Final Project Report
submitted for the fulfilment of the degree of MSc in Telecommunications
Supervisor Professor Andy Valdar

Content Delivery Opportunities and Challenges
The Wireless User Perspective

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Abstract

This study provides a review of the major issues involved in extending the scope in which content is currently delivered over the internet. In order to properly determine possible areas of growth, a characterisation of commercial content attributes enabled through Internet delivery is provided. The selected areas are mobile Internet and streaming media delivery, which are developed in two complementary reports by means of case studies. A comprehensive review of business modelling techniques is included in order to distinguish an appropriate methodology. The resultant methodology is applied to the relevant study subject (i.e., mobile Internet or streaming media delivery) with the purpose to identify the commercial relations between the players that take place in the content delivery life cycle. Business implications of several service scenarios are detailed. Based on the outcome of the business case study, an engineering-economic analysis focusing on a key business player (i.e., Internet wireless provider or streaming media service provider) is developed in the form of a case study. Finally, from this economic analysis, recommendations and further challenges directed towards the viability of the Internet delivery services in question are set out.
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1. Introduction

1.1. Introduction

Internet and its technologies have transformed the way content is produced, commercialised and accessed. Enabling mobility seems to be one of the next important steps. Content services exploring the mobility aspect, apart from facilitating accessibility, allow the exploration of further appealing possibilities, such as high degree personalisation and location awareness applications.

In spite of that, many barriers have been pointed out for the ready deployment of 3G service infrastructure, as it commercial viability is still seen as uncertain from the point of view of operators and investors worldwide. On the other hand, in Japan, the Docomo i-mode service offering and its more recently 3G FOMA addition have demonstrated otherwise. Although counting on favourable environmental conditions (for example, no need for high expenses with spectrum license fees), Docomo shown how strategic integration between the suppliers required for the final service (handset terminals, wireless network and applications) can be beneficial for all. Through creating the right incentives, it managed to overcome the “chicken-and-egg” platform obstacle: users are not attracted to the service if application diversity is not available, while content service providers don’t find it advantageous to join a platform with limited number of consumers. This study uses business modelling tools to map and examine the many interactions composing the i-mode value chain, providing an overview of the main points of its strategy. The resulting model mapping is also used to explore different service composition possibilities within the typical content provision lifecycle.

While different studies have addressed many aspects of the i-mode experience, a particular point of analysis is seldom mentioned. Wireless data services are normally proposed to be paid for on a per-usage basis, contrarily to what happens with fixed line access, where unlimited flat rate fee is often the formula. Furthermore, many content services are also charged within the i-mode offering. The study takes this point and investigates the technological factors for the differentiated per-usage charging decision, and evolves to an economic case study examining its effects on general consumer behaviour. To this end, a simple consumer preferences model based on microeconomic theory is proposed, which is possibly the greatest contribution to this work. The analysis takes in consideration the influence of fixed-line broadband competitors, and is applied to current pricing conditions and different user budget restriction situations. Parameters are included to account for different personal inclinations and usage patterns, for which different scenario situations are defined.
General observations are provided on the relative importance and complementarity between content and communications services, as well as on business modelling techniques. Specific conclusions are taken on their application to the i-mode case study, and on the implications derived from the user preferences model. Finally, additional questions demanding future work are suggested.

1.2. Motivation

The main personal aim in proposing this project was to expand on the economic and business concepts acquired during the course of the MSc Telecommunications Programme in order to complement our technical formation. While we were satisfied with the methods and knowledge gained for addressing engineering problems, this work is an initiative to structure our approach towards business and economic issues in the telecommunications industry.

As an illustrative application area, we elected content delivery focusing on two of its areas of growth: wireless delivery and streaming of rich media. We perceived that the economic interactions resulting from the recent technological advances in these areas would be enriching for the purposes of this study. We also took the opportunity to experiment on taking an alternative view from that traditionally employed on engineering, and attempted to use a combined approach where both consumer needs (market pull) and technology advances (technology push) were taken in consideration.
1.3. Scope of the Study and Problem Approach

This section aims at explaining the approach taken for the realization of this study. The rationale behind this study can be represented by the following steps:

1) As a first step, content is defined for the context in which it is used in this report and its importance is pointed out as compared to communication services. Next, current Internet usage trends and consequences brought by the digital distribution of content over the Internet are discussed.

![Figure 1 - Content delivery characteristics](image)

2) Based on the current offering of content delivery services in the market, the typical existing content provision value network was worked out and taken as a reference model so as to indicate current content desirable attributes delivered with the current infrastructure. In this step, possible implementations of unexplored content desirable attributes are examined with the purpose to identify the two major areas of growth for the delivery of content. In this sense, we have adopted delivery areas according to the content attributes whose service implications would have the greatest impact on traffic and network infrastructure. The provision of these services is achieved through the inclusion of new actors in the value network. New services are thus enabled by the relationship between existing and new players, and these are represented by different service scenario paths.

![Figure 2 - Enhanced content delivery value system supporting new service scenarios](image)
The next steps are directed at detailing the relations and effects caused by the new player within the value system in order to complement on the initial value analysis. The interactions the new player establishes with the others are further examined from two different standpoints: economics and technological. Practical analyses from these viewpoints are developed throughout the report in the form of case studies. Relevant concepts and theory are described along when appropriate. As to the economic aspects, emphasis is given in formulating, on a per-service type basis, consumer utilities and valuations, cost structures and volume relationships, as well as the resulting appropriate charging models and optimal bundling strategies. On the technological issues, a brief description of the most relevant enabling technologies used by the content service provider is given.

Figure 3  Analysis perspectives to be developed for the new player enabling new content delivery services
1.4. Structure of the document

This report is the result of a joint project that is composed of both common and individual work contributions, which are documented accordingly. Chapters 2 and 3 include a theoretical and a practical part. The theoretical part (jointly documented) has the aim to provide a conceptual framework for the development of the practical part (individually documented), which is presented in the form of a case study. The reader is referred to Appendix C for a finer detailing on the documentation of common and individual work contributions.

The remainder of this report is set out as follows: Chapter 2 defines the context in which content is used in this study and provides an examination of the current exploration of its commercial attributes through Internet delivery. Moreover, this chapter resumes the importance, at the present time, that Internet users place in accessing content on the Internet as compared to communication services and presents market indicators to support this notion. Chapter 3 presents an extensive review of existent business model methodologies and selects the most illustrative technique, which is applied to the case study of NTT Docomo i-mode/FOMA wireless internet content delivery. In this chapter, an overview of the major players in this market and their most significant commercial relations is given. Chapter 4 introduces the theory behind the economics of information technology, as well as relevant economic concepts and practices, such as costing, pricing and bundling techniques. In this chapter, an engineering-economic analysis on cost structures, charging models and joint effect on consumer preferences of wireless internet access and content delivery is presented from the service provider’s standpoint in the form of a case study. Chapter 5 provides a brief description of the main technology enablers for the competitive differentiation of wireless services. Finally, conclusions and suggestions for future work are set out in Chapter 6.
2. Background and Scene Setting

2.1. What is content?

The word content derives from the Latin “contentum”, which refers to “that which is contained”. Content is a broad term with broad implications. It refers to time-dependent, audience-targeted, relevant information presented in a logical, structured format of value to the consumer. In simple words, content is the information a particular group of people wants at a given time. In order to be relevant and in some cases providing some entertainment value, it is essential that the content contain an up-to-date and specific-purposed value to consumers. In this sense, content is valuable to the extent that it is useful for the user whether it will entertain, educate, share or serve to locate other content.

In the context of Internet, content is one of the most common terms used to describe information, which is interchangeable with other terms, such as digital assets, intellectual assets or knowledge. It includes far more than traditional document-style material. Rather, digital content embraces all types of media including text-based documents, images, videos, music, animations, transactions, etc., which are commonly experienced on a man-to-machine mode. That is the sense in which content is used in this work. Conversely, communication services such as e-mail, video-phone, etc., which are accessed on a man-to-man basis and valuated according to different criteria (i.e. social networking), are considered out of the scope in the above content definition.

2.2. Comparing importance of content against connectivity

The Internet is predicted to produce “digital convergence”. This term implies the merge of computing, telecommunications and broadcasting industries over a single ubiquitous network, which is generally used for two main purposes: communication and content localization. In the light of ever-increasing commoditizing bandwidth facilities due to recent developments in core transmission technologies and last mile bandwidth capacities, network providers (ISPs and Telcos) have been dealing with dwindling Internet access revenues. This has been exacerbated by the effects of subscription-free Internet access provision and unmetered calls at a fixed cost subscription-based Internet access. For this reason, some people argue that the value of the Internet will lie in its content rather than in connectivity issues.

This preoccupation with content is particular for network providers which are struggling to repurpose their business strategy towards the offering of substantial content in order to build a sustainable business. As a result, many network providers have re-branded and repositioned themselves as Internet portals rather than Internet access providers. However, it has been proven that having a brand identity and aggregating customary content is not enough for Internet portals
to succeed in growing a customer base and collecting profitable fees from it. In this sense, portals are being faced with the challenge of obtaining or creating differentiated content. Accordingly, alliances between ISP portal operators and content owners from old media companies have taken place. Examples of this can be seen in recent mergers between content providers and broadband companies, such as AOL/Time Warner and Vivendi/Seagram.

Certainly, most of the commercial development effort on the Internet is devoted to content. While network operators seem to be confident about the importance of content as a key service differentiator, contrary theories to this idea have arisen. Odlyzko [1] supports the argument that connectivity is more important than content provisioning in the interest of the network provider.

According to Odlyzko [1], it has historically been proved that people are reluctant to pay for content rather than for connectivity over a communications infrastructure. For example, almost all revenues of domestic postal systems have been derived from letters rather than from newspapers or magazines, despite the fact that about as many letters as newspapers are delivered. Similarly, although wireless communications were initially conceived as content delivery systems, Odlyzko gives evidence that revenues from wireless telephony already exceed by far those from radio broadcasting. This is due to the fact that the content industry as a whole has traditionally derived revenues indirectly from advertising. For instance, around two thirds of newspapers revenues and almost all of broadcast TV and radio revenues come from advertising. Following this, content has usually been given away in order to attract people to goods and services they are willing to pay for. In addition, the content industry, as opposed to the communications industry, has to use its revenues to pay for the delivered content. In this sense, a significant revenue proportion goes to the content creator (in average a third of content piece).

Odlyzko claims that people’s appraisal of connectivity for point-to-point communications is much higher than that of content provision. This can be proved by some examples of daunting attempts of content delivery services such as the teletext, the French Minitel and the start-up of some ISPs set-up for database access that were forced to drop their content provision arm and emphasize on communications. On the contrary, Odlyzko contends that e-mail has been and continues being the most user-valued service on the Internet. Moreover, in the wireless industry the Wireless Application Protocol (WAP), designed to deliver content to mobile devices, has not been widely taken up, whereas the Short Message System (SMS), providing low bandwidth digital messaging between users, has surprised the industry by its success. In brief, communications services over fixed or wireless networks seem to be more profitable than content provisioning services.
As above discussed, there are diverse conceptions of the value that content provides to a communications infrastructure. In our opinion, the argument that content has been less important than personal communication in the past, including the emergence of the Internet, gives an indication that people might be willing to pay more for communications issues than for content. However, this argument cannot be taken to an extreme, since content can be highly profitable. Moreover, in the intensely competitive bandwidth provisioning market, the offer of user-valuable content serves a key differentiator for network providers. Following this, content can also be value to a network as a means to attract new users by enhancing user experience. This is the content strategy that most Internet portals are currently adopting as to reinforce and enhance the user-perceived value of content with the aim of increasing their customer base and, inclusively, charging for content in a short future.

2.3. Current trends in Internet usage and willingness to pay for content

The usage of Internet depends on preferences derived from the individual’s characteristics, such as age, sex, social group; and external factors, such as type of Internet connection, subscription, etc. Trends in Internet user behavior are typically drawn by means of Internet usage surveys. According to the annual survey “Which? Online Internet Survey” [2], study that examines Internet usage amongst a representative panel of UK adults, Internet usage patterns showed that information replaced communication, in 2001, as the most widespread purpose of Internet use. In this sense, e-mail, regarded as the most user-valued service on the Internet, was overtaken by Internet use for education and research as shown in Figure 4. Arguably, this is due to the advent of SMS (Short Messaging System) as a more convenient service substitute.

![Purpose of Internet Use (% of users) 2001](image)

Figure 4  Purpose of Internet Use (Which? Online Internet Survey - 2001)
A study undertaken by the market research company Content Intelligence in the U.S.\cite{3}, shows current trends in the willingness to pay for content in men and women. According to the report, industry-specific business sites seemed to attract the majority of electronic content purchases while music, video and news in electronic format showed to be bought by a roughly 10 percent of the interviewees, as shown in Figure 5. This study also drew that the willingness to pay for content over the Internet is highly correlated with the level of Internet experience. In this regard, about 30 percent of men who have used the Internet for at least 4 years have done an electronic content purchase, whereas only about 15 percent of women have.

![Type of Internet content purchased](image)

Figure 5  Type of Internet content purchased

Willingness to pay for content depends on the type of content and is distinct for different countries. In this sense, a survey conducted by Forrester Research in the U.S. \cite{4} found that only 4 percent of the American Internet users would be prepared to pay for news, while 10 percent would pay for books, music and video. Other results derived from this study showed that in 27 countries examined, 35 percent of Internet users would be willing to pay for content. Countries that showed the highest willingness from the 27 examined included Switzerland, Sweden and China.

### 2.4. Content delivery over the Internet

The Internet is the technology that has liberated vast quantities of information and enabled it to be distributed globally. However, this is the same technology that has made content resistant to valuation in traditional economic terms. According to Morris \cite{5}, the Internet has created content in superabundance. In other words, companies attempting to sell content online are faced with the situation where their information is in demand, yet it is something people are not willing to pay for. This is due to the fact that superabundance and dematerialization of digital information, as Morris \cite{5} points out, have led to a collapse of classical pricing structures based on producer control supply.
Traditional ties imposed by content creators between content origination and distribution are rapidly disappearing in the digital environment. Before the advent of the Internet, information was tied to a physical container. Following this, in order to get information, it was needed direct contact with that container which created value. For example, to find out daily news one needed to buy the newspaper. There were limited access points to information and therefore their scarcity made them valuable in economical terms. The Internet has changed this. Conventional content, available on physical media, such as books, CDs and videotapes, loses much of its value once it enters into the digitized world of the Internet. Once digitized, pieces of content drop their intrinsic value characteristics and become simply transferable data or commoditized goods, which can be easily duplicated and shared among numerous Internet users.

Numerous business models have emerged for content originators and distributors. The limited success that some business models have so far shown serves to visualize the underlying tension between the demand for information and its lack of valuation. Music companies, press members, film studios and other old economy content owners are struggling to develop new business models with the aim to benefit from the exchange or transfer of digital data. We can see this problem by giving the example of the New York Times online. When the New York Times initially went online, it attempted to follow its print model and charge a subscription fee in order to release its content. Challenged by free news sources online and unwillingness to pay from users, it had to follow a new model, which consisted of charging for its archive. Finally this model did not succeed and the New York Times had to open up its entire content by requiring a simple free registration.

Additionally, traditional content owners have not managed to translate business assets of the old economy, sometimes readily available on the Internet, into an equivalent value derived from exchange of digitized content and have instead seen their libraries devalued. For example, this has happened in the distribution of music mainly due to delay tactics for resistance to digital distribution, where record companies have been hit by a proliferation of decentralized technologies employing Internet users in peer-to-peer models as nodes for content distribution.

In this difficult terrain, it is believed that the key to selling content on the Internet relates to enriching its intrinsic value by offering it in accordance with desirable content attributes. These are additional characteristics on top of its basic requirements, such as usefulness, meaningfulness and emotional appeal for entertainment purposes. Next, a brief review of the most significant value-adding content characteristics resulting from our own judgment is given.

i. **Diversity.** Perhaps the most important is the ability to obtain contain for several sources including different geographical, social and ideological ranges. Internet connectivity has greatly contributed in this aspect through eliminating distance and
time restrictions for the exchange of content. The distributed storage effect associated with such interconnectivity further contributes to enhance its diversity.

ii. **Richness** This aspect relates to the fact that users are expecting to access content of numerous media types. Currently, content provision capabilities over the Internet are being enhanced in order to deliver content not only in conventional media types (e.g. text, graphics), but in nearly all media types (e.g. audio, video)

iii. **Context - Timeliness.** In general, context could be described as the additional value a piece of information acquires when presented or accessed at a certain time, space or audience. The first component, timeliness, refers to the time-dependent value of information. The current easiness to digitize information, the ability to process and exchange content through end-to-end internet connectivity during its lifecycle, as well as content managements tools are the major drivers that allow exploring this attribute.

iv. **Context – Personalisation** –Typically, content services face a high uncertainty on the valuation of their target audiences, since normally a single source produces the same piece of content to a number of individuals with different interests. The ability to select and provide content according to personal criteria allows the reduction of such uncertainty, thus increasing the average value per piece of content supplied. One example of exploring the context personalization attribute can be taking advantage of the location awareness of the user in order to supply location sensitive information, such as maps or advertisement from neighborhood shops.

v. **Context – Interactivity** Through enabling interactivity on content, a further step to reducing uncertainty in user valuation is achieved, since the user is presented with the ability to refine its interests through interactive selection. Interactivity features can also be employed in order to learn user preferences.

vi. **Accessibility and Availability** Even though information and content have been dematerialized into digital, it still needs to be a physical infrastructure for its delivery. The dominant enabler in this case is network access, whose main restriction are the high costs involved in providing high speed connectivity to geographically disperse and possibly moving recipients.

vii. **Reliability and Fidelity** – These aspects are included to account for the need of integrity of the quality and significance of the content being provided. In the context of delivery of content over the internet, network quality of service mechanisms are needed to assure integrity of real-time media. Also, given the openness of such environment, certification and watermarking methods are employed in order to assure the corroboration of the information and protect producer's property rights.
The attributes are summarized in the following table, along with their most determinant content lifecycle players and technology enablers:

