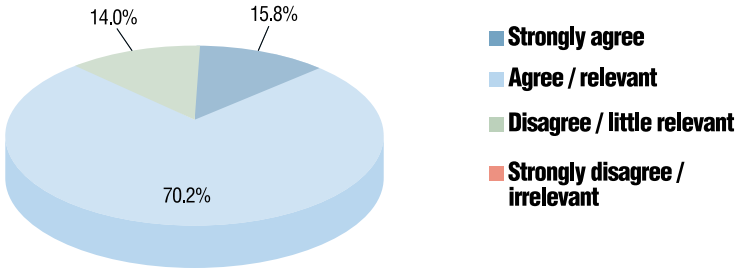
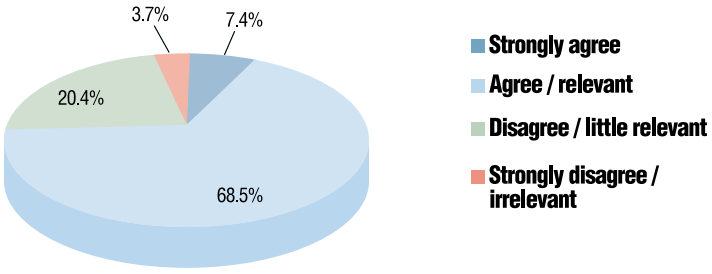
11. *Developing (or subsidising) content production*
12. *Supporting some European champion*
13. *Public procurement, (administrations are the first buyers and users)*
14. *No policy support required*

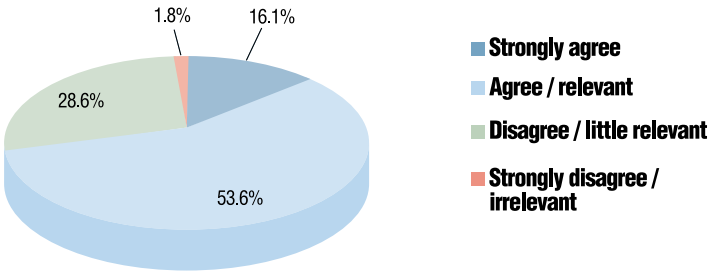
QA. The establishment trusted-third-parties will be necessary pre-requisite for the emergence of applications –and businesses– linked with the use of very personal data



QB. Applications as the one described in this scenario will be highly profitable. They will be amongst the first to appear in the market segment of "advanced mobile search" combining elements of many other different technologies and solutions

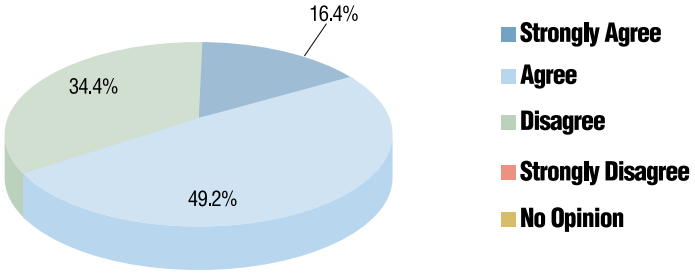


QC. "Adult" content and applications were amongst the first and most profitable businesses over internet. This is likely to happen on the mobile sphere

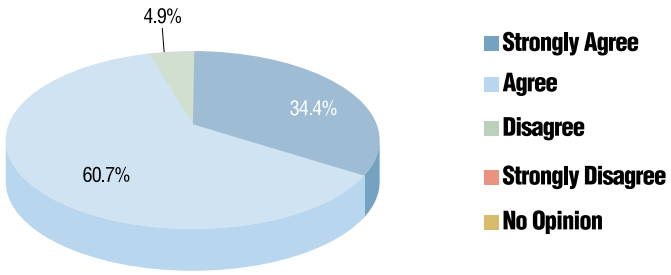


General questions about privacy

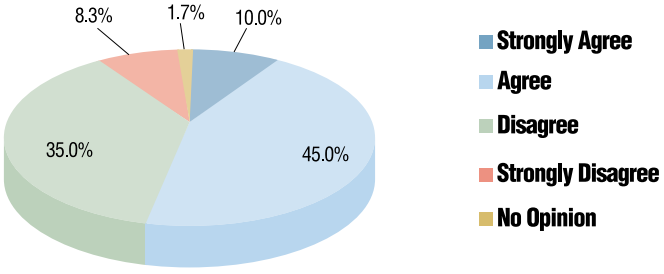
Q1. Privacy will irrevocably be eroded by the take up of mobile search services