<table>
<thead>
<tr>
<th>Content Attribute</th>
<th>Determinant Player</th>
<th>Technology Enabler</th>
<th>Technology Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIVERSITY</strong></td>
<td>Content Creator</td>
<td>Digital Editing</td>
<td>Microsoft Office</td>
</tr>
<tr>
<td></td>
<td>Content Broker</td>
<td>Desktop Processing</td>
<td>IP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internet Connectivity</td>
<td>Optical Storage</td>
</tr>
<tr>
<td><strong>RICHNESS</strong></td>
<td>Content Creator</td>
<td>Multimedia Data</td>
<td>MPEG</td>
</tr>
<tr>
<td></td>
<td>(whole system has to support)</td>
<td>Multimedia Terminals</td>
<td>PCs, Nokia phones, Set-top boxes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Data Compression</td>
<td>JPEG</td>
</tr>
<tr>
<td><strong>CONTEXT</strong></td>
<td>Content Publisher</td>
<td>Content Management Tools</td>
<td>Macromedia</td>
</tr>
<tr>
<td><strong>(Timeliness)</strong></td>
<td>Content Packager</td>
<td>Search Engines</td>
<td>Google</td>
</tr>
<tr>
<td><strong>CONTEXT</strong></td>
<td>Content Publisher</td>
<td>Metadata</td>
<td>XML and MPEG7</td>
</tr>
<tr>
<td><strong>(Personalisation)</strong></td>
<td></td>
<td>Content Repurposing</td>
<td>XSLT Transformations</td>
</tr>
<tr>
<td><strong>CONTEXT</strong></td>
<td>Content Publisher</td>
<td>Hypertext and Links</td>
<td>HTML, Netscape</td>
</tr>
<tr>
<td><strong>(Interactivity)</strong></td>
<td></td>
<td>Script Languages</td>
<td>Java, ASP</td>
</tr>
<tr>
<td><strong>ACCESSIBILITY</strong></td>
<td>Delivery</td>
<td>Access Networks</td>
<td>3G, ADSL</td>
</tr>
<tr>
<td>and <strong>AVAILABILITY</strong></td>
<td></td>
<td>Storage Standards</td>
<td>Peer to Peer, Distributed Storage</td>
</tr>
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<td></td>
<td></td>
<td>Network Scalability</td>
<td>W3C Standards, PDF</td>
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<tr>
<td></td>
<td>Whole System</td>
<td>Encryption</td>
<td>Watermarks and Certificates</td>
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<tr>
<td></td>
<td></td>
<td>QoS</td>
<td>ATM, CDNs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Digital Encoding and Reproduction</td>
<td></td>
</tr>
</tbody>
</table>

Table 1  Enhancing Content Attributes, Determinant Players and Technology Enablers

The content provision process has achieved fair maturity in some stages with the deployment of most of the aforementioned attributes. These factors have contributed to a state of rich, diverse and timely presentation of media. However, other attributes particularly in the delivery process can be pointed out as far from being fully explored, as follows:

Accessibility is still somewhat limited to stationary access. A first step to providing mobile content was performed by 2.5 generation wireless companies, such as NTT Docomo i-mode. Although lacking richness due to terminal and bandwidth restrictions, i-mode gave evidence of the importance in improving this content characteristic. Despite such indication, the replication of similar initiative still faces reluctance from investors and operators in other countries outside Japan, due to caution over the balance between potential market size possibilities and service costs.

Rich content (i.e., in the form of audio and video) has been traditionally offered through terrestrial and satellite delivery platforms. Yet, these delivery platforms are restricted in diversity because they are limited number of broadcasters due to the high spectrum license fees and/or significant infrastructure investments (e.g. CATV networks). For this reason, higher content diversity could be achieved once rich content delivery is enabled on the Internet. At the present, attempts to deliver rich content on the Internet are being increasingly
performed, but deficiencies on network reliability and scalability issues prevent its commercial exploration. The implementation of Internet network appliances such as CDN (Content Delivery Networks) coupled with streaming media technologies intends to compensate for the lack of QoS on the Internet and to increase scalability; whereby enabling the delivery of rich multimedia content.

2.5. State of the Internet wireless market

Regardless of the technologies that drive the market, most analysts agree that the global wireless market will increase tremendously as a result of Internet wireless access directed at mobile transactional and content delivery services. Ovum predicts that the number of wireless users will be around 484 million by the end of 2005 [6]. Similarly, the market analysis company IDC forecasts 1 billion worldwide wireless users by the end of 2004. The IDC also foresees that the handheld devices market will consist of 89 million devices and be worth approximately $18 US billion by the end of 2004, having surpassed the PCs market valuation in 2002 [6]. As to wireless Internet users, a report from Computer Industry Almanac estimated that by the end of 2001, 16 percent of worldwide Internet users accessed the Internet via a wireless device. A large contribution to this figure is derived from the high penetration of wireless Internet subscribers in Asia-Pacific countries - mainly Japan & South Korea - as a result of the notorious success of second generation packet-based wireless technologies. Table 2 resumes the number of wireless internet users as a percentage of the total number of Internet users in the main regions where mobile Internet access has been offered.

<table>
<thead>
<tr>
<th>Region</th>
<th>Year-end 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worldwide</td>
<td></td>
</tr>
<tr>
<td>Internet users (millions)</td>
<td>149</td>
</tr>
<tr>
<td>Wireless Internet user share</td>
<td>4.5%</td>
</tr>
<tr>
<td>U.S.</td>
<td></td>
</tr>
<tr>
<td>Internet users (millions)</td>
<td>533</td>
</tr>
<tr>
<td>Wireless Internet user share</td>
<td>16%</td>
</tr>
<tr>
<td>Asia-Pacific</td>
<td></td>
</tr>
<tr>
<td>Internet users (millions)</td>
<td>115</td>
</tr>
<tr>
<td>Wireless Internet user share</td>
<td>34.8%</td>
</tr>
<tr>
<td>Western Europe</td>
<td></td>
</tr>
<tr>
<td>Internet users (millions)</td>
<td>126</td>
</tr>
<tr>
<td>Wireless Internet user share</td>
<td>13.9%</td>
</tr>
</tbody>
</table>

Table 2 Wireless Internet users penetration as percentage of absolute Internet users.

The commercial implementation of wireless Internet access systems has been based on three major wireless network standards:
Wireless Network Standard | Commercial wireless Internet access systems | Description
--- | --- | ---
GSM | WAP implementations (2G Services; e.g. WAP T-Mobile) | WAP implementations use a page description language called WML (Wireless Markup language). European implementations operate over a circuit-switched network, whereby users need to dial-up in order to connect. Generally, data transmission rates are symmetric involving 9.6 kbit/s for uplink and downlink. WAP implementations over circuit-switched networks have only been used for the delivery of text-based content. Websites for WAP-based services in a WAP specific page description language, which has deterred the rapid proliferation of WAP-based applications and content. WAP in Europe has mainly been marketed to business.

Packet switched PDC / GPRS | i-mode (2.5 Services; e.g. NTT DoCoMo i-mode) | i-mode use a page description language called chtml. It operates over a packet-switched radio communication network overlaid onto the NTT DoCoMo Network (Personal Digital Communication; PDC). This technology permits an acceptable data transmission rate at a reasonable cost. Although the transmission rate is only 9.6 kbit/s downlink, it is sufficient for most current needs as the content is mostly text and still images. In addition, the terminal is always connected and ready to receive data. Websites for i-mode are very similar to html based Internet websites, whereby promoting the rapid proliferation of content sites. i-mode has been mainly marketed to ordinary consumers.

UMTS | FOMA (3G Services; e.g. NTT DoCoMo FOMA) | NTT DoCoMo's FOMA (Freedom of Multimedia Access) accounts for the first commercial implementation of 3G services recently introduced by the end of 2001. It operates on a dual-mode, packet- or circuit-based depending on whether the application is non-real time or real-time, respectively. FOMA's high-speed data communications based on W-CDMA technology allows asymmetrical transmission rates with uplink speeds up to 64 Kbit/s and downlink speeds up to 384 kbps. Following this, for packet-switched connections downlink speeds up to 384 kbit/s are available, whereas for circuit-switched downlink speeds up to 64 kbit/s are being offered for large volume-data. FOMA includes the i-mode service with enhanced data transmission rates, whereby apart from text-based and still image-based content, video and audio content is enabled for delivery. As a result, the content development process for FOMA is likely to be performed on the same basis as for i-mode. Some of the applications that FOMA includes are videoconferencing, video-phone, mobile radio, mobile TV and video mail among others.

Table 3  Major commercial implementations for wireless Internet access

Analysts claim that one of the reasons for the overwhelming take-up of i-mode’s success, as opposed to WAP implementations, relies on i-mode’s flexible and straightforward content development environment, which can easily enable numerous content websites.
3. Business View

3.1. Groundwork on Internet business model methodologies

Business models have recently been broadly used, especially in the domain of Internet business ideas. However, rarely has a precise definition given of what is exactly meant by using Internet business models, in spite of being extensively used during the period of Internet explosion. This is one of the reasons why the concept of business modelling has been discredited and is not widely accepted anymore.

Whereas in the industrial age business models were based on clear sequential supplier-driven value schemes, Internet business models suggest the introduction of more complex networked value systems. In this regard, the business model concept is an interesting tool for understanding, designing, measuring and even simulating business ideas before any implementation takes place on the Internet. Rather than being a simple depiction of actors, relations and processes within a social system, a business model describes the logic of business interactions required for creating the value that lies behind the actual business processes. In other words, as explained by Osterwalder, Lagha and Pigneur [10], “a business model relates to the conceptual and architectural implementation of a business strategy that lies as the foundation for putting business processes into practice”.

In our opinion, the understanding and use of Internet business models is crucial in reacting and deciding in an increasingly dynamic and uncertain Internet business environment. For this reason, in this section a brief review of existent Internet business modelling approaches is offered with the aim of identifying a comprehensive framework for stating Internet business models.

3.1.1. Three views of Internet business models

This section contains an overview of important Internet business model literature as investigated over the last five years. This review has been structured considering three perspectives that are founded on product/revenue aspects, business actor and network considerations and marketing specific issues.

i. **Product/revenue aspects.** This approach provides a general description an Internet business idea rather than an explanation of the elements that build up the correspondent Internet business model. Some authors characterize Internet business models according to the position a company takes along the value chain. This position dictates how a company captures revenues in relation to the nature of its value proposition. According to Rappa [11] (2001) enterprises can adopt one of the following
nine generic forms of Internet business models: brokerage, advertising, infomediary, merchant, manufacturer, affiliate, community, subscription and utility. Tapscott, Ticoll and Lowy [12] (2000) provide an alternative approach by typifying five generic Internet business models for companies (agoras, aggregations, value chains, alliances and distribution networks), which are classified according to their degree of value integration (from self-organising to hierarchical) and their degree of control of the value creation process (low/high).

ii. **Business actor and network aspects.** This perspective suggests that an Internet business model consists of the adopted company's role(s) in a value system architecture for a product or service, including a description of the various business actors and their roles, as well as an explanation of their potential benefits and prospective sources of revenue. Timmers [13] (1998) pioneered this classification scheme when defining electronic business models and categorized eleven generic Internet business models for enterprises according to their degree of innovation and their functional integration. Similarly, Gordjin and Akkemars [14] (2001) provide a quite thorough actor-oriented methodology for Internet business modelling, which focuses on a generic value-centred framework. This approach is proven as highly descriptive and useful for the representation and understanding of value flows between the several actors of a value network. Finally, Amit and Zott [15] (2001) offer a vastly network-centred approach, which describes an Internet business model as an architectural configuration of a network of firms, suppliers, complementors and customers producing value through transactions designed to exploit business opportunities.

iii. **Marketing specific aspects.** The main contribution of this business modelling perspective consists of providing a view of the overall picture of a firm. On the one hand, Hamel [16] (2000) identifies in his business model methodology four main business model components that range from core strategy, strategic resources over value network to customer interface. These business model components are interrelated and can be further decomposed into different sub-elements in order to detail more particular company practices. On the other hand, Weill and Vitale [17] provide a systematic analysis of eight so-called atomic Internet business models that are examined according to their strategic objectives, value proposition, sources of revenue and critical success factors. In place of only focusing on value, these approaches also outline the different customer segments, distribution channels and IT-infrastructure; thus these frameworks are treated from a marketing standpoint.
3.2. Value analysis for assessing Internet business ideas

Many innovative business ideas over the Internet are subject to ambiguities and are hardly understood by stakeholders when expressed just by simple words. For this reason, the use of a formal framework for assessing business ideas in a short time window is of paramount importance. According to [14], a rigorous framework for developing Internet business ideas from their conception to their implementation must comprise the following three distinct viewpoints: the business value viewpoint, which focuses on the way economic value is created, exchanged and consumed in a multi-network; the business process viewpoint, which indicates a way to put the value viewpoint in operation in terms of business processes and the information system viewpoint, which focuses on the development of the information systems that enable and support the business processes. With regard to these three viewpoints, common engineering analysis tools are generally related to either process or information systems modelling techniques (e.g. UML), which are not aware of the concept of economic value and, therefore, are not suitable for the representation of the value exchanged in a multi-party network of stakeholders. This section aims at identifying a formal methodology for describing the value created from an Internet business idea based on the extensive review on business modelling literature discussed in the previous section.

3.2.1. Value analysis requirements

An analysis seen from a value perspective typically describes companies and end-users as actors whose goal is to create profit or to obtain products or services which are of economic value for them. For this reason, the main requirement expressions that a methodology for value analysis should include are:

- Business actors involved.
- Objects of economic value created, exchanged and consumed by these actors.
- The economic reciprocity of value objects, that is, what an actor expects in return for an object of value delivered.
- The events that cause exchange of value objects between actors.
- Bundles of value objects being offered and requested. Bundling assumes that some objects are only requested in combination, since an actor may consider that two or more objects can be sold at a higher price when being sold in combination rather than being sold separately.
- The value-creating or adding activities performed by each actor. This allows identifying who actor is doing what and, therefore, who is making profit with what.
g) The prospective partnerships between actors in the value network in case they decide to offer something of value together in their environment.

h) Possibility to sense potential profits for actors involved, or in case of end-users utility levels.

In addition to including the above mentioned points, a value analysis framework should permit a graphical representation that allows illustrating these points distinguishably from each other. In this sense, a standardised notation for representing graphically Internet business ideas is of great importance to prevent misinterpretations.

3.2.2. Existing ways for specifying value graphically

In the initial phase of representing Internet business ideas, two approaches that are less informal than natural language and have a graphical representation were widely used: the value chain approach introduced by Porter & Millar [18] and the value maps presented by Tapscott [12]. The former method divides a company's practices into the distinct value activities that it performs to do business. This model follows a sequential flow, in which value objects enter a company as costs. Then the company's business is regarded as profitable when the output value it creates exceeds the cost of performing the value activities required. Furthermore, by aggregating all the actors involved in a particular industry, the value chain shows the sequence of the value-adding process from the manufacturer to the consumer. However, this way of representing economic value loses power in expressiveness, since it does not necessarily show who exchanges value objects with whom and does not recognize the notion of economic value reciprocity. Moreover, this model lacks of some of the above mentioned requirement expressions, such as giving indication of bundling of services, appointing economic value to an object and communicating potential partnerships among stakeholders.

Some of these limitations are overcome by the value maps approach proposed by Tapscott. As mentioned in section 3.1.1, value maps provide a means for graphically modelling value systems, which in Tapscott’s terminology are also called b-webs. Typically, a value map shows actors and exchanges of goods, services, revenues and intangible benefits. However, neither economic reciprocity nor bundles of value objects nor partnerships of actors can be illustrated using this modelling approach.

3.2.3. The e3-value framework and service scenario techniques

Since none of the value modelling techniques explained in the previous subsection embodies the expressiveness required to clearly conceptualize and evaluate business ideas over the Internet, research was done on recent economic value modelling proposals. From the review
on existing business modelling literature (included in section 3.1.1), we believe that Gorjin and Akkemars [14] extend the reach of traditional value modelling techniques in their $e^3$-value methodology. The $e^3$-value methodology represents a highly comprehensive methodology that reveals clearly new value propositions and abides fully by the representation guidelines before mentioned. In simple words, from the notion of economic value, it represents explicitly and graphically how value objects are created, exchanged and consumed in a multi-actor network.

The $e^3$-value methodology, as its name suggests, follows a three-phase process in modelling the economic value of a business over the Internet. Firstly, it conceptualizes graphically a framework comprising all the stakeholders and their relations from an overview perspective in order to hide complexity. Secondly, it displays the value exchanges among the various players in the value system needed for the provisioning of a final electronic product or service. Thirdly, it intends to map value exchanges into economic value with the aim to identify cost structures and appropriate pricing schemes that guarantee assured profit margins and utility for all the stakeholders involved. Additionally, the $e^3$-value methodology also permits assessing numerous scenarios by doing sensitivity analysis on future events such as increasing competition, price erosion, etc. that may influence the sustainability of the e-business idea. Next, a summary of the most important concepts when modelling $e^3$-value systems is given [19]:

| i. Actor | An actor is modelled within a value system as an independent economic entity. Actors are expected to make profit or increase their utility within a value system. When this condition is fulfilled for all the actors, the business model for an Internet business idea is considered to be sustainable. |
| ii. Value object | Actors exchange value objects, which can be either tangible or intangible, and thus can represent services, products, money or even consumer experiences. A value object is generally of value for one or more actors. |
| iii. Value port | By means of a value port an actor can show to its environment that it wants to provide or request value objects. |
| iv. Value interface | A value interface clusters individual value ports that make up a particular value activity. The exchange of value objects is atomic is at the level of the value interface. |
| v. Composite actor | A composite actor consists of a partnership of actors that may decide to work together in offering jointly value objects for providing a particular service. Generally, a single value interface is used by a composite actor for supplying jointly value objects to its environment. |
vi. **Value exchange.** A value exchange connects two value ports with each other. The economic reciprocity concept is exhibited by the value exchange, as it shows how an actor is willing to exchange a value object in return for another one through its ports.

vii. **Market segment.** A market segment refers to a concept that breaks a market into groups of actor entities that share common properties, which are termed segments. Moreover, a set of actors representing a market segment will value objects equally from an economic perspective.

The concepts above only permit to identify pairs of players who want to do business with each other. However, they communicate no sign of all value exchanges required to satisfy a specific end-consumer need. To this purpose, the e³-value framework employs service scenario techniques, called Use Case Maps (UCMs), which network the value exchanges that should occur as a result of either a consumer’s need or other value exchanges. Below, the main UCM modelling constructs are briefly discussed.

i. **Service scenario path (SSP).** A service scenario path indicates all the value exchanges via their corresponding value interfaces that take place in the provisioning of a service. A path consists of one or more segments sketched along the value network, which are related by connection elements, start and stop stimuli.

ii. **Stimulus.** A service scenario path starts with a start stimulus which represents a consumer need and is connected to the first segment of the SSP. Correspondingly a SSP is finished by connecting a stop stimulus to the last segment(s)

iii. **Segment.** A service scenario path is composed of one or more segments. Segments serve to relate value interfaces with each other, to explicitly show that a value exchange is taking place between two players.

iv. **Connection.** Connections are used to either merge or split segments composing a SSP. Connectors in the form of ANDs and ORs are used. An AND fork splits a SSP into two or more sub-paths, whereas an AND join combines sub-paths into a single path. Similarly, an OR join merges two or more sub-paths into one path while an OR fork designates that the continuation of a SSP can chosen from multiple alternatives.
3.3. Case Study: Value Model for Wireless Internet Content Delivery – 3G Foma and i-mode

3.3.1. Conception of the value model

The aim of this case study is to analyse the set of business relationships composing the structure of NTT Docomo i-mode offering. The value framework was found appropriate in order to express the many particularities, as differentiation between Official and Non-official sites, billing relationships and advertisement restrictions. A complete content provision lifecycle was included in the model, so as to account for the many possible interactions between other players interested, such as corporate companies which use portals to provide customer surround service, or their advertising relations with content creators and packagers. Additionally, in October 2001 an important additional service was introduced in i-mode offerings so as to provide broadband wireless access, being the first commercial implementation of 3G network services. FOMA (Freedom of Mobile Access), as the service is named, was also included in the analysis, as delivery option for users to access the set of content offered within i-mode.

Following the methodology proposed by the e-3 value framework, a first step is to identify actual service scenarios are by using fragments of the original Internet business idea which refer to products or services wanted by a consumer or end-user. By examining the common set of associated with the provision of content as it is understood in the scope of this work, the following scenarios were identified:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Official Content</td>
<td>Content enjoyed through official sites, with no advertisement content from corporate companies</td>
</tr>
<tr>
<td>2</td>
<td>Non-Official Content (Embedded Ads)</td>
<td>Content enjoyed through non-official sites, with embedded advertisement inserted at the content packager</td>
</tr>
<tr>
<td>3</td>
<td>Corporate Costumer Surround</td>
<td>Customer surround content enjoyed at corporate portals through non-official sites</td>
</tr>
<tr>
<td>4</td>
<td>Non-Official Content (Portal Ads)</td>
<td>Content enjoyed through non-official sites, with advertisement content inseted at the stage of publishing (e.g. banners)</td>
</tr>
</tbody>
</table>

The next step is related to identifying actors, which are to be named by their role in the value network. Thereafter, value objects and ports are to be identified for the commercial relationships among the players with the purpose of clustering value offerings into bundles and indicating their value exchanges.

Finally, once all players and value exchanges have been recognized, value ports belonging to the same value exchange are grouped into more complex value interfaces, as
described in the e³-value methodology [19], with the aim to simplify commercial relationships and interfaces between stakeholders. For the proposed study, application of the e³-value methodology yielded the value model depicted in Figure 6.

Figure 6  Proposed Value Model Network Actors and Interfaces for Wireless Content Services

As a first general impression of the outcome, it should be noted the diversity of interactions that resulted on the end-users and official and non-official portals. End-users maintain relations with the access provider, official and non-official sites, as well as corporate companies interested in extending their reach through internet presence. Official sites are the central point of convergence between end-users, ISP and wireless access providers, corporate companies and the remaining content lifecycle players. The actors composing the value network and services scenarios will be addressed in their context within i-mode specific structure in next sections.
One-time relationships not directly associated with continuous usage of the service, such as terminal retailers and network infrastructure providers, are not included in the representation for simplicity, however their influence is taken in account at the economic case study analysis.

3.3.2. Description of players and value exchanges

Next, a description of the actors and value exchanges composing the proposed model for i-mode and FOMA service analysis is given.

a) NTT Docomo Composite Actor. Is the consortium that initiated and devised the service platform, and the one which integrates customer relationship. It performs the main activities of wireless access, primary internet service provision and content billing for official sites. The composition of actors and activities as displayed enhanced the aspects of vertical integration. Apart from the explicit service related value activities next explained, it provides terminal retailing and maintains non-value exchange relationships with content providers and terminal manufacturers. With the content providers, the most significant interactions are the supervision on the level of content diversity, quality and prices, as well as the definition of technological standards for their applications. With terminal manufacturers, it acts by specifying requirements for mobile handset R&D and levels of production.

a.1) Narrowband Wireless Internet Access Activity Accounts for the first wireless data service offered, employing 2.5G PDC 9.6kbps packet access technology. Used mostly for text access and still images. It interfaces directly with the end-user and the service is charged on a data-volume basis, through measurement of the number of packet delivered.

a.2) Broadband 3G Wireless Internet Access Activity. Represents the FOMA service, introduced in October 2001. With different classes of services, it provides access to real time media charged on a time usage basis, directed to streaming of audio and video (64Kbps circuit switched data). Non-real time transmission, charged on a per data volume mode is used for accessing graphical web pages as well as background file and e-mail transmissions (up to 384Kbps packet switched data). A price differentiation depending scheme depending on quantity is applied for packet charges, where lower upfront payment fees have higher per data volume prices (full plan transcription is included in Appendix 0).

a.3) Billing and Gatekeeper Activity Provides outsource billing for content official sites. In exchange, a percentage of content subscription the final subscription fees (9%) is demanded. This activity can be considered as a key feature implemented for i-mode, since the facility to charge end-users for content acted as a significant incentive to attract
content providers to the platform. Through unified billing with the wireless access accounts, the need to register consumer information profiles for each content service was avoided. The small amount usually charged in content fees would otherwise render many initiatives impractical, as a result of the relatively high transaction cost components in alternative systems. The security and reputation of Docomo provided additional approval of this configuration from the point of view of the customer.

b) Content Publisher – Official Sites – represent the sites under Docomo supervision. Official sites are the primary content interface experienced by the end user. They have their content controlled by i-mode policies in order to assure diversity and quality. No adult content and social networking or links to other sites is allowed, as official content sites are used by Docomo for the promotion of its own service platform. In exchange of having to abide to such policies, a prominent position of being easily accessible by i-mode menu is granted. More importantly, the unified billing facility with Docomo system and customer database provides a convenient low cost charging platform. Advertisements were restricted at first, (no connection to corporate companies in the value model), however after combined pressure arguing on their business sustainability, the restriction was relaxed. Subscription charging prices are also subject to Docomo approval, ranging from 10¥ to 300¥ (approximately 0.1€ to 3€).

d) Content Publisher – Non-Official Sites – Non official sites account for all the content offerings that are not regulated by Docomo policies. They can explore different advertisement possibilities, and provide adult and social network content. Such nature of content, although avoided by Docomo because of the risk of to their reputation, can provide opportunities for high profits in some market segments. Non-official sites also enjoy higher flexibility in their modes of charging, being allowed to set their own prices and charge on a per-usage basis. However, the lack of a billing relation with Docomo puts a significant operational hindrance on their suitability for extracting payments, as they have to recur to 3rd party providers. With that in view, the possibilities and difficulties are similar to the ones faced by plain fixed-line internet models.

e) Corporate Companies. For this value model, corporate companies account for profit-maximizing companies that have adopted business strategies over the Internet. Their Internet strategies are basically focused on two primary value activities: costumer surround and product promotion. By getting launched a Website, corporate companies enable additional service surround features to consumers, which can be reflected both in operational savings and customer base retention. Post-sale service support, product information and availability information are example of activities that found great application on the internet as complements to physical world offerings. Secondly, a company can promote its products and services by inserting advertisements in typical content-only services. Different schemes processes have been devised for such purposes, such a direct advertisement on official/non-official sites (e.g banners), or
publicity being embedded in the content by the content packager (e.g. online newspapers). Both alternatives are and are explored through different service scenarios in the following section.

f) End-User. End-users cause start stimulus when they wish to access mobile content services. In order to access mobile content, at least two exchanges have to be maintained: wireless delivery (charged on a per-usage basis) and content access to wireless portals. The former can be enjoyed via one of two possible value ports, either through the narrowband 2.5G access or through 3G broadband access via the FOMA service offering. Content exchanges are performed with official portals (subscription fees are required), or with non-official sites, for which no special charging scheme is defined (might be per-usage, subscription fees, free access, or paid indirectly in the form of advertisement exposition). End users also interface with corporate companies, for which another two value exchanges are defined. The first represents the customer surround activities offered by the companies, through which users can enjoy higher general service convenience by accessing their portals, for example checking the status of delivery of a package, or obtaining information about their services (e.g. address of a restaurant, sample catalogues). The second interface accounts for the relations of direct m-commerce or promotion through advertisements, for which the end-user responds with consuming their goods or services. Lastly, the joint effect of both wireless access and content charges being necessary for wireless the wireless content is the main subject of the economic case study analysis.

g) Third Party Billing - This activity is added for completion and accounts for alternative mechanisms of charging for content, which have to be accessed by non-official sites desiring to establish a commercial relation with the end-user. Amongst the most common methods are pre-paid cards and credit cards. With pre-paid cards, the user buys a card with a unique 16-digit identification number for a sum ranging between 20 and 100 000 yen [20]. Credit Cards charges are performed in the traditional way its done over the internet, although for initial i-mode offerings the lack of the secure socket layer implementation on mobile handset applications has accounted for a major security barrier.

g) Content Creator. The content creator refers to the entity that authors and produces the first instance of the value object that is consumed by the end-user and reflected in terms of utility. In the proposed value model shown in Figure 6, the content creator receives a fee from the content packager for the syndication of its content. This consists of granting other companies with the rights of disseminating that content globally [21]. In return, the content creator gives pieces of content, which still are perceived in the industry as raw and timely info.

h) Content Packager. A content packager captures content from a variety of sources and categorizes it given desired consumer and distribution channels criteria. The content packager adds value to the content by performing three main functions: ensuring that the content
ready for retail by testing it against QoS statutes; contextualizing content by aggregating it into packages targeted to particular market segments and making content available through standard formats. For example, a TV channel aggregates programs of similar characteristics and fits them into standard formats so as to target them to a specific audience. For the suggested value model, the content packager receives a contextualization fee from the content broker, which alternatively could be paid directly by the content distributor, and provides in return theme-specific content bundles. The content packager can also exchange value with corporate companies, in the form of fees for embedding corporate advertising information in its content packages.

i) Content Broker. A content broker brings together content from a variety of content sources and frees content distributors from having to find and negotiate with dozens or hundreds of content originators (packagers or creators) to get the desired content. A content broker adds value to the content lifecycle by providing a single point of sale and purchase between content distributors and originators. For the study in subject, the content broker business model lies in obtaining commission fees for canalizing adequate content sources to content distributors, which are represented by Internet portals in this industry.

h) Internet Service Provider (ISP). In this context, the term ISP accounts for local, national and global networks providers that offer Internet access and connectivity. It interfaces both Docomo and with official and non-official sites, as it provides the means for their interconnection to the i-mode wireless service gateway. ISPs must also be accessed by the remaining players across the content lifecycle for a more efficient and timely content provision process. However this interaction is omitted for the sake of simplicity, as it represents more of a process condition than an actual form of value exchange influencing final services to the user.

3.3.3. Value-based service scenarios for wireless content access

Players in the aforementioned value model can either perform or not play a role depending on the service in subject. By following a service scenario path, it can be seen which actors have to exchange value objects in reaction to a start stimulus, as described in section 3.2.3. The four most descriptive scenarios of content services performed through i-mode are described next.
Scenario 1 (Figure 7) - Official sites with content subscription.

The first scenario depicts the interactions that have to take place when a customer accesses an i-mode official website. The service stimulus starts at the end-user. As it can be seen by following the scenario paths, two parallel activities must be maintained in order for the customer to enjoy the service. One accounts for the per-usage charged exchange for wireless access (narrowband or broadband), while the complementary represents the content subscription payments made to the official websites.

The value exchange between Docomo and the official sites represents the 9% billing commitment incurred when the gatekeeper detects access to official sites. The scenario path is joined at the official site activity, coming from the wireless access activities through the billing commission port and from the end-user content subscription port. Form the official portals it is split in two additional paths. One represents official site’s bandwidth spending with ISPs, while the other accounts for the remaining content lifecycle process. Examples for this service are official, games, entertainment guides as required by the Docomo content portfolio policy requirements. The effect of the combined charges on the user will be the subject of the economics case study.

Scenario 2\(^1\) (Figure 8) – Customer convenience – Non official sites.

Physical world companies take advantage of lower costs of internet channels for performing customer surround service. After-sales service (tracking a package) and online banking are common examples, which provide more convenient services with permanent availability (24hours x 7days functionality). Additional features facilitated through mobility can be used for increasing customer satisfaction and retaining customer base. Restaurant and Travel reservations are examples of applications, where users could access services.

On the diagram, three scenarios paths are generated at the end-user, one for wireless access, one for non-official sites hosting corporate portals, and one representing the direct relation of customer support between companies and end-users. The later value exchange is often non-monetary, as companies tend to use this feature in order to obtain competitive advantage for their physical-world services. As this scenario intends to depict straight relation with end-user and corporate portal customer surround services, no interaction with the remaining content lifecycle actors is shown. The path between non-official sites and 3\(^{rd}\) party billing is shown for completeness, as often this type of activity won’t require payments for content access.

\(^1\) On scenarios 2, 3 and 4, only access through broadband access is displayed for simplicity, as the intention is to explore the differences in the content lifecycle. Access through narrowband could be easily represented through addition of an OR path from the end-user.
Scenarios 3 (Figure 9) and 4 (Figure 10) - Non-official content with advertisement

Scenarios 3 and 4 explore the content delivery alternatives where advertisement represents a portion of the income earned by the portals (in this case non-official sites) providing the content service. The advertisement-related path is generated at the end-user and passes through the "promotion" activity of corporate companies. The value exchange taking place can be understood as many end-users giving a probability of buying the products or services being advertised in turn of some users actually buying the goods. This path continues through different ways (depending on scenarios 3 or 4) and finishes at the non-official sites, representing the fees corporate companies must pay to have their advertisements published. Scenario 3 accounts for the case promotional information is embedded in the content by the content packager actor, while in Scenario 4 corporate companies interact directly with the portal for placing their advertisements (e.g. banners).

A concurrent path starts from the user to non-official sites access and consists of the exchange of subsidised or “free” (i.e. not paid in monetary terms) content from non-official portals in exchange of being exposed to non-requested content in the form of advertisements. A common practice employed by content providers to increase sources of income is providing both free and premium content in through the application of pricing differentiation techniques. In this case, the free version is funded by advertisements, and the premium version is often paid for, but either provides additional content features or reduces the level of advertisements. By applying this technique, portals can capture a higher fraction of the surplus in the market, since users placing a high valuation on the service being offered will be willing to pay for the service, at the same time that the greater majority of customers with not so high valuation is still offered the choice of accessing part of the content at a lower price. The general concepts of price differentiation techniques are addressed in section 4.4.4.

The third parallel scenario path accounts for the value exchange relating to wireless access service, and has interesting effects for this case. As users have to pay on a per-usage basis for each piece of the content they receive through the wireless delivery interface, advertisements imply additional costs on the user, apart from the inconvenience of being exposed to them. This characteristic can be extracted from the AND relation between the content subscription path and the wireless access delivery path, which suggests the import effect of complementarity between the two part of the service. As it will be touched on the economics section, complementarity has an important effect: the decrease in attractiveness of one complement can interfere on the demand for the other. In this example, the higher price of delivery in wireless (per usage) is likely to lower the demand for advertisement affected content.
Service: i-mode and FOMA
Non-official sites
Subsidised content with built in advertisements
by Cassiano O. Becker UCL 2002

Figure 9  UCM Service Scenario for i-mode FOMA non-official sites embedded advertisement on content

[C Becker 2002]
Figure 10  UCM Service Scenarios for companies advertising directly with portals

Service: i-mode and FOMA
Non-official sites
Advertisements included
by the portals

by Cassiano O. Becker UCL 2002
3.3.4. Overview of Docomo i-mode Strategy

On a broader view, by analysing the strategic marketing instruments employed by Docomo for i-mode, the following important aspects should be pointed out:

- NTT Docomo performs the customer relationship function not only for the wireless access services, but also for terminal retailing and billing of official content services. Therefore, customers are provided with the increased convenience of a single point of contact.

- NTT Docomo also controls which terminals are available and can be used for the service, what functions as a mechanism of assuring their quality standard and appropriateness for the content applications.

- NTT Docomo further influenced the creation of content for the platform by generating and quickly specifying its technical standards. The hypertext language (cHTML), the i-mode wireless application protocol (corresponding to WAP), and later a standard Java application development environment (i-appli) were all required. Although the i-mode protocol turned out not compatible with WAP, discussions for the specification of the latter were still taking place at the service implementation time.

Besides the fully integrated activities on terminal retailing, wireless access and mobile ISP, Docomo i-mode has developed further strategic ties with terminal manufacturers and content providers, which are performed in a quasi-integration method. Quasi-integration can be understood as a form of close cooperation throughout the value chain, which avoids some of the costs of full vertical integration. As a result of a study conducted by Devine and Holmqvist [20], the following actions were pointed out as composing Docomo quasi-integration policy:

<table>
<thead>
<tr>
<th>Action</th>
<th>With Actor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlling terminal manufacturing through handset specification and R&amp;D guidelines</td>
<td>Terminal Manufacturers</td>
</tr>
<tr>
<td>Controlling what type and price of content is made available.</td>
<td>Content Publishers (Official Sites)</td>
</tr>
<tr>
<td>Provide standard technical specification platform (e.g i-appli Java)</td>
<td>Content Publishers</td>
</tr>
<tr>
<td>Providing Billing for Official Sites and prominent position at the menu</td>
<td>Content Publishers (Official Sites)</td>
</tr>
</tbody>
</table>

Table 5  Docomo quasi-integration interactions with other actors

The reason for such interactions can be understood and if the high complementarity characteristic of the products needed in order for the user to enjoy the service is observed. Mobile handsets, wireless data access and high quality content are necessary for a good wireless content service experience. If the provision of one of the complementary components is impaired
by lack of availability, high prices or low quality, the demand and success of the other two is put under strain. On the other hand, if one component is made more attractive to the user, demand for the others will be increased. Therefore, even though complements are provided by different suppliers as a result of their different core capabilities, partial collaboration agreements will often be beneficial and raise the attractiveness of the whole platform.

Possibly the most determinant action has been the billing interaction with official sites. By providing a suitable platform for content providers to charge for their service, they encouraged a high number of content providers to join the platform. With rich content available, Docomo made the complementary content offering attractive, and could advantage of the revenue generated from increase in mobile traffic.