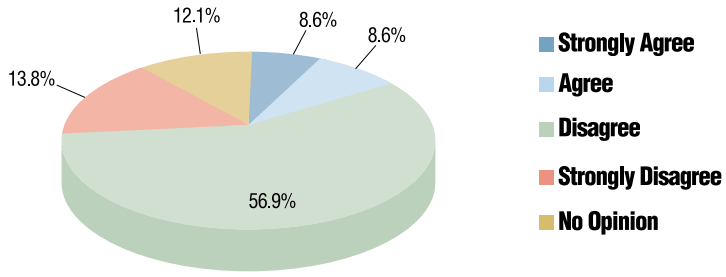
Q2. Users are willing to exchange personal data for customised services



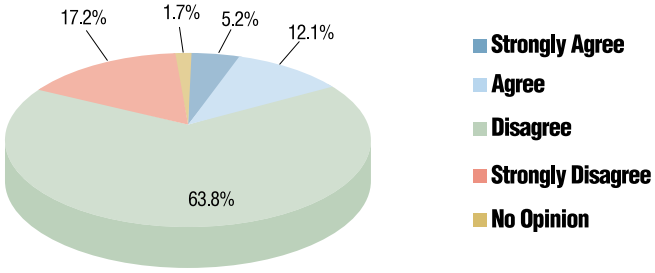
Q3. Profiling by search engines (e.g. cookies, log-files, IP-addresses, etc.) is fundamentally not different to tracking via other digital footprints (e.g. credit card records, cell phone calls, ATM machine use, etc)



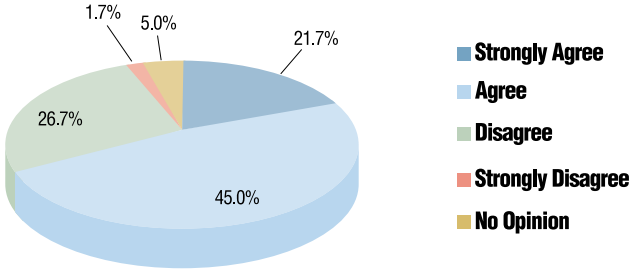
Q4. Privacy by design (e.g. privacy-enhancing, transparency-enhancing technologies) is not viable (e.g. hacking, costs, etc)



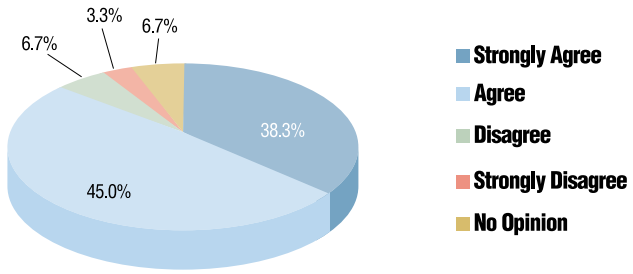
Q5. Approaches requiring user consent for processing their data will kill innovation (e.g. as opt-in options difficult to implement, as use of data for the development of future applications unclear, etc)



Q6. Profiling of small groups (or individuals) is indispensable to generate customised services



Q7. Privacy by law will be absolutely require to avoid abuses



Annex II: Workshop

A validation workshop on mobile search prospects took place on 16 and 17 April 2009 at the Institute for Prospective Technological Studies (IPTS), in Seville (Spain).

Aim of the Workshop

The objectives of the workshop were to explore and assess the impact of mobile search on society and economy in Europe, to identify key areas and policy options to confront potential issues regarding mobile search, and to consider different options on possible strategies for the European Union to take the lead of upcoming technological developments, business opportunities and social benefits.

The main questions to be raised during the workshop therefore were: how are going to evolve mobile search technologies and markets?, which are the perspectives and interests of potential users?, on what do users' acceptance and adoption depend?, which are the expected next innovations in this field?, which will the impact of mobile search in (Europe's) society and economy be?, and, above all, as mentioned, which are the most likely future scenarios?, and whether there will emerge issues (market, social, institutional) during its deployment, and which could be the policy options, should that be the case?.