As to the reproduction such experience in other countries, two factors can be pointed out as environment reasons that contributed for its success of the i-mode offering:

- Low fixed internet access infrastructure penetration, available at expensive tariffs
- High commuting times and level of social life drivers for mobile usage
- NTT Docomo didn’t suffer initial burden of high spectrum license fees
- NTT Docomo market dominance (market share of 55% [20]) and pioneering position on wireless internet, which allowed it to enforce standards and requirements across suppliers

Nevertheless, the lessons learned from its strategy for providing the incentives and conditions to attract content and application providers must be considered as highly instructive, since such barriers are likely to be a ubiquitous and determinant issue for the uptake of future 3G services.
4. Economic Aspects

The following sections address the main economic concepts later employed at the case study. Notions of costing methods, pricing mechanisms, consumer preferences and bundling strategies are explored with a focus on information industry applications.

4.1. Economics of Information Technology

According to Varian [26], information technology has substantially changed the influences of the major drivers in the current economy. Forces that were relatively minor in the industrial economy turned out to be critical in the so-called information technology. This can be clearly demonstrated by characterizing cost structures in the two types of economy. For example, goods in the industrial economy are commonly characterized by high marginal costs in proportion to the involved fixed costs. This is due to the fact that physical goods incur a fabrication cost that is relative to the resources used and the capacity of the production process. On the contrary, information goods follow a cost structure that is characterized by a constant level of fixed costs and almost zero marginal costs. This cost behaviour is not only applicable to the information industry but to any other high technology industry, in which the production process implies a significant upfront cost for the conception and first functional copy of a good and further replicas can be produced at a negligible marginal cost. For example, a piece of software or a chip fabrication plant can cost several billion euros to construct and outfit; but producing an incremental chip or software copy in a CD only costs a few euros.

Another important characteristic of the commercialization of information goods is that it allows for a fine-grained observation and analysis of consumer behaviour. This permits various ways to commercialize goods and services that were previously extremely difficult to carry out, at least on a large scale. In other words, the ability to use more effective price discrimination methods is possible in the information economy. In this sense, the Internet allows for the facility to offer highly personalized products that can be sold at a highly personalized price. A seller can more easily offer differentiated prices for digital products over the Internet, based on individual preferences and product characteristics than in physical delivery. This can be partly explained by the fact that the Internet enables the possibility to condition prices based on consumer purchase history. This is also possible because Internet retailers revise their prices much more often than conventional retailers, whereby prices are adjusted in much finer increments. A brief revision of price discrimination methods is to be exhibited in section 4.4.4.

The Internet marketplace raises special interest in adopting bundling practices for the sale of information goods. According to Varian [26], bundling refers to “the practice of selling two or more distinct goods together for a single price”. He claims that bundling practices are
predominantly attractive for information goods as the production cost of assembling a bundle of these goods can be zero, i.e. the marginal cost of adding an extra good to a bundle is negligible. However, we consider that while the cost of creating a bundle of information goods can be negligible, the cost of delivering it over the Internet might not be the same case. This is an issue that will be further analysed in the form of a case study. The economic implications of bundling information goods will be discussed in more detail later on in section 4.5.

A final important economic effect occurring particularly in high tech industries including telecommunications is the one of network externalities. Network externalities occur when the value of a product or service to a consumer will depend on the number of other consumers using the same good. A classic example is the one of a fax machine, where its utility increases directly with the number of other users owning compatible units. This has important consequences shaping marketing and commercialisation strategies for such products, where companies need to firstly create attractive conditions for their initial adoption. The inter-dependence between individual valuation and existing market penetration of a product is felt as a non linear demand curve, where the product faces a very low demand at lower quantities. Therefore, to reach the minimum number of users where the product platform starts being attractive to the general market, companies usually apply marketing strategies such as low penetration prices or periods of free evaluation. A similar behaviour exists in service platforms with different suppliers, and is referred to as indirect network effects, chicken-and-egg problems or platform markets. They occur when different components are necessary for the consumer to enjoy a product or service (complements), but are supplied by different producers. The demand for one component will dependent on the supply (price or quantity) of the other, while the supply of the latter depends on the demand for the first. One example is the adoption of DVDs, where the attractiveness and demand for DVD players is dependent on the number of compatible DVD titles, while the offer of the latter is dependent on number of DVDs purchased in the market. A similar effect is expected in the adoption of 3G terminals and subscribers. Their demand will be dependent on the number and quality of content applications, while the application providers and providers are expected to be create applications to the extent that there is adoption to the platform.

![Non linear demand curve resulting from network externalities](image)

* For high prices, there is no point of equilibrium, as demand for product is also low at small quantities
* As supply price is lowered, two market equilibrium points appear.
* Since the lower demand point is unstable, market quantities converge to the point of higher demand quantities

![Figure 11](image)
4.2. Cost Structures

4.2.1. Principal costing terms and concepts

While the characteristics of content and internet delivery heavily influence the structure of costs when compared to traditional industries, the nature of costs is still kept the same, for which the fundamental concepts and terms are developed below.

i. Fixed costs – cost incurred that do not vary as a volume of production. These are typically associated with spending on infrastructure or underlying platforms necessary for the provision of a service. A specific type of fixed cost is sunk costs, costs that cannot be changed or avoided by ceasing production entirely. For instance, a head office building is a fixed cost, whereas installation of the copper wire in the local loop is a sunk cost.

\[ FC = \Phi \]

ii. Variable costs – are costs that vary with the volume of production. For example, energy costs, wages from employees under production related contracts, raw material inputs and transaction costs.

\[ VC = VC(n) \]

A further important notion regarding the differentiation between fixed and variable costs is related to the time horizon over which they are interpreted (short-run or long-run). Short-run is defined as the period during which one of the factors of production cannot be altered if an increase or decrease in production is necessary. For example, it is easier to alter the level personnel necessary for a higher production if a higher level of output is desired. However, infrastructure factors cannot be changed freely as a result of demand variations. If the larger time-scale is considered though, new production infrastructure can always be constructed, therefore it is said all costs can be considered as variable on a long run horizon.

iii. Total costs – cost that refers to the aggregated amount of all costs incurred in producing a specified volume of output. The sum of fixed and variable costs equals total cost.

\[ TC(n) = FC(n) + VC(n) \]

iv. Average costs – are cost calculated on a per-unit of production basis, therefore being more informative for pricing decisions and costs analyses. If decomposed into the fixed cost and variable costs contribution, it is seen that the fixed cost component will tend to fall as output increases. For industries where the fixed cost component is very significant, this effect is the main reason for their drive to produce higher quantities of outputs, as the resulting average total cost will tend to fall to the variable cost component. With that view, different industries can be classified according to their minimum efficiency scale of production (MES), which is their typical minimum level of output for which the fixed cost influence has fallen enough so as to allow for a constant average production costs

\[ AC(n) = \frac{TC(n)}{n} = \frac{\Phi}{n} + \frac{VC(n)}{n} \]

v. Marginal costs – the change in the total costs resulting from producing an extra unit in the volume of output. Due to the fact that marginal costs are difficult to estimate, these are commonly interpreted as incremental costs, which equal the total cost assuming the increment is produced minus the total cost assuming the increment is not produced.
Marginal costs are extremely useful and are often the variable the producer observes in order to make its pricing decisions, as they provide information on the behaviour of costs for varying units of output. Generally it could be said that while marginal costs are following, there would be an incentive for the producer to increase its output, however under monopoly situations, other market incentives become important. A summary of most common pricing techniques is presented in section 4.4.1.

Another important concept to be derived from the behaviour of marginal costs is the one of Economies of Scale (EoS), or returns to scale. It is said that one production process presents returns to scale if it generates decreasing average costs for increasing levels of output. Therefore, the occurrence of high fixed costs is in itself a source of economies of scale. Firms under a cost structure that presents EoS find an incentive to produce high levels of output. Such effect is also considered as a source of barriers of entry for new competitors.

For an illustration, a general cost function is proposed next, where the behaviour of variable costs is varied through the inclusion of an exponent $\gamma$ in order to account for different configurations of economies ($0 < \gamma < 1$) or diseconomies of scale ($\gamma > 1$).

\[
(6) \quad VC(n) = \beta \cdot n^\gamma
\]

then marginal costs can be calculated and expressed as:

\[
(7) \quad MC(n) = \frac{\partial}{\partial n} \beta \cdot n^\gamma = \gamma \cdot \beta \cdot n^{\gamma-1}
\]

Both $VC(n)$ and $MC(n)$ are graphed for various values of $\gamma$ (EoS factor) and the their behaviour with increasing quantity (cost volume relationship) can be observed.

![Normalized Variable Costs](image1)

![Normalized Marginal Costs](image2)

Figure 12 Normalized variable and marginal cost-volume relationships for different EoS factors
4.2.2. Cost allocation approaches for telecommunications services

The practice of determining costs in the telecommunications industry is often complex and controversial. This complexity is mainly driven by different cost approaches, concepts definitions, interpretations and data sources. Nevertheless, a thorough cost analysis is of crucial importance when setting optimal retail service prices (i.e. for consumers) and wholesale service prices (i.e. for competitors or resellers). Next, a brief revision of telecommunication costing approaches is given based on The World Bank’s Telecommunications Regulation Handbook [27] with the purpose to serve as a theoretical framework for the cost-based service pricing considerations to be discussed in a case study:

i. Historical cost approaches.

These approaches generally involve the compilation and analysis of accounting and other historical data and include two main methods. The former is Fully Distributed Cost (FDC), also referred to as Fully Allocated Cost (FAC). FDC does not define a rigorous way of distributing common costs. It commonly focuses on groups of services rather than on individual services and thus its challenge is how to allocate common and joint costs (i.e., a cost incurred when a production process yields two or more services) to specific categories of services in a group. Cost allocation per service category is generally achieved by formulas that reflect relative usage. For instance, if network access lines in an exchange are utilized 30% for international calls, 20% for national long-distance calls and 50% for local calls, the FDC method allocates costs accordingly. The second method refers to Embedded Direct Analysis (EDA), which unlike FDC only assign those costs that can be directly traced to a particular service category. In this way, an EDA method does not assign joint and common costs typically leaving them as cost to be accounted independently from service categories. One criticism to these approaches is that services can be cost inefficiently in the case in which outdated technology or unproductive labour and/or management practices are used.

ii. Forward-looking cost approaches

These approaches generally involve the formulation of engineering-economics models, which aim at estimating the costs of providing services based on the costs of network elements assuming the use of current technology. In other words, these methodologies calculate the relevant cost of providing an incremental output measured from a defined starting point that would be incurred, taking a long term horizon where all costs can be varied. These approaches, as opposed historical cost approaches, assume that operating and capital costs will be incurred efficiently. There are two main methods that follow this approach: Total Service Long Run Incremental Cost (TSLRIC) and Total-Element Long-Run Incremental Cost (TELRIC). The former calculates the difference in cost between provisioning the entire service or not provisioning it in the long term. The latter measures the incremental cost resulting from adding or subtracting a
specific network element in the long run. Because common and joint costs are not included in any of these two costing methods, mark-ups are required to recover their correspondent portion. In this respect, LRAIC (Long Run Average Incremental Cost) is a special form of TSLRIC, adopted by the European Commission, which intends to capture the total cost of producing a service including the service-specific fixed costs (usually left out in TSLRIC).

4.3. Modelling Consumer Preferences

As seen in section 4.1, one of the main characteristics of information economics is that the marginal costs (cost of producing an additional unit of output) are very small compared to the figure of fixed costs, where the former tend to zero in some situations. This implies that the common approaches of mark-up pricing and marginal pricing (to be explained in section 4.4), which take marginal costs as their principal determinant, should be avoided. Focus on pricing has to be shifted then to estimating the valuation consumers place on goods so as to define optimum pricing strategies.

4.3.1. Utility Functions Approach

As defined by Varian [28] – “A utility function is a way of assigning a number to every possible consumption bundle such that more-preferred bundles get assigned a large number than less-preferred bundles”. Bundles in this case refer to different combinations of quantities of ordinary products. Initially, utility functions were described simply in terms of the quantities of goods. However, this approach is applicable only for goods that tend to be undifferentiated, such as the situation where the consumer has to decide between the relative amount of potatoes \(x_1\) and bread \(x_2\). Here, utility increases directly with the quantity of potatoes and bread, and given their relative prices and its budget restriction, the consumer chooses the quantities of both so as to get the maximum utility from the combination of the two goods. For example, in this case, where bread and potatoes can be interpreted as substitutes, their utility can be modelled by:

\[
U_1(x_1) = a x_1 \quad U_2(x_2) = b x_2
\]

Defining utilities for each good is the starting point for obtaining important economic conclusions depending on the assumptions and variables including in their models, and is often the approach taken by economists. Direct results following from this approach include the determination of ideal relative quantities between two products given a budget constraint, and individual or aggregated demand functions for varying unit prices. From these, and if a cost structure for varying quantities is obtainable, pricing approaches can be recommended. Following these, the determination of the prices and quantities to maximize revenue can be obtained, and the overall marketing efficiency for that point (social welfare function) can be evaluated. Some of
these concepts are going to be explored in the following sections, but for more information on their methods, the literature is abundant and the reader is directed to the references Business Economics - Cook [7] and Intermediate Microeconomics – Varian [28].

Further developing on utility functions, Lancaster (1969) in his approach included the concept of product attributes, and proposed that for differentiated products, the utility perceived by the consumer is directly influenced by the attributes they embody. This is applicable to markets where product or service differentiation is possible, and implies that they are fundamentally perceived and evaluated by the consumer as the composition of their valuations of their characteristics, such as style, durability, customer service, and the like. For example, in the case of modelling the valuation a consumer is likely to have for choosing a pair of shoes, one of the components might be suggested as the durability in months he understands it is going to present. The utility function under this approach can be generally represented as:

\[ U(\beta, X) = \beta \cdot X \]

where the vector X represents the quantification of the different attributes, and the vector \( \beta \) the relative coefficients with which they contribute to the overall utility. Price can be included as one of the attributes, generally with a negative unit coefficient, when the utility function is expressed in monetary terms. The utility function with price put in evidence can be then expressed as:

\[ U(\beta, X, P) = \beta \cdot X - P \]

For many products, however, the amounts the consumer must decide on varies in integer steps, and in some cases is even not likely to exceed one unit (e.g. purchasing a car or watching a certain film). This implies that the utility functions be described in discrete terms, and requires a modified modelling approach. In this case, the first term of the above equation (\( \beta \cdot X \)) is interpreted as the consumer’s reservation price, which captures the monetary value perceived by consumer, also referred to as its valuation. In the absence of close substitutes, it is assumed that the utility she gets from not buying is null. This approach leads to the consumer purchasing the unit under evaluation if her reservation price is greater the actual price charged for the good, i.e., the utility he or she gets by buying the good is greater than zero, and greater than the one they get by not buying.

Next, an example is developed by the authors for the case of the SMS service against the utility of calling. One general utility function is defined for each service, and their relative utilities and disutilities are included to allow for a comparison:

\[ U_{SMS} = \beta_{communicating} - P_{SMS} - \delta_{unreliability} - \delta_{typing} \]
$U_{\text{calling}} = \beta_{\text{communicating}} - P_{\text{calling}} + \delta_{\text{interaction}}$

$B_{\text{communicating}}$ is the objective of using either service and is defined as the inherent value the user places on having his message conveyed to the recipient (letting him or her know what he needs to), and is the same for both cases.

$P_{\text{SMS}}$ and $P_{\text{calling}}$ are the respective prices charged for using each service.

$\delta_{\text{unreliability}}$ is the valuation placed on the inconvenience incurred by the use of SMS of not knowing on time whether the recipient has read the message. Since this is normally a negative value, it is commonly referred to as a disutility.

$\delta_{\text{typing}}$ represents the inconvenience of having to type the message, and is influenced by the quality of the mobile terminals used.

$\delta_{\text{interaction}}$ represents the value the user places on the real time interaction with the recipient, and can be either positive (for a person the user enjoys talking to), or negative, for the case where the user would rather not directly interact with.

The user then will choose the SMS service if:

$$U_{\text{SMS}} > U_{\text{calling}}$$

and defining the price difference between the two services:

$$\Delta P_{\text{SMS to calling}} \overset{\text{def}}{=} P_{\text{SMS}} - P_{\text{calling}}$$

Developing the sides, and canceling the inherent value $\beta$ (was made independent of the service for this purpose) the user will choose using SMS over calling when:

$$\Delta P_{\text{SMS to calling}} < \delta_{\text{unreliability}} + \delta_{\text{typing}} + \delta_{\text{interaction}}$$

As a remark, the parameter $\delta_{\text{unreliability}}$ should be expanded and have included a weighing probability to take into account the occasions when a calling attempt is made and the recipient is busy or unavailable, assuming the caller would leave a voice message. In this case, the calling service implies the same unreliability as the SMS service and the factor should be then reduced to $(1 - P_{\text{recipient=busy}}) \cdot \delta_{\text{unreliability}}$

$$\Delta P_{\text{SMS to calling}} < (1 - P_{\text{recipient=busy}}) \cdot \delta_{\text{unreliability}} + \delta_{\text{typing}} + \delta_{\text{interaction}}$$

The result implies that the consumer will choose to use the SMS service when the difference in price compensates for his valuations for the relative disutilities resulting from the
unreliability, inconvenience from having to type and reaction towards the lack of interaction. The service provider then has the opportunity to act either on the price of the service or on minimizing the relative disutilities to encourage the use of the service, and the expression (16) provides a structured way of representing the problem.

Apart from the basic applications of formalizing service characteristics, utility functions are increasingly being employed to express the dependency of consumer valuations on otherwise exogenous variables, in order to account for the externality effects, as in the hardware compatibility and telecommunications connections examples. Including such externalities in the utility functions definitions can lead to important conclusions when these are further developed to evaluate more general results (e.g., maximum revenue points), as done in Oz Shy [22].

4.3.2. Uncertainty in Utilities

Utilities in the symbolic form above presented are very useful as a starting point for obtaining theoretical results, if further economics analysis methods such as profit maximization are applied. Utility functions can also be used for estimating actual consumer valuations, providing useful information for pricing and market segmentation studies. In order to allow for the heterogeneity and own valuation uncertainty naturally presented by consumers, an uncertainty component has to be included in the general Lancaster utility function form. The utility function in this case is transformed in a random variable, and is referred to as a Random Utility Function.

\[ U_i = V_i + \epsilon_i = \beta_i X_i + \epsilon_i \]

Additional methods have been defined to estimate values for the \( \beta \) coefficients according to the attributes under analysis, and can provide concrete approximations for terms of the utility functions. These are fundamentally statistical methods, being the two of greater use Revealed Preferences and Stated Preferences. Revealed preferences relies on the analysis of existing demand data from past market records and uses them as an indicative to recover the preferences manifested by consumers. However, this method is heavily dependent on the availability of valid data and can seldom be tailored to provide information on specific attributes of interest.

The Stated Preferences method, on the other hand, consists of extracting information from interviewee’s responses to hypothetical choice questionnaires, which are tailored to elicit the influence of the specific attributes of interest. Results are obtained by presenting users with questions where they have to elect between various sets of alternatives (which include service and price differences), and through later analyzing the correlation between the intensity of preferences stated (answers are declared in a range of intensities). However, caution has to be taken with common problems both when designing the questionnaire and determining the results. On questionnaire design, a concern is the risk of biased responses, where respondents might be
inclined to provide deliberately low valuation answers expecting to profit from lower pricings in future offering. On the analysis of results, care must be taken on assessing the heterogeneity presented by the valuations, as average results with high standard deviations might be of little application.

Good examples of applications of these techniques can be found in two reports available commissioned by the UK Radiocommunications Agency [29] and [30]. The first addresses the valuation consumers have for different options of terrestrial and satellite TV and Radio broadcast packages. The second addresses the available consumer surplus for different alternatives and user profiles for cellular and pager communications.

4.4. Pricing

In addition to outlining traditional pricing techniques, this section will examine some of the economic consequences that result from the ability to use more effective price discrimination methods.

4.4.1. Traditional pricing techniques

i. Marginal-cost pricing

Marginal pricing is based on the principle of profit-maximization. This pricing approach is generally employed under monopoly or collusive oligopoly (i.e., cartels) conditions with the aim of locating the price that maximizes profits for an offered product or service. Marginal pricing accounts for a formalized pricing technique that takes as input the demand, cost and revenue functions of a product or service and situates the optimal production level at the point where marginal costs equalize marginal revenues. Following this, the profit-maximization price is derived by reflecting the optimal production level on the demand curve, as shown in Figure 13. A common criticism against marginal pricing is that, due to the lack of competition, it sets artificially high monopolistic prices. This implicates that only a limited quantity of the product is offered on the market, since the profit-maximizing production level is set below the one seen under competitive conditions. However, marginal pricing is regarded as a highly valuable and accurate pricing technique by companies trying to sense the most profitable price level for an offered product or service.

ii. Mark-up pricing

Mark-up pricing, also called cost-plus pricing, accounts for a less rigorous and more practical pricing technique than marginal-cost pricing. It consists of setting the price of a product or service in order to cover all direct costs plus a percentage mark-up as a contribution pointed at gross profits. This pricing technique describes the sequence of activities that a company needs to
effectuate with the intention of determining a lucrative price for a product or service. First, a firm estimates its total costs (fixed and variable) per unit for producing an item for a standard level of production. Typically, this analysis is simplified by focusing on estimating an average for variable costs. On top of these variable costs, the firm adds an assessment of the overhead costs incurred in the production of the product. Generally, this overhead charge is approximated as a percentage of the average variable costs. The result of these calculations provides the firm with an estimated sum for its average variable costs. Finally, on top of these costs a margin is added for gross profit purposes resulting in the desired price, as described in Figure 13. It is worth mentioning that the extent of freedom to which the firm can set its markup can be dictated by demand conditions, the level of competition in the marketplace or regulatory stipulations. Since mark-up pricing is based on average variable costs rather than the interaction of marginal revenue and costs; the former is not regarded as accurate as the latter method. Nonetheless, mark-up pricing accounts for one of the most common approaches in setting prices.

![Marginal-cost and mark-up pricing implications under economies of scale.](image)

**4.4.2. Ramsey pricing**

Ramsey pricing accounts for a thorough mark-up pricing technique that is mainly used for regulating prices in products and services offered under monopoly conditions. Ramsey prices may also be referred to as Ramsey mark-ups. It aims at minimizing the social welfare losses (i.e., the reductions in quantity purchased compared to the quantities that would be bought at prices determined under perfect competition) induced by the practise of marginal-cost pricing. The general principle is that prices are raised above marginal costs more for products or services with a lower elasticity of demand and less for those with higher elasticity, as shown in Figure 14. In other words, the products or services with the least price-sensitive demand should have the highest prices relative to their marginal costs. In doing so, Ramsey prices will result in welfare improvements relative to alternate pricing measures. However, in order to apply Ramsey prices in

![Figure 13  Marginal-cost and mark-up pricing implications under economies of scale.](image)
an exact manner, regulators require a great deal of information, given that they face two challenges: determine the elasticity of the demand for distinct services and identify accurately the costs of providing these.

![Graphs illustrating Ramsey pricing and perfect competition](image)

Figure 14 Ramsey pricing implications compared to pricing under perfect competition.

4.4.3. Value-based pricing

This form of pricing technique allows an organization to charge for its products or services according to what customers are willing to pay for them. The consumer willingness to pay is not always uniform for all goods or services, as this depends on the individual’s utility placed on a certain good or service. As a result, the effectiveness of this pricing technique is highly reliant on estimates of consumer valuations determined by means of market research. A fundamental condition in adopting this pricing technique is that a producer be a monopolist or have significant market power, as well as the demand for a good or service be considerably inelastic. By using this pricing technique a producer is empowered to capture a noteworthy part of the entire consumer surplus from the consuming public.

4.4.4. Price discrimination

Price discrimination is usually practiced by a monopolist, or a group of organizations acting together as a monopolist would. As suggested by Parkin and King [7] price discrimination can be defined as “an attempt to capture the consumer surplus (or as much of the surplus as possible) for itself”, that is, to charge as closely as possible to each individual consumer’s preferred price for a product or service in order to capture the highest consumer surplus. Typically, there are three categories that indicate the level on which firms are able successfully to discriminate on price:

1. **First degree price discrimination.** This level describes the most extreme case, in which each customer pays a different, individual price determined by their highest willingness to pay for it. Similarly, this theory can also be seen as firms charging the highest price they can to each customer, capturing the entire consumer surplus. For goods and services delivered over the
Internet, this degree of price discrimination allows for the concept known as “mass customization” or “personalization”, in which highly customized information products can be sold at a highly personalized price. For example, consumers can personalize their front page at several on-line newspapers and portals. In doing so, service providers are in the position to trace consumer behavior and produce offers on that basis. However, this pricing method has not been so far put into practice on the Internet as it has not been fully accredited.

ii. Second degree price discrimination. This approach consists of discriminating on price following product differentiation aspects. The idea is that sellers design a product based on a broad range of consumer preferences in order to make it appealing to different market segments. This form of price discrimination is widely used. Other ways to call this type of price discrimination are: product line or versioning pricing. Product line pricing is commonly employed in the manufacturing industry, whereas is broadly adopted in the information goods industry. For example, newspapers are available on-line and in physical form; software is sold in multiple versions and still through Internet a time-dependent information versioning has been adopted by charging fees for real-time stock quotes or offering them for free after a 20 minutes delay. This type of price discrimination is imperfect because the producer does not necessarily capture the entire consumer surplus, as there will be consumers who maintain their surplus by choosing the most economic choice.

iii. Third degree price discrimination. Third degree price discrimination refers to selling at different prices to different groups of people, but every unit of a good sold to a given group is sold at the same price. This is the most common form of price discrimination and includes more than one set of price discrimination criteria. Typically, this approach involves market segmentation on a consumer-type and/or consumption-time/date basis. Examples of this might be student discounts at the movies or telephone charges based on the type of customer the time of the day and/or day of the week. A challenging issue in third degree price discrimination is related to determining the optimal price to charge for each market segment.

One good example of how this form of price discrimination is applied in telecommunication markets is the different rates charged between residential and businesses telephone connections and usage rates, which are applied for essentially the same product (telephone service). By differentiating the prices for the two different targets, the telecommunications provider can take advantage of the higher willingness to pay presented with higher prices, while still capturing the surplus from residential markets through lower fees.
4.5. Bundles of digital information goods

The importance of bundling from the producer’s perspective is that on the supply side, bundling can result in significant cost savings due to the presence of economies of scale, whereas on the demand side, bundling can be used as an effective tool for extracting consumer surplus. Moreover bundling techniques serve as a means to reduce dispersion (uncertainty) in consumer valuation on a group of goods or services. The effectiveness of bundling, from the consumer’s standpoint, lies in the fact that it allows someone to pay less than if she/he had purchased the individual goods separately. There are three major types of bundling strategies according to Adams and Yellen [31]:

- Pure Unbundling – when goods are only sold individually.
- Pure Bundling – when the consumer can only purchase a bundle of goods or nothing.
- Mixed Bundling – when the consumer has the choice to either buy the bundle or buy goods of interest individually.

![Bundling strategies for different consumer choices on a two-good bundle model](image)

The figure above shows a two-good valuation space, where the bundling and unbundling prices, as well as different consumer valuation possibilities are be represented for an initial analysis. The valuation of each consumer for the pair of goods is represented as point in the $w_1, w_2$ valuation space. The valuations $w_i$ here can be understood as the reservation prices $V_i$ as introduced in the utility functions section. Figure 15 (a) shows the case of pure unbundling, which requires that the valuation for each good be higher than its individual price for the consumer to buy them. “Alice”, because her valuation for good 1 is higher than the price charged, decides to purchase it. “Bob”, even though having positive valuations for both goods for which the sum is higher than any of the prices, does not buy any, for his individual valuation for each one is below each price. Figure (b) represents the case of pure bundling, where only a bundle with price $P_B$ is offered. Because $P_B$ is set higher than the price of individual goods, “Alice” chooses not to buy the bundle (and hence anything), since the sum of her valuations for goods 1 and 2 is lower than the price of the bundle. “Bob”, on the other hand, now decides on acquiring the bundle, since the
sum of its valuations is higher that the bundle price. Finally, figure (c) depicts the case of mixed bundle, where the pricing scheme is set to capture both opportunities. "Alice" then decides on buying only good 1, while "Bob" goes for the bundle.

As pointed out by Chuang [32], the best strategy to capture consumer surplus (i.e. providing a pricing / quantity situation where the maximum number of customer decides for buying) is heavily dependent on the distribution of his valuations for each good. On the side of the producer, it will be heavily dependent on their cost structure, and will determine the minimum increase in the bundle price necessary for recovering the expenses. For the case where the proportion of variable costs to fixed costs is high, it can be anticipated that the bundle price will be required to increase directly with the number of goods offered, and a pure bundling strategy is likely to exclude many selling opportunities. For the case of low marginal costs, on the other hand, the cost requirements for adding an additional unit to the bundle will be relatively low, and the producer will be free to set the price of the bundle in a way that maximizes the capture or consumers and hence its revenue. Chuang’s more formal model is further explained to quantify these effects.

Firstly, a method for modeling and formalizing the space of possible consumer valuations was proposed. This method consists of ranking from highest to lowest the relative valuations for individual goods, where the highest valued good is assigned valuation \( w_0 \). Successive valuations are ordered until the goods with zero valuation are reached, as depicted in Figure 16. Their rate of decrease is modeled by a straight line, reaching zero at the point \( kN \). The variable \( N \) refers to the total number of goods in the bundle, whereas \( k \) can represents the ratio of non-zero valuated relative to \( N \). The valuation of any individual good can be approximated by the equation:

\[
(18) \quad w(n) = \max \left\{ 0, w_0 \left[1 - \frac{1}{k} \left( \frac{n}{N} \right) \right] \right\}, \quad 0 \leq n \leq N - 1
\]

Figure 16 (b) shows possible configurations for these parameters, where extreme cases can be identified. On one side, very selective consumers (or product offerings) are characterized by high \( w_0 \) valuations, but low \( k \) coefficients. In contrast, homogeneous consumers or products should show intermediate \( w_0 \), but with high \( k \) values.
Consumer’s valuations distribution for individual goods can be then evaluated by these two descriptive variables. These can be then further specified for different types of goods and modeled as random variables. As the original study is focused on the provision of academic journals, it included a study of the distribution of consumer valuations for the case of bundle journal subscriptions. In figures, 40 per cent of the readers had a valuation greater than zero (used to read) no more than 5 (kN) out of the typical N of 80 to 100 units composing the bundle.

In order to specify the best pricing practices, the cost composition on the production side must also be evaluated. As stated by Chuang, given that if total revenue is greater than total costs, the optimal pricing decision is independent of FC, these can be treated as an exogenous variable. Under this assumption, the cost structure on the production side can be determined by relation between the marginal costs of the bundle (MCB) with respect to those of the individual component units (MCU), as expressed in the below expression.

\[ MCB = N^\gamma \times MCU \cdot \]

where \( \gamma \) accounts for economies and diseconomies of scale and N for the number of units in the bundle.

For \( \gamma = 1 \), no economies of scale are present, and the cost of the bundle is N times the cost of the individual goods. For \( \gamma < 1 \), EoS arise, and the total marginal cost of the bundle is less than N times the unit cost. For \( \gamma = 0 \), the extreme case, there cost of providing additional goods to the bundle is null. If cost the components are known, an approximate value for the EoS factor can be estimated as:
Practical results drawn from a case study in Academic Journal subscriptions over the Internet [32] show that for different conditions of EoS, mixed bundling is the dominant bundling strategy across all MC\_B levels and EoS conditions. These results also show that pure bundling does not necessarily dominate over pure unbundling, given that when MC\_U are non-zero, pure bundling is undesirable if there is absence of EoS or its degree of presence is too weak. These results are illustrated in the below figure, in which the vertical axis accounts for the degree of efficiency in which consumer surplus is captured (producer surplus) and the horizontal axis refers to the ratio between MC\_B and the maximum valuation (w\_0) of an individual component in the bundle.

Figure 17  Optimal bundling strategies under the presence or absence of EoS [32].

Figure (a) – No economies of scale. Mixed bundling or pure unbundling dominates
Figure (b) – Low EoS – same qualitative behaviour as with the case of no EoS
Figure (c) – Partial EoS- Pure unbundling is better for low marginal cost ratios, but is surpassed by pure bundling when the MC ratio increases
Figure (d) – Extreme EoS- Pure bundling dominates over the entire range.
To sum up, the choice of optimal bundling strategy and optimal pricing is affected by the MC\textsubscript{U} and presence of EoS on the supply side and the distribution and correlation of consumer valuations on the demand side. For this reason, by analyzing the cost structure and relationship to volume ($\gamma$), as well as the distribution and correlation of consumer valuations for the possibilities of bundle compositions, the producer will be able to identify the optimal bundling strategy to follow that allows him to capture more efficiently consumer surplus. The producer can also design different bundles to cover different market segments with the purpose to achieve higher correlation of consumer valuations on the bundled goods and, therefore, increase the attractiveness of its bundle offerings. However, the producer must bear in mind that a mixed bundling strategy is optimal for the cases where a single good in the bundle stock has an expected valuation substantially higher than the average of the rest. In this case, a pure bundling strategy might result in an inflated bundle price which could lead the producer to forgo some selling opportunities. A common example of a successful mixed bundling strategy is done in pay-per-view channels and television subscriptions, where special events or latest movie releases are sold separately.
4.6. Case Study: Economic Aspects on FOMA and i-mode service offerings

The following sections are directed towards evaluating the main economic costs and pricing drives behind the actors that directly interface with the end user. Why i-mode and FOMA are independent services and what is the joint effect the separate and per-usage charging models when compared to existing alternatives are the main issues to be analysed.

Reiterating from the business case study, the following issues have generally been pointed out as barriers for wireless internet service adoption:

- Convenience of terminal for accessing rich content
- Need of data-aware wireless network infrastructure (packet switched transmission)
- Availability of wireless tailored content that takes in account terminal limitations
- High costs of spectrum license fees
- Higher service costs arising from per-usage charging

While the first issues have been successfully tackled by the strategies developed for the i-mode service, the per-usage charging characteristic persists even in the recently launched 3G broadband service.
The focus of this case study is thus to investigate the reasons leading to and the effect of such charging schemes on the consumer, from an economic point of view. The approach takes as a basis for comparison the service of content delivery provided by fixed broadband alternatives. Technological aspects are developed only to the extent required to characterize their influence on economic effects, such as cost-volume relationships.

Figure 18 illustrates the scope of the case study, where the end-user and its two value interfaces are highlighted. As pointed out for different service scenarios in section 3.3.3, both value exchanges have to be maintained for the user to enjoy the service. The first interface interacts with wireless network provider for the delivery of content over wireless access, while the second interacts with official and non-official wireless content providers.

4.6.1. The Delivery Interface

The delivery interface is implemented in this case study by the FOMA service offering. As with telecommunication services, where external restrictions imposed by regulators and competition are internalized, these are likely to be priced following a cost based approach. For that reason, the main cost components and their behaviour are described next.

1) Network Costs - Spectrum Costs - 3G License Fees

Perhaps the cost of spectrum licenses can be seen as the main single cost contributor to the wireless network service, and in the cases where they has been assigned by upfront payment auctions, its influence is further aggravated by its fixed-cost nature. Fixed costs are problematic because there are many different ways with which they can be translated to prices, although no overall ideal method is unreservedly agreed. One allocation method example is the Ramsey method (addressed in section 4.4.2), which takes optimum social assignment as a directive. Fixed costs are often the main determinant for the long term continuance of the provider business, once the basic condition that price must be higher than marginal cost is fulfilled.

However, many methods are employed to assign spectrum slices. Formerly, licenses were distributed via beauty contests, where the regulating agency would use a mixed set of criteria (efficiency, past history, political influences) to allocate licenses to the “most deserving” contenders. As the potential revenue latent to the later 3G licenses was realised by governments, European regulatory bodies started changing the allocation method approach to the one of auctioning, with the understanding that such process would more efficiently explore the license value using the self-regulating market forces.

The most characteristic example of the upfront payment auctioning method has been the one performed in the UK, which raised unexpectedly high figures, and is recorded as the highest auction having taken place in history. The spectrum destined to 3G licenses was divided in 5
licenses in order to promote a reasonably competitive behaviour. Under such competitive scenario, it was assumed that firms would base their prices on the expectation of “forward” costs and profits, and consider license costs as sunk factors, thereby having no influence in the final consumer price. However different views with mathematical proofs have arisen to show that under a condition of imperfect information (e.g. the regulator not being able to fully determine the composition of firm costs), providers are likely to collude and pass on (include amortization of license as annual costs – at least the lowest common license amount) in order to achieve the return of investment expectations and support the pressure from shareholders (for continuance in the long term). A mathematical proof of this tendency can be found in Bennet [35]. As an additional consequence, and one that is not previewed under the sunk cost assignment assumption, is that the high spending would cause a delay on the start of the service implementation, while the providers would try to put off further spending due to their financial and funding limitations.