Participants in the workshop

Participants: Project Team

Name	Organisation	Location
José Luis Gómez-Barroso *(Project coordinator)*	UNED	Madrid, Spain
Ajit Jaokar	Futuretext	London, UK
Rudy de Waele	mTrends	Brussels, Belgium
Oscar Westlund	Gothenburg University	Gothenburg, Sweden

Participants: External Experts

Name	Organisation	Location
Pieter Ballon	SMIT - Studies on Media, Information and Telecommunication	Belgium
Ana Bernardos	UPM	Spain
Mark Bole	ShoZu	United Kingdom
Alvin Wang Graylin	mInfo	China/United States
Juha Kaario	Nokia	Finland
Nicklas Lundblad	Google Sweden -Public Policy and Government Affairs	Sweden
Claudio Moderini	DOMUS ACADEMY Master in Interaction	Italy
Wandrille Pruvot	BuzzCity	France
Sergio Ramos	REDTEL – Spanish Association of Telecommunications Network Operators	Spain
Pierre Scokaert	AB Phone	France
Hendrik Speck	University of Applied Sciences Kaiserslautern	Germany

Participants: IPTS

Name	Organisation	Location
David Broster	IPTS	Seville
Ioannis Maghiros	IPTS	Seville
Ramón Compañó	IPTS	Seville
Claudio Feijóo	IPTS	Seville
Margherita Bacigalupo	IPTS	Seville
Anssi Hoikkanen	IPTS	Seville
Gianluca Misuraca	IPTS	Seville

Agenda of the workshop

Thursday 16th April

09h00 Registration

Introduction
- 09h15 Welcome *(D. Broster, IPTS)*
- 09h20 Project Objectives *(R. Compañó, IPTS)*
- 09h30 Roundtable Presentation *(all participants)*

Main Project Findings and Scenarios
- 09h45 Overview of Project Findings *(J.L. Gómez-Barroso, UNED)*
- 10h00 Scenario Overview *(C. Feijóo, IPTS)*
- 10h20 Comments to Scenarios *(all)*

Part 1&2: Time Frame and Technological Aspects
- 11h00 Survey Results *(C. Feijóo, IPTS)*
- 11h10 Discussion *(all)*

Part 3: Business Models
- 11h45 Landscape of Mobile search players *(Rudy de Waele, MTrends)*
- 12h00 Survey Results *(R. Compañó, IPTS)*
- 12h10 Discussion *(all)*

Part 4: Demand Side
- 14h00 Users' vision on mobile search *(Oscar Westlund, Univ. Gothenburg)*
- 14h20 Survey Results *(M. Bacigalupo, IPTS)*
- 14h30 Discussion *(all)*

Part 5: The dark side of mobile search
- 16h00 Survey results *(I. Maghiros, IPTS)*
- 16h30 Discussion *(all)*

Friday 17th April

Summary of first day
- 8h45 Presentation of findings *(C. Feijóo, IPTS & J.L Gómez-Barroso, UNED)*
- 9h00 Discussion *(all)*

Part 6: SWOT for Europe
- 09h30 Projecting into the future *(Ajit Jaokar, Future Text)*
- 09h50 Discussion *(all)*

Part 7: Policy Options
- 11h00 Survey results *(C. Feijóo, IPTS)*
- 11h15 Discussion *(all)*
- 12h15 Prioritisation of Policy Options

Close
- 13h15 Wrap-Up *(R. Compañó, IPTS)*
- 13h45 Close *(D. Broster, IPTS)*

European Commission

JRC56100 – Joint Research Centre – Institute for Prospective Technological Studies

Title: Prospects of Mobile Search

Authors: José Luis Gómez-Barroso, Ramón Compañó, Claudio Feijóo, Margherita Bacigalupo, Oscar Westlund, Sergio Ramos, Ajit Jaokar, Federico Álvarez, Rudy De Waele, Gema Mateos-Barrado, and María Concepción García-Jiménez

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Abstract

Search faces (at least) two major challenges. One is to improve the efficiency of retrieving relevant content for all digital formats (images, audio, video, 3D shapes, etc). The second is to make relevant information retrievable in a range of platforms, particularly in high diffusion ones for mobiles. The two challenges are interrelated but distinct. This report aims to assess the potential of future Mobile Search. Two broad groups of search-based applications can be identified. The first group adapts and emulates web search processes and services to the mobile environment. The second is made up of services which exploit the unique features of mobile devices and mobile environments. Examples of these context-aware services include location-based services or interfacing to the internet of things (RFID networks).

The report starts by providing an introduction to mobile search. It highlights differences and commonalities with search technologies on other platforms (Chapter 1). Chapter 2 is devoted to the supply side of mobile search markets. It describes mobile markets, presents key figures and gives an outline of main business models and players. Chapter 3 is dedicated to the demand side of the market. It studies users' acceptance and demand using the results of a case study in Sweden. Chapter 4 presents emerging trends in technology and markets that could shape mobile search. This vision was partly based on an analysis of forward-looking scenarios for mobile, developed by the authors and evaluated by experts in the field (Chapter 5). Another input was a questionnaire to which 61 experts responded. Drivers, barriers and enablers for mobile search were summarised in a SWOT analysis. The report concludes with some policy recommendations in view of the likely socio-economic implications of mobile search in Europe.

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