In practical terms, one of the strategies to recover initial fixed costs has been charging an initial one-time connection charge, allowing a better correspondence between cost causations. In the case of the European licenses allocated by upfront auctions, most notably the UK and Germany, this is likely not to be a complete solution, since the per capita spectrum fees alone surpass the amount of €500, which even if shared by the long period to which the licences are valid, are seemingly excessive.

Sensing these effects, many countries considered adopting the alternative of royalty auctions. This implies that fees should be paid as a fraction of the revenue when service is made available, what constitutes a lower initial cost incurrence, and therefore lower barriers to entry and to investment on infrastructure. A critique to the outcome achieved by upfront payment auction mechanisms can be found in Ure [34].

For the sake of this case study, NTT Docomo didn’t suffer the imposition of high costs for the licenses necessary to FOMA 3G service, and the spectrum was allocated without any application of fees [36]. While the strategy was viewed at first as under-optimized in terms of government capturing, it might on the other hand be understood as one of the determining reasons for the effectiveness and readiness with which Docomo started to deploy its infrastructure.

ii) Infrastructure and System Costs

Next, the mains cost components for wireless network infrastructure are considered. The references are extracted from a recent publication from Oftel 2002 [37], where cost components are broadly divided in traffic and non-traffic related. Their assignment follows the LRIC model, used for price regulation purposes The non-traffic related cost comprised the costs incurred by
the handling of customer processes (marketing, billing and customer surround) and the ones referred to as minimum coverage presence (MCP). The later, as put in the report “consist of the costs of a network management system and of acquiring, preparing and leasing the number of sites needed to meet the coverage requirements”

<table>
<thead>
<tr>
<th></th>
<th>900 operator (£m)</th>
<th>% split</th>
<th>1800 operator (£m)</th>
<th>% split</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic</td>
<td>1,606.6</td>
<td>96.2%</td>
<td>1,782.4</td>
<td>94.6%</td>
</tr>
<tr>
<td>Customers</td>
<td>8.5</td>
<td>0.5%</td>
<td>8.5</td>
<td>0.4%</td>
</tr>
<tr>
<td>MCP (common costs)</td>
<td>54.3</td>
<td>3.3%</td>
<td>92.4</td>
<td>4.9%</td>
</tr>
<tr>
<td>Total</td>
<td>1,669.3</td>
<td>100.0%</td>
<td>1,883.2</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Table 6  Cost causation for UK GSM operators 2005/2006 – source [37]

Table 7  Total cost components for UK GSM operators 2005/2006 – source [37]

The study pointed out that the traffic related costs (of variable nature) heavily dominate over non-traffic cost, being expected to be reduced to the figure of 3 to 5% in a forecast for 2005/2006, as traffic demand increases. Non-traffic generated costs can be assigned the nature of fixed costs, since they do not increase with higher service utilization. However, a higher
percentage of investment is actually necessary to establish initial operational coverage, as a result of the minimum modularity presented by base station equipment. In spite of that, this fraction of additional costs is included by the regulator as traffic related, under the concept of cost causation. As an additional observation, MCP costs are likely to have a higher influence in countries or regions with less dense population, since the ratio of coverage dedicated base stations to traffic related tends to be higher.

The dominant traffic related costs (non MCP) are expanded in Table 7 and their behaviour with increasing capacity demand will be analysed next.

![Figure 20](image)

Figure 20 depicts the behaviour of traffic related costs for mobile networks in through different definitions. The first graph shows total variable costs for increasing traffic, where the presence of modularity effects (resulting from minimum number of channels each wireless transceiver adds) is observed. Such effects are enhanced when the short-run incremental costs are evaluated, where it is seen that for a given base station, incremental costs will occur only at necessary upgrade points. The effects are smoothed if short run average costs are calculated, and for high traffic figures the lumpiness from modularity tends to disappear. Most importantly, when costs are evaluated in the long run, the effect of aggregation and spread-out due to depreciation further smoothes the behaviour of costs. The resulting figure of long run average costs present constant returns to scale, and is directly depend on the resulting average utilization.
of the installed capacity. For a full evaluation of network costs, good references are presented in [37] and [38].

One point to remark is that due to the fact that networks have to be dimensioned based on a peak traffic requirement for a minimum grade of service, average utilization will always be lower than the installed capacity at any given period greater than the usage cycle. Under this reasoning, the excess capacity installed occurring at typical lower usage periods could be seen as a source of short-run economies of scale, where more attractive pricing can be practiced.

On the other hand, by reasoning over the nature of wireless usage, it would be fair to expect a more equally distributed network traffic pattern throughout the day than the one of wireless voice calls. Wireless voice networks experience peak times during the morning and in the end of the afternoon as a result of its use for work and social appointments. These factors are not likely to be present with the same intensity in mobile wireless internet, given its very value propositions of mobility, availability and personal convenience, which might be translated as continuous but shorter session of use throughout the day.

On the practical network implementation aspects, the direct linear relationship between traffic capacity demand and network costs is allowed by the cell splitting and sectoring processes. This can be done in existing TDMA systems through the lowering the power and re-using the same subset of frequency channels of distant neighbouring cells. For future 3G implementations with the CDMA architecture, since each cell uses the whole frequency band and is differentiated by the sets of code of access, a better average utilisation can be achieved, as the trade-off between capacity and cell-size for each station can be able to be varied dynamically, according to traffic requirements.

![Figure 21](image)

Figure 21  Illustration of Cell Splitting Process to Increase Traffic Capacity

Another effect on 3G implementations will be that the ratio of necessary coverage cells will be higher, as a result of the higher UMTS carrier frequencies (free space attenuation increases with the square of frequency). This was already felt in the UK by the last two GSM
entrants, which had to operate on the 1800MHz range, where the non traffic-related coverage costs fraction were comparatively higher than for the two 900MHz licensed operators. While this represents a stronger initial burden that can be interpreted as fixed costs, it might also be seen to a limited extent as a source of EoS to initially allow for initial marketing penetration strategies.

For GSM networks deploying 2.5G data (GPRS or HSCD) in their existing infrastructure, the upfront investment impact as fixed costs is to some extent alleviated, since initial coverage is already available. The inclusion of data capability in such networks can be performed in an overlay fashion, insofar as the existing voice air interface capacity is sufficient.

Finally, mobile network costs when compared the fixed alternative present significant differences on their cost-volume relationships. For fibre optic data networks for example, the most significant cost component is the physical installation of the ducts, which is incurred independently of the level of traffic. Once new the cable with many fibres in installed, additional capacity can be obtained at much lower incremental costs by illuminating additional fibres and adding new wavelengths to the DWDM multiplexers. On the access through broadband cable, an even more extreme behaviour is found, as new users within a service area are added to the existing cable bus at almost insignificant costs. The presence of economies of scale to such a high degree in these services is the main factor to allow providers to charge for unlimited access, what finds approval from the consumer point of view. However, such charging schemes can be also understood as a consequent measure to encourage utilization of a structure enabled at the burden of high initial spending, which can nonetheless in the long term still force providers out of business due to high upfront investment debts. Put in general terms, the mobile wireless cost structure trades the need of incurring high physical network-construction related initial costs, for linearly capacity-dependent equipment variable costs.

Therefore, from a cost point of view, the absence of significant economies, as pointed out by the constant long-run average cost curves and by low initial fixed costs requirements, indicate that a per-usage charging model, instead of an unlimited flat rate model, should be indicated. Partial allowances for time-of-day flat rate charging could be useful as an incentive to achieve a higher utilization at off-peak periods, but that would dependent on the actual wireless data-traffic distribution. NTT Docomo FOMA actual service offering coincide with such view, however no off-peak allowances are encountered. The effects of such per-usage charging scheme on the consumer, as compared to the flat-rate fixed broadband competitors will be addressed in section 4.6.3

iii) Terminal Costs

As in many cases in the industry where network externalities are present, service providers need low entry barriers to encourage an initial number of users to reach the critical
mass, so that service adoption starts experiencing positive feedback. Terminal costs are perhaps the most significant individual barrier to entry (together with the engagement on long-term usage contracts). Therefore, a common strategy employed by providers is to subsidise terminal costs or provide subsequent compensation via service allowances. Also, as terminals can be seen as a complement to other elements enabling other services in the value chain, there is an incentive for vertical cooperative action between the players. This cooperation can take the form of mutual subsidies, where for example producers and the retailers renounce a portion of the profits during the period of critical mass build up.

For the case under study, wireless services are compared to fixed line substitutes (mostly PCs). If seen through a total cost of ownership perspective excluding the network service (which is the subject of the following sections), the remaining cost components of purchase, energy and software maintenance are likely to be comparatively advantageous for the wireless terminal. Also, it will be assumed that the wireless provider will have the optimum policy to the influence of terminal costs in service adoption and usage. For example, i-mode enabled terminals were offered at the same price as alternative mobile phones, so that new users wouldn’t face barriers for joining the service. The relative easiness with which terminal operations can be learnt and the personal appeal of owning a new mobile phone while it is still a novelty are further factors to lessen the barriers for consumer spending, as compared to the fixed counterparts.

In our understanding, the influence of terminal purchase costs, as they will be shared by a number of enabled applications, is bound to be less significant than the influence of the terminal characteristics themselves on the service adoption. Such influences are going to be built in on the model adopted in section 4.6.3, and are later specified on specific service examples (section 4.6.5).

4.6.2. The Content Interface

This section analyses some basic economic implications on the content interface and applies them to the characteristics observed in the i-mode offering. The aspects explored derive significantly on the concepts developed in the previous Costs and Bundling sections.

The content industry is characterized by high fixed costs, i.e. costs that are incurred regardless of the quantity of units sold. These are incurred mainly by the production, or purchase in the form of the property rights, of the pieces of information and content themselves. The main source of variable costs, on the other hand, is the costs of distributing the content pieces to the final user, what we refer in this work to as “delivery”. In the traditional physical sector, these costs have been predominantly caused by the reproduction and transportation of the bearer that conveys the information to users, for example the costs of printing and distributing books, or the cost of buying and transporting DVDs to the rental shop.
As it was seen in the business sections, the content provided through i-mode offerings is charged separately from the delivery interface. This has important implications shaping the pricing and the number of items being available, as it frees the content provider from the variable costs of distribution. The only direct charging relation between the portals (official and unofficial sites) is the billing commission, which is charged as a fixed percentage on subscription fees, and can be interpreted more as a tax loss than as a source of cost.

Therefore, given the occurrence of high economies of scale in the behaviour of content costs with the absence of the distribution component, appealing possibilities to attract users such as bundling and flat rate pricing can be explored. As it was studied in the bundling section, two basic conditions are necessary for a bundle offering to be profitable and attractive. From the point of view or the point the supplier, high economies of scale by providing additional goods when compared to the offering of a single unit have to be present. From the point of view of consumers, their valuation for the different units has to present a minimum degree of correlation.

The possibilities for bundling and charging flat rate according to their cost components can be summarised as in the figure below.

![Figure 22 Influence of content cost components](Image)

- Property Rights
- Storage
- Customisation*
- Delivery*
- Transactions Handling*

Number of Items Offered (bundling possibilities)

Number of Consumers (Per usage of subscription charges)

* Depending on the number of items actually consumed from the bundle < total number of items in the bundle

[C Becker 2002]
Storage Costs – Information presentable to wireless terminals is less dense than
information access through other means due to terminal and network bandwidth restrictions. Therefore, the corresponding necessary storage doesn’t represent a significant component when compared to other costs. Storage costs tend to be significant for higher resolution video or content provided with higher level of customisation.

Delivery Costs – the separation of content and transmission services in the i-mode offering frees content providers from incurring delivery-associated variable costs. This helps on enabling both flat rate subscriptions and bundling, what is perceive favourably by costumers. The only delivery-related costs incurred are the interconnections to the i-mode/FOMA gateway servers.

Transaction Costs – The occurrence of transaction costs is another incentive for subscription and bundled charges, since in such circumstance they are incurred only once, on a monthly basis. For official i-mode sites, transaction (billing) costs are paid as a percentage of each user’s revenue, and final service fees are charged for together with mobile services through Docomo’s billing system. Alternative micropayments systems are being increasingly considered, but current technological status is still unfavourable. These face the problem of high relative cost fractions per micropayment event, as well as double-sided platform adoption barriers (a minimum number providers and users must adopt the platform).

Development and Property Rights - Content usually has been created with a focus on being tailored to the delivery device. However, with tools for content repurposing and XSLT format transformations, economies of scope with other platforms can be enjoyed, where the same content can be commercialised through different delivery targets (fixed portals). For wireless-only produced or purchased content, their fixed cost relation with the number of users suggests a flat rate subscription charging approach, which is actually verified in i-mode official sites.

Customisation Costs – are manifested as variable costs with the increasing number of users and diversity of items being offered, and occur as a result of dedicated processing requirements. The development of the customisation enabling applications (software) has a fixed cost nature, and should be accounted for as Development and Property rights components. Customisation also has an effect on storage needs, as user profiles and content versions records often need to be kept.

From the cost point of view, there should be no necessary distinction between official and non-official site structures, apart from the 9% billing commission exchanged between official sites and Docomo. The most significant division arise from the nature of content policies imposed by Docomo on the official sites, whose consequences are analysed next.
**Official Sites** – Operator controls the content through evaluation of content portfolio. This can be understood as strategy to assure attractiveness and decrease uncertainty on the average valuation of a larger market share. Diverse offerings, as explored in section, are better explored by a bundling approach, through the charging of subscription fees. As a trade-off requirement for the reduction of uncertainty, content valuations are have their maximum practicable prices reduced, which is confirmed by the actual Docomo policies.

**Unofficial Sites** – Through making technology platform (mark-up languages and protocols) an open standard, Docomo allowed for greater of content diversity. The absence of restriction and policy control permits the exploration of more specific content topics so as to meet particular market segments, which are likely to be highly valued, but by a limited number of individuals. As explored in the bundling section, services with uncorrelated valuations are best explored by an unbundled strategy. Higher prices can be then used to capture higher user valuations. Because non official sites don’t suffer price cap restrictions from Docomo, they are able to explore this opportunity.

An additional effect felt in the content portals is the incentive to increase the number of goods in their bundle offerings so as to diminish uncertainty in different valuations. Thus, the more sources of content a portal has available, given their selection and layout is correctly managed, the higher the number of users and market share is likely to be attracted. This can be interpreted as source of economies of scale, which together with other sources of economies of scope (intellectual production, the same present in R&D), lead to a monopoly-like effect in the industry. On traditional fixed-internet content providers, this effect can be verified by the concentration of access rates to a small number of content providers (MSN, Yahoo, CNN, BBC). This leaves a small space for smaller providers, which have to concentrate on exploring highly focused type of content, seeking to attract fewer but higher margin customers. For wireless specific content though, the smaller display are and more limited navigation capabilities can have an opposing influence. Since the appreciable information density is likely to be lower, the number of items in the bundle will tend to be limited, therefore reducing the attractiveness of single large portals.
4.6.3. Joint effect on Consumer

The previous sections addressed the description of the cost components and charging models for each value interface individually. However, in order for the content services (e.g. as proposed in section 3.3.3) to be enjoyed, both the network delivery and content subscription services must be maintained simultaneously. The following is a proposition of a simple model based on microeconomic concepts, so as to analyse the joint effect on consumer usage for the different charging models present on the case study. The analysis employs the concepts of consumer preferences and utility functions introduced in section 4.3.

To begin with, the main elements composing the model are illustrated in Figure 23. The two interfaces that form the content service as faced by the end-user are represented as “Content” and “Delivery”. These components are assumed to be complements also under the economic point of view, since their both required in order for the consumer to have the combined final service of enjoying content over the internet. The same notion of complementarity is suggested by the service scenario path in section of business modelling, through the need of the AND fork joining the content and wireless exchanges.

The combined service is then expanded to two different options, which will be considered to be substitutes. By including the fixed delivery options (fixed dial up, broadband xDSL and broadband cable) as substitutes, the model attempts to account for the effects of existing service alternatives, what is expected to yield to conclusions on the new service usage and adoption rates. The analysis refers to the substitutes as PC for simplicity, but the results are directly extendable for similar terminals (TV set top boxes, video game consoles) and using broadband cable or xDSL access, since these are usually charged at flat rate tariffs, and their usage characteristics are satisfactorily similar as far as a comparison to the wireless alternative is concerned.

![Figure 23](image)
Because of the per usage charging characteristic of the wireless delivery plans, delivery will be treated as a continuous good, which means that the resulting utility is dependent on the quantity of service enjoyed, i.e., volume of data accessed from the network. For generality of the model, content services will be also considered as continuous. The complements characteristic can be understood by looking at the available content library, with the user only being able to derive utility from the composed service to the extent that the pieces of content are enjoyed through the delivery service.

As introduced in the “Utility Functions Approach” section, a simple form to represent the utility of a continuous good with respect to its quantity is to assume that the resulting utility function increases linearly with quantity. In the case of two goods being complements, their combined utility can be derived, and is defined as corresponding to the minimum value of the two individual complement utilities, as follows:

\[ U_c(q_{good1}, q_{good2}) = \min(\alpha q_{good1}, \beta q_{good2}) \]

This means that the total utility is restricted by the good with minimum quantity. The perfect physical example is the case of right and left foot shoes [28], where the increase in the quantity of one (say right foot) will not increase the resulting utility if the amount of the other good doesn’t follow. The constants “a” and “b” are included to allow for relative quantities, as is necessary for example in the case of the complements 1 cup of tea and 2 sugar spoons.

If content is offered on a subscription basis and charged at flat rate, it means that once the consumer is allowed access to the library, it can get unrestricted access to quantity. For simplicity, let’s assume it normally subscribes to large portal, where the library size is very large and constantly updated. In this case, the limiting factor in the complements equation would be the delivery part of it, and the resulting utility can be expressed as:

\[ U_c(q_{content}, q_{delivery}) = \beta q_{delivery} \]

which is a simple linear function of the quantity of content delivered, with the linear coefficient \( \beta \) being the per unit individual consumer valuation.

With this form of utility defined, the different substitute delivery options can be specified to proceed with the model. Because the competitor in this case is fixed access by means of flat rate dial up, broadband xDSL or broadband cable (with PC or other set top box terminals), it will be established as a basis for comparison, being expressed by:

\[ U_{PC} = \beta q_{PC} \]
with the subscript PC used for simplicity, but referring to the set of fixed access substitutes.

$q_{pc}$ is the quantity of data received at the terminal (in Bytes)

$\beta$ is the coefficient of utility valuation for that attribute

For the wireless delivery alternative we want to analyse, additional parameters are introduced, so as to analyse the influence of the wireless service characteristics.

The proposed utility derived from the wireless service still takes the same linear form as the previous substitute, but now the linear term will be expanded to include additional service parameters, as below:

$U_w = \eta (\beta + \Sigma \delta_i) q_w$

The form proposed includes a sum of individual service differentiators valuations ($\Sigma \delta_i$), that is added to the inherent valuation for the piece of content ($\beta$), as defined for the fixed delivery substitute. The sum of service differentiators can be positive or negative, and will vary accordingly to each individual and to the type of content application being considered. Three general factors proposed to compose the sum of service differentiators are described below, namely mobility, personalization and terminal convenience. The resulting sum of the inherent content valuations with the sum of service differentiators is multiplied by a factor $\eta$, wireless content efficiency, included to account for the different presentation formats (and hence data sizes) the same piece of content is likely to have when delivered to the different wireless and fixed platforms. Higher wireless content efficiency has the effect that less wireless units ($q_w$) delivery are necessary to yield the same resulting utility. The proposed utility function components are further described below:

$\Sigma \delta_i$ is the resulting sum of mobile service differentiators:

Mobility - $\delta_m$ is the component for mobility, and is included to account for the increased valuation a piece of delivered content will have when accessed on the move. A simple example would be having access to travel or entertainment information, whose need is often unexpected and very time sensitive.

Personalisation - $\delta_p$ is the component for personalisation, since the wireless terminal is likely to be used by a single person, and is translated to utility through customised user preferences and predictive behaviour through evaluation of his usage profile.
**Terminal Convenience -** \( \delta_t \). accounts for the terminal convenience, and can assume positive or negative values, depending mostly on the applications under analysis. For example, for music streaming applications, the mobile terminal is likely to acquire a positive value because it would enable the user to enjoy the service on the move. Conversely, for watching full length movies it most certainly acquires a negative value, due to the screen limitations.

**Wireless Content Efficiency -** \( \eta \) is the wireless content efficiency, and is defined as the ratio of the necessary PC delivered quantity of data for a piece of information, to the necessary one when delivered to a wireless terminal yielding the same user utility. This is included to account for terminal screen and storage limitations, and can be achieved by exploring the different format encoding possibilities enabled by the latest mark up languages (XML and XSLT), and will be further expanded in section 5.

An important application of this parameter be to evaluate the influence of the level of advertisement embedded in the content. High levels of advertisement can be modelled as low efficiency factors.

**Inherent Content Valuation -** \( \beta \) is the same as in the case of PC and is used as a basis for comparison between both, measuring the user’s inherent valuation for accessing a piece of content encoded in PC data.

Valuations for these parameters will assume different relative values depending on a specific service, as well as for different individual preferences. Section 4.6.5 will present a per service example of the composition of service differentiators.

The following picture displays the PC and Wireless utilities for an efficiency factor \( \eta = 1 \) and the two possible cases of resulting sum of service differentiator valuations. For referring to the case where user value the later positively, the term “Wireless Lover” is going to be adopted, while for the negative case, “PC Lover” will be used.
The graph depicts the increasing utilities resulting from increasing quantities of content being delivered, taking as a reference the PC substitute alternative and including two possible cases depending on the resulting sum of wireless service differentiators.

However, consumer preferences will depend not only on the utility derived from the service, but also on the prices being charged for each alternative. As the utility components are defined in a way as to yield monetary valuations, service prices can be directly compared, and increasing prices will lead to decreasing resulting utilities.

The effect of prices will be considered next, for what the different charging schemes, taking as reference the actual FOMA offerings, are represented below:
It should be observed that wireless plans with lower upfront fixed payment (γ₁) portray higher per unit charging rates (τ₁). Also, even though starting at a point γ greater than zero, all the charging inclined lines, if projected towards lower quantities, would reach the origin point at zero. This means that the point in quantity delivered where the fixed rate stops and per unit charging starts is determined by the plan’s γ₁ / τ₁ point. This characteristic means that after this point is surpassed, the total amount the user will have paid for the service will be the same as if had been charge on a constant per unit price τ₁, and the constant charging portion of the plan loses its significance. Such charging models are referred to in general as non-linear pricing models, and for this case are also known as three-part tariffs. Flat rate PC charges are also shown for completeness and are represented by the dotted line at T₀, what is equally done for the flat rate content subscription charges.

In order to allow for a simple numerical analysis actual, service prices were collected from the FOMA offerings and UK incumbent fixed access. As it is intended as informative only, service prices are compared directly by means of only applying the exchange rate conversion, without any further price index correction between the two countries. The overall FOMA billing plans consist of a Basic Communications Allowance, which cover other communication services as voice calls, SMS, including packet communications, and an optional additional Packet Communication plan, which is mostly intended to accessing content, listed below. While the communications allowances can be used for accessing packet transmission services, they are charged at the rate of the Wireless Plan 1, which does not require specific upfront fee payment. Therefore, for the objective of comparing the outcomes between different plans and substitutes, the allowances included in the basic general communication allowances can be understood as pertaining to the case of analysis of the Wireless Plan 1. Also, in order to be able to enjoy any service at all, the user has to engage in a contract with a minimum fee. For simplicity of analysis, it is assumed that the minimum fees are allocated to the communication services alone. While these should ideally be regarded as common costs and be apportioned following for example the LRIC guidelines, the analysis would turn more complicated, and no improved qualitative results would be obtained. An extract of the overall plans including communication charges and other fees is presented in Appendix A for further referencing.

<table>
<thead>
<tr>
<th>Summary of FOMA Transmission Charges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Plan 1 (No Packet Pack)</td>
</tr>
<tr>
<td>Plan 2 (Packet Pack 20)</td>
</tr>
<tr>
<td>Plan 3 (Packet Pack 40)</td>
</tr>
<tr>
<td>Plan 4 (Packet Pack 80)</td>
</tr>
</tbody>
</table>

* 1 Packet = 128bytes


### Currencies**

<table>
<thead>
<tr>
<th>Currency</th>
<th>Pound (£)</th>
<th>Euro (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yen (¥)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Euro (€)</td>
<td>117.20</td>
<td></td>
</tr>
<tr>
<td>Pound (£)</td>
<td>182.35</td>
<td></td>
</tr>
</tbody>
</table>

** as of 17-JUL-2002

### i-mode info charges

<table>
<thead>
<tr>
<th>Description</th>
<th>Pound (£)</th>
<th>Euro (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i-mode</td>
<td>300</td>
<td>2.56</td>
</tr>
<tr>
<td>if FOMA subscriber</td>
<td>100</td>
<td>0.85</td>
</tr>
</tbody>
</table>

### PC Access Plans

<table>
<thead>
<tr>
<th>Plan</th>
<th>Pound (£)</th>
<th>Euro (€)</th>
<th>Additional Characteristic and Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADSL Broadband</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BT Openworld Set up</td>
<td>65.00</td>
<td>101.13</td>
<td></td>
</tr>
<tr>
<td>Business 500 or Residential Equipment</td>
<td>85.00</td>
<td>132.25</td>
<td></td>
</tr>
<tr>
<td>Plug and Go Monthly</td>
<td>29.99</td>
<td>46.66</td>
<td>Contention 50:1; 10 email add + 20MB Webspace</td>
</tr>
<tr>
<td>Dial-up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BT Surftime Monthly</td>
<td>7.00</td>
<td>10.89</td>
<td>Evenings (Monday to Friday) 6 to 8pm, and Weekends</td>
</tr>
<tr>
<td>Monthly</td>
<td>25.00</td>
<td>38.90</td>
<td>Anytime</td>
</tr>
</tbody>
</table>

Table 8

Summary of actual service offerings for PC and wireless delivery [39] and [40]

A graph with the behaviour of amount paid translated from packets to megabytes and European currency is included below, for the four available packet data FOMA plans.

![Wireless and PC Delivery Plans](image)

Figure 26

Now if utilities and charging models are combined, different resulting utilities will be originated by different charging models. For charging plans with upfront payment, the resulting utility will typically be negative for lower quantities, as a consequence of the utility derived from the service to be increasing linearly from zero. For these quantities, usually the user will find higher utility in keeping his money and not acquiring any service. For increasing quantities, the
composition will be heavily dependent on the relative values of the many parameters composing the utility functions and different charging models.

However, the non-linear characteristic of the per-usage wireless plans gives a kinky behaviour to the resulting utilities which is very useful for defining usage regions where the resulting utility tends to be higher and overcome the other alternatives. A possible outcome for the composition of utilities and charging plans for varying quantities is shown next, where different plans are superimposed for comparison. It is suggested as a general case, with the parameters and inclinations being pointed out, along with the regions where each plan achieves higher resulting utility.

![General resulting utilities including price effect for different charging models](image)

<table>
<thead>
<tr>
<th>Quantity of Delivered Content</th>
<th>Resulting Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_0$</td>
<td>$\eta (\beta + \Sigma \delta_i)$</td>
</tr>
<tr>
<td>$C_0 + \gamma_2$</td>
<td>$\eta (\beta + \Sigma \delta_i)$</td>
</tr>
<tr>
<td>$C_0 + \tau_0$</td>
<td>$\eta (\beta + \Sigma \delta_i)$</td>
</tr>
<tr>
<td>$C_0 + \gamma_3$</td>
<td>$\eta (\beta + \Sigma \delta_i)$</td>
</tr>
</tbody>
</table>

Figure 27  General resulting utilities including price effect for different charging models

[C Becker 2002]
Next, four different scenarios for different parameters of service valuations, content efficiencies and PC substitutes are considered with the above mentioned charging plans.

The first scenario depicts the situation of a “PC Lover”, where its valuation for the basic fixed content service is assumed to be 1 euro per megabyte. The resulting sum his valuations for the of wireless service differentiators is set at negative 0.5 euro per megabyte (e.g. resulting from high aversion to the disutility of the terminal). Efficiency in the wireless content delivery is assumed to be 1.5, and flat rate PC transmission fee is the lower restricted dial-up plan presented in Table 8. As all the values here were assumed in a “wireless pessimistic” environment (except for the efficiency), only the PC service assumes positive resulting utilities. It is only surpassed by the wireless plan 1 at extremely low quantities, because of the difference in upfront payment.

Scenario PC Lover $\rightarrow$ Resulting Sum of Differentiators Negative $\Sigma \delta_i = -0.5\,\text{€/MB}$
Inherent Valuation $\beta = 1 \, \text{€/MB}$, Flat Rate Fixed PC $T_0 = 11.89 \, \text{€}$, Efficiency $\eta = 1.5$

![Resulting Utility Functions](image)

Figure 28 Resulting utilities for different wireless plans – Scenario “PC Lover – Dial Up”
The following scenario considers the case of a neutral user who is indifferent between wireless and PC characteristics (sum of differentiators, $\Sigma\delta_i = 0$). It is compared now to the higher flat rate fee of a broadband connection. Efficiency in this case is left at unity; but a similar case with higher efficiencies will follow. In this case, the indifference manifested by the consumer will cause the PC alternative to dominate at higher quantities, since all the wireless plans entail usage charging, which in turn reduce the resulting utility. On lower quantities though, wireless plans 1, 2 and 3 yield higher resulting utilities, due to the high upfront payment on the fixed broadband service.

**Scenario Neutral Preference \(\rightarrow\) Resulting Sum of Differentiators Zero \(\Sigma\delta_i = 0\)**

**Inherent Valuation**  
$\beta = 1€/MB$, Flat Rate Fixed PC $T_0 = 42\ €$, Efficiency $\eta = 1$

![Resulting Utility Functions](image)

**Figure 29** Resulting utilities for different wireless plans  
Scenario “Neutral – PC Broadband – Low Wireless Content Efficiency”

The influence of different content subscription charges would be translated to different vertical offsets in corresponding utilities, yielding different regions of relative dominance. At the same time, content subscription charges influence the quantities of delivery where the resulting utilities are positive, i.e., the user finds it attractive to engage in the service instead of keeping his money for other purposes. Also influencing this decision (purchasing or keeping the money) is the inherent valuation for content delivered $\beta$. For higher $\beta$'s, resulting utilities will turn positive at lower quantities being delivered. However, as the objective of this analysis is to compare resulting
utilities between wireless and fixed delivery, the user inherent valuation for content was assumed to be at a general modest value, which is kept throughout the scenarios.

The following is an equivalent case for a neutral user, but in this case the wireless efficiency is supposed to be higher (Efficiency=2). While this figure might be unlikely to occur, it is included as a scenario exercise, in order to draw attention to its importance. On the other hand, the very characteristic of per-usage charging characteristic might be an incentive to improve its efficiency not only on the encoding stage but also on the content itself at the stages creation and packaging. As a practical effect, it could be expected that the level of embedded advertisement be reduced in the wireless platforms, since the user will be reluctant to pay for being delivered content that is mixed with non requested advertisement. As a result of the efficiency increase, more wireless plans start to be attractive at higher quantities. However, since the per-usage rate $\tau$ is higher than the difference between the wireless utility valuation and PC for all the wireless plans (a neutral consumer is being evaluated), for higher quantities the PC alternative will still yield to higher resulting utilities. At low quantities, as before, the wireless plans still dominate, as a result of the high upfront payments for the fixed service.

**Scenario Neutral, High Content Efficiency → Resulting Sum of Differentiators Zero $\Sigma \delta_i = 0$**

Inherent Valuation $\beta=1€/MB$, Flat Rate Fixed PC $T_0 = 42€$, Efficiency $\eta = 2$

![Resulting Utility Functions](image)

Figure 30 Resulting utilities for different wireless plans
Scenario "Neutral – PC Broadband – High Wireless Content Efficiency"
The last scenario depicts the situation of a “Wireless Lover”, i.e., the user placing a high valuation on the wireless service differentiators. The delta factor ($\Sigma \delta_i$) is set at 2 euros per megabyte, and the basic service valuation is kept at the same previous values. Efficiency is set at a neutral value. PC access fee are also maintained as before. In these circumstances all wireless plans yield higher utilities than the ones achieved by fixed PC, though each one dominates at a different usage region. In this case, because of the high valuation for the differentiators ($\eta(\beta+\Sigma \delta_i) = 3\€/MB$), the resulting linear coefficient for the wireless service utility is greater than the unit price charged at plan 4 ($\tau_4 = 1.4\€/MB$). Therefore, the utility for this plan turns positive for higher quantities. Also, because the resulting utility inclination ($\eta(\beta+\Sigma \delta_i) - \tau_4 = 1.6\€/MB$) is higher than the inherent content valuation for the PC alternative ($\beta = 1\€/MB$), the resulting wireless utility for plan 4 dominates over the one PC even for high quantities.

**Scenario Wireless Lover → Resulting Sum of Differentiators Positive $\Sigma \delta_i = 2\€/MB$**

Inherent Valuation $\beta=1\€/MB$, Flat Rate Fixed PC $T_0 = 42\ €$, Efficiency $\eta = 1$

Figure 31  Resulting utilities for different wireless plans

Scenario “Wireless Lover – PC Broadband – High Wireless Content Efficiency”
The development of different scenarios further clarified the idea that the wireless provider uses different plans in order to address different market segments. These can be associated to parameters of the plans through the amount of data to be received (defining usage patterns) and level upfront payments (defining budget regions or average revenue per user). The non-linear characteristic (kinkiness) of the charging plans was shown to be useful in order to provide further demarcation between their regions of higher attractiveness. To illustrate their regions of applicability, it could be seen that lower upfront payment fees are directed at addressing a wide market segment of occasional users, who can derive a higher utility from this option than if engaging on a fixed broadband alternative (where comparatively high upfront payments are required). However, their resulting utility will fall quickly as delivery quantities are increased. Higher upfront payment plans are designed to be attractive at higher quantities, where the lower per-usage charging rate can be more easily compensated by positive valuations for the wireless service differentiators.

On the consumer perspective side, a negative point to be raised is the possibility of generating indecision and confusion when presenting them with many charging options. A countermeasure to be taken by service providers is to allow easy switching between plans, so that such discomfort element can be minimised. For that purpose, a flexible billing system has to be made available. On the technological implementation aspect, as far as the billing-to-network interface is concerned, the habilitation of such feature shouldn’t be the most demanding problem. More elaborate requirements are placed by the need to charge usage on a data-volume base, which have to be fulfilled before any billing operations on this charging basis can take place.

The utility concepts have further shown that per-usage charging requires the wireless service valuations to be at least as high as the per-usage charging rates. The user valuation can be decomposed for analysis, as proposed, in a fraction that is inherent to the accessing content service plus a term that is dependent on the service differentiators implemented by the mobile platform. Their main components are suggested as being mobility, personalization and terminal convenience, and will assume different values depending on the type of application being offered (an example is provided in section 4.6.5). A more complete analysis addressing consumer decision outcomes is performed in the next section, where the effect of budget restriction and behaviour of utility maximization is taken in consideration.
4.6.4. Consumer Preferences under Budget Constraint

The analysis just presented addressed the effects of different charging models with varying utility functions. However, if a budget restriction exists, additional results can be obtained, as the user will commonly try to maximise his utility for a given budget condition. The next analysis is based on established microeconomic tools and concepts for utility maximisation choice, and uses the same definitions as employed in the previous problem.

Problem Technique

Figure 32 shows the common space diagram where the problem is analysed. It consists of two axes containing the quantities of the two goods that compose the utility functions subject to the maximisation problem. In this case, these are going to be the quantities of wireless delivery and its fixed broadband competitor.

The first element to be added is a budget boundary, which is a function of the charging models and prices associated with each good or service. It is defined as the location of the relative quantities points of wireless and fixed delivery \((q_w, q_{pc})\) for which the total consumer budget assigned for these goods would be spent. In other words, it represents different possibilities of total spending for the various combinations of prices and quantities of the goods under analysis.

Next, a family of total utility indifference curves is defined and is superimposed on the graph. A utility indifference curve can be defined as the location of points in the two-good space where on which any of its points yield to the same resulting total utility. For example, a consumer might be have the option to have 3 black pens along with 1 blue pen, but might be equally happy to have 3 blue pens along with 1 black pen, since they are substitutes. These two points would be located on the same indifference curve. Parallel indifference curves are then included to represent higher utility outcomes for the same set preferences, say 6 black pens and 2 blue, or vice-versa.

The problem of utility maximisation consists of finding the highest utility curve which can still be validated by the line of budget restriction in practice\(^2\). In other word, depending on the relative prices between the two goods, a rational consumer will attempt to find the relative quantities between both goods based on its personal preferences that lead to the highest resulting outcome.

\(^2\) For information on the theory and methods for its application, a widely adopted text on Microeconomics is included on the reference, Varian [28].
Higher utility indifference curves are obtained following the direction of the arrow shown in the picture, since it points to the direction where quantities enjoyed are higher. The inclination of the indifference curves is a function of personal preferences towards each service, and can be interpreted as the ratio with which the consumer is likely to exchange quantities of one good (say $q_{pc}$) for quantities of the other ($q_w$). Microeconomic theory explains that the maximization of utility problem can be solved by highest utility indifference curve that can be afforded by a budget constraint, which in turn will determine the maximizing relative quantities of purchase of the two goods ($q_{pc\ max}$ and $q_{w\ max}$). Graphically one can proceed to determine it by moving the parallel indifference curves outward the origin point until it finds the last tangent point to the budget line, as seen in Figure 32. The problem can be also solved analytically, but for this application, the graphical approach for determining qualitative behaviour shall be sufficient. For detailed information on general methods for the problem, the reader is referred to [28] or [9].

**Indifference Curves for Wireless and Fixed Broadband Services**

In the case of the goods or service being substitutes, the resulting total utility can be represented by the sum of the utility from each good, since additional quantities of each can contribute to the overall resulting utility. For the case under analysis, and taking the utility functions proposed in the previous section, total utility can be expressed as:

$$U_T = U_{pc} + U_w = \beta \cdot q_{pc} + \eta (\beta + \Sigma i \cdot \delta_i) \cdot q_w$$  

(25)

---

3 For implications where the assumption of perfect substitution is relaxed, please refer to Appendix A
Next, to arrive at the expression for the parallel indifference curves as a function of both quantities, total utility is taken as parameter to be varied, and the quantity of one good is expressed in terms of the other. This yields to:

$$q_{pc} = m - \frac{\eta \left( \beta + \sum \delta_i \right)}{\beta} q_w,$$

(26)

where increasing values of $m$ lead to higher parallel indifference curves.

Indifference curves can be then represented by straight lines, and relative valuations between the two goods can be interpreted by their inclination. In this case, this implies that the higher the wireless efficiency factor $\eta$ and the resulting sum of service differentiators $\delta_i$, the more inclined the utility indifference curves will be. Cases where these variables assume high values will be referred to as “Wireless Lover” for brevity. Cases where these values assume low or negative values will, on the other hand, will be referred to as “PC Lover”.

The next figure shows that different values for the relative preferences (inclination of indifference curves) can lead to different points of utility maximization, and therefore different relative quantities purchased. In the case of a “Wireless Lover” for the arbitrary budget restriction shown, it is seen that the maximizing utility quantities will be buying only wireless service, while for the case of “PC Lover”, it is seen that the maximization would lead to a combination of quantities of both services. Lower indifference curves at the alternative point are also shown for comparison and clarity.

Figure 33  Different points of maximum utility depending on relative service valuations

[C Becker 2002]
Budget Restriction Boundaries Definition

The budget constraint line, in its turn, is a function of the prices and charging models for each quantity. Next, the actual charging models for the FOMA\textsuperscript{4} service and competing fixed broadband flat rate plans are going to be considered, and different scenarios and resulting utility maximization points will be determined.

For the case under analysis, the budget constraint can be expressed as:

\begin{equation}
B = P_{pc}q_{pc} + P_{w}q_{w} + C_{pc} + C_{w} \text{, where}
\end{equation}

\(B\) is the total consumer budget assigned for the combination content service purchases. 

\(P_{pc}, P_{w}\) and \(q_{pc}, q_{w}\) are the per unit prices and quantities for the delivery of broadband PC and wireless respectively.

\(C_{pc}\) and \(C_{w}\) are the flat rate content subscriptions.

To focus on the analysis of the effect of delivery transmission charges for varying quantities, the content fees are held constant and a modified budget including the expenditure on these subscriptions is defined. In order to simplify the decision analysis, it is assumed that a content fee is incurred independently of the delivery choice. A practical situation would be the subscription to a portal that has gateways to both delivery platforms, though charging a unified flat rate subscription \(C_{0}\).

It will be seen later that the qualitative results are the same even if this assumption is relaxed, i.e., different content fees being incurred for different delivery choices.

The modified budget including content subscription

\begin{equation}
B' = B - C_{pc} - C_{w} = B - C_{0}
\end{equation}

And for the case of flat rate broadband PC delivery, the amount charged is independent of the quantity delivered, so the term \(P_{pc}q_{pc}\) can be substituted by the constant subscription fee \(T_{0}\), as depicted Figure 25. It is important to note that in this case, the expenditure in PC delivery is independent of its quantity. The resulting budget constraint equation stays as:

\begin{equation}
B' = T_{0} + P_{w}q_{w}
\end{equation}

In order to construct the budget line frontier, the behaviour of total expenditure for different chosen quantities has to be determined.

\textsuperscript{4} In order to obtain the first results, only the first wireless plan (zero initial charge with per packet price of \(\tau_{1}\)) is considered. The results for the other plans will be indicated later.
First Case – Budget below broadband flat-rate fee

Firstly let’s consider the case where the consumer modified budget is less than the PC broadband flat rate fee. The user is unable to buy any PC quantity and its budget line is restricted to a point in the $q_{pc}=0$ axis, with quantity of wireless determined by:

\[ q_w = \frac{B'}{p_w} = \frac{B'}{\tau_i} \]

By proceeding to the utility maximization, which is represented in the figure below, it can be seen that in this case, independently of their relative preferences between the two services, consumers will have to always choose buying wireless service.

Second Case – Budget above flat-rate broadband fee

The next case considers the scenarios where consumer budget is enough to cover the broadband PC flat rate tariff.

Firstly, for the case where zero quantity of PC is purchased, the resulting quantity of wireless delivery is the same as in the previous case.

\[ q_w = \frac{B'}{p_w} = \frac{B'}{\tau_i} \text{, for } q_{pc}=0 \]
Now, for the cases where quantities of PC delivery greater than zero are desired, the budget line is independent of the amount of PC units desired, since it is charged at flat rate T₀, which does not increase the amount charged with increased quantity delivered. Graphically it yields to a vertical line increasing indefinitely. Its position on the horizontal axis (representing the possible wireless quantities of purchase) will be determined by the excess budget and the price of wireless service, as follows:

\[ q_w = \frac{B - T_w}{r_1}, \text{ for } q_{pc} > 0 \]

The resulting budget lines and points of utility maximization for this case are represented in the next figure. In this case, it can be shown that, as with what happened in the previous case, the utility maximization point is independent of the relative preferences. Given that the user has enough budget to afford the flat rate PC broadband subscription, he or she would always prefer spending on it, and will assign only the remaining budget to the wireless service. This behaviour can be justified because once the flat rate PC service is acquired, the user would be able to obtain an arbitrarily high utility from it, which wouldn't happen if he or she would choose otherwise.

![Diagram](image-url)
PC opportunity. The reason for such is that the utility obtained by PC is allowed to be arbitrarily high once the consumer decides to spend the fixed amount of the flat rate subscription. However, if a ceiling to PC utility is suggested, an extension to the result possibilities is achieved.

**Third Case – Saturation in fixed broadband utility – budget just above flat rate fee**

A simple reason for the inclusion of such restriction is the very time availability (or willingness) the user might have at disposal to enjoy the service. For an example, let’s suggest the adult residential market segment, where it would be unlikely that the user would spend much of his off time using the service at home.

In order to account for that effect, a saturation quantity in the utility provided by the PC service (q_{sat}) is introduced in the model, and two new scenarios are considered.

Firstly, the case where the total user budget slightly exceeds the PC broadband flat rate is considered. This implies that if the consumer decides to by PC (q_{pc}>0), the remaining budget for wireless quantities will be very small, and therefore the straight line will be situated in a horizontal position close to the origin (q_{w} \rightarrow 0). On the other hand, for no quantities of PC purchased, his entire budget is spent on wireless, leading to a much higher quantity of this service when compared to the previous one.

This condition can be summarized as:

For \( B' = T_0 \), \( q_{w} (q_{pc} > 0) \ll q_{w} (q_{pc} = 0) \)

The resulting utility maximization conditions are shown below, and lead to important conclusions. Only for a case where there is saturation on the utility provided by the PC service, consumer choice leading to different relative quantities will depend on the service differentiators. In this case depending on the PC saturation quantities, the “PC Lover” will still firstly choose PC first and spend the remaining on wireless (for high saturation quantities – as in figure), or they might even choose to buy only wireless. On the other hand, the “Wireless Lover”, even with relatively high PC saturation, will normally choose the only wireless point (q_{pc}=0). The following figure illustrates this situation, where the alternative lower maximization conditions are shown in dotted lines for comparison.
Fourth Case - Saturation in fixed broadband – budget highly above flat rate fee

The next scenario considers the condition where the budget destined to the services is much greater than the flat rate fee $T_0$. In this situation, the quantities of wireless delivery will approximate each other, and at high amounts, what can be expressed as:

$$q_w = B' - T_0 \approx \frac{B'}{\tau_1}$$

The resulting maximizing points in this case, even in the presence of utility saturation, are that again the consumer will tend to purchase the fixed flat rate PC subscription and the remaining in wireless delivery, unless his preferences for wireless are extremely high. Such behaviour can be justified by the resulting proximity of the wireless quantities in both situations, and implies that the consumer would be trading a small additional quantity of wireless for the possibility of enjoying the utility of PC delivery up to the quantity of saturation.

This is a result that can be easily confirmed by common sense, since for high budgets it would be expected that the consumer would be able to spend and enjoy both services.
Fifth Case – Saturation in Wireless Quantities

The last case includes the saturation restriction for the wireless delivery quantities as well. However, saturation in wireless can only influence on the decision outcome if its quantity is lower than the affordable quantity. This behaviour has a different effect than the saturation of PC, where it is always a limiting factor, given that otherwise it would allow an infinite utility.

Amongst the reasons for wireless saturation would be the inconvenience of the terminal, screen and input characteristics, which would limit the willingness to use the service. On the other hand, when the i-mode/FOMA case is considered, the high fraction of time spent on commuting and social events (reasons that are exhaustively pointed out as determinants of its success), can be translated to the model as high quantity of wireless saturation. Likewise, the limited amount of time spent the population spend at home and the high price of internet access \(T_0\) lead to a dominating condition that is close to the one represented in figures Figure 34 and Figure 36.

For the sake of completeness, the case where a saturation in the utility derived from wireless is present is shown in the next picture, where the overall result is the acquisition of both PC and wireless services.
The introduction of additional plan possibilities implies the inclusion of alternative budget boundaries on the same plane, since with a different charging model, the same budget can lead to the ability to obtain different combinations of relative quantities. However, given the characteristic that higher plans require increasing fixed upfront payment fees, a minimum budget restriction appears. If the user budget is below it, no unit of the quantities defined in the plan can be acquired, what leads to the same situation as in Figure 34, where only the wireless option, and not the flat broadband fee, is available for choice.

**Extension to additional wireless plans with three-part tariffs**

As it will be seen in the next analysis, additional plans (if well designed) can yield to conditions where better utility outcomes are achieved. The problem, as it has been addressed, assumes one of the utility maximisation analysis common premises of *perfect rationality* and *perfect information*, which means that the user would normally perform the optional reasoning in his decision process. Nevertheless, the existence of four different plans in the FOMA service offering has been pointed out as a negative feature leading to confusion, which was perceived negatively by the average consumer. On the other hand, the offer conditions preview the ability to easily switch between different plans, and the first negative impression might be softened with increasing usage awareness.
Figure 39  Utility maximisation problem when more than one plan is available

The picture above shows the case where the available user budget would be enough to include either the flat rate fixed broadband, and two different wireless plans, or a combination of both. A combination of two different wireless plans would be senseless, since plans at higher levels of expenditure are designed to yield additional quantities when compared to lower plans. The characteristic of lower per-usage cost at higher plans is translated to the graph as budget lines shifted to the right, where for the same budget, higher wireless quantities are achievable. Also with interesting implications is the characteristic that by projecting the per-usage lines of the different plans inside their region of fixed fees, the origin point with zero quantity and zero payment is reached. It means that once the plan is affordable (additional quantity \( \gamma_i \) can be spent either with or without the flat rate broadband fee), the wireless quantities can be determined as if the upfront cost were inexistent (by \( q_{w} = \text{Remaining Budget} / \tau_i \)). Graphically, this restriction corresponds to having a minimum wireless quantity from where the budget boundaries for higher wireless plans start being possible. This point is determined by the ratio \( q_{w} = \gamma_i / \tau_i \), and is the same point on the definition of the wireless plans where the flat rate stops and per-usage charging starts. Figure 39 illustrates the case where the user budget can afford and has a high wireless saturation quantity. It can be seen that the inclusion of the additional wireless plan, in the case of a wireless inclined user (“Wireless Lover”), would result in the change of the decision outcome, where in order to maximise his utility he would have to cease purchasing the PC flat rate and
spend his entire communication budget in wireless delivery. The “PC Lover” user, on the other hand, should maintain the same nature of choice, and would be granted a higher overall utility by engaging in the wireless plan 2, where the wireless delivery quantities obtained are higher.

As can be concluded by the many cases analysed so far, the problem of utility maximisation will take a different form for different available budget restrictions. For increasing budgets, more possibilities is available for the user to choose from. The following diagram shows the space of available delivery plans for increasing budget availability. Different budget regions (A, B, C and D) are defined, and each one will have a different set of conditions for the utility problem. In region A, only the first wireless plan is possible, and the problem is similar to the one seen in Figure 34. As budget increases to region B, the flat rate broadband tariff is affordable, and the problem turns to the one analysed in Figure 36 or in Figure 37. When a budget in region C is available, the second wireless plan can be taken in consideration, and higher quantities of wireless data are attainable, given its lower per usage rate when compared to the wireless plan 1. Since region C does not allow the consumer to take both wireless plan 2 and the flat rate broadband, it will face a decision between purchasing a combination of flat rate PC and spending the remaining money with Wireless Plan 1, or spending all his budget in wireless quantities at plan 2. In this situation, the wireless-only budget point turns highly attractive, and might influence the user to change to a wireless-only choice, depending on its personal utility parameters. Finally, as region D is reached, both the flat rate broadband PC access and the more attractive Wireless Plan 2 are available, and a situation similar to the one already shown in Figure 39 is encountered.

In order to conclude on the many situations are parameters influencing the possible decision outcomes, a qualitative analysis was performed for each budget region, taking low/high values for PC and wireless saturation quantities, as well as Wireless/PC utility inclinations as parameters. For reasons of space, only a summarised table is provided, where the utility maximization choice outcome for each case is indicated.
<table>
<thead>
<tr>
<th>Budget Region: A</th>
<th>PC Usage Saturation</th>
<th>Wireless Usage Saturation</th>
<th>Utility Preference</th>
<th>Utility Maximisation Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Low Wireless Lover</td>
<td>Only Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Low PC Lover</td>
<td>Only Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low High Wireless Lover</td>
<td>Only Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low High PC Lover</td>
<td>Only Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Low Wireless Lover</td>
<td>Only Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Low PC Lover</td>
<td>Only Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High High Wireless Lover</td>
<td>Only Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High High PC Lover</td>
<td>Only Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Budget Region: B</th>
<th>PC Usage Saturation</th>
<th>Wireless Usage Saturation</th>
<th>Utility Preference</th>
<th>Utility Maximisation Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Low Wireless Lover</td>
<td>PC first + Remaining on Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Low PC Lover</td>
<td>PC first + Remaining on Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low High Wireless Lover</td>
<td>PC first + Remaining on Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low High PC Lover</td>
<td>PC first + Remaining on Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Low Wireless Lover</td>
<td>PC first + Remaining on Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Low PC Lover</td>
<td>PC first + Remaining on Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High High Wireless Lover</td>
<td>PC first + Remaining on Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High High PC Lover</td>
<td>PC first + Remaining on Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Budget Region: C</th>
<th>PC Usage Saturation</th>
<th>Wireless Usage Saturation</th>
<th>Utility Preference</th>
<th>Utility Maximisation Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Low Wireless Lover</td>
<td>PC first + Remaining on Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Low PC Lover</td>
<td>PC first + Remaining on Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low High Wireless Lover</td>
<td>Only Wireless Plan 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low High PC Lover</td>
<td>Only Wireless Plan 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Low Wireless Lover</td>
<td>PC first + Remaining on Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Low PC Lover</td>
<td>PC first + Remaining on Wireless Plan 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High High Wireless Lover</td>
<td>Only Wireless Plan 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High High PC Lover</td>
<td>Only Wireless Plan 2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Budget Region: D</th>
<th>PC Usage Saturation</th>
<th>Wireless Usage Saturation</th>
<th>Utility Preference</th>
<th>Utility Maximisation Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Low Wireless Lover</td>
<td>PC first + Remaining on Wireless Plan 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Low PC Lover</td>
<td>PC first + Remaining on Wireless Plan 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low High Wireless Lover</td>
<td>Only Wireless Plan 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low High PC Lover</td>
<td>Only Wireless Plan 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Low Wireless Lover</td>
<td>PC first + Remaining on Wireless Plan 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Low PC Lover</td>
<td>PC first + Remaining on Wireless Plan 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High High Wireless Lover</td>
<td>Only Wireless Plan 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High High PC Lover</td>
<td>Only Wireless Plan 2</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 9: Utility maximisation outcomes for different budget restriction regions
4.6.5. Example of Service Differentiators Influence

The following is an exercise for exploring the utility differentiators on a specific service basis. Typical user utilities are defined for each delivery method, and are later combined in order to indicate under what conditions the users would be likely to elect one service in detriment of the other.

The service elected for comparison is the provision of audio songs on a real-time streaming mode as well as on background transmission. For real-time streaming the wireless service is compared to the fixed broadband alternative. For the background transmission, the service is compared to the one of obtaining a CD record from the store. The wireless transmission is the first case is performed on a dedicated connection, as enabled by the UMTS service, and is charged on a time basis. On the second case, wireless transmission can be done on a packet switched mode, being charged by the volume of data transmitted.

Music Streaming

\[
U_{\text{wireless-song-once}} = \beta_{\text{song-once}} - P_{\text{song-once}} - P_{\text{TxW}} + \delta_{\text{library size}} + \delta_{\text{personalisation}} + \delta_{\text{mobility}}
\]

\[
U_{\text{PC-song-once}} = \beta_{\text{song-once}} - P_{\text{song-once}} - P_{\text{TxPC}} + \delta_{\text{library size}} + \delta_{\text{personalisation}} - \delta_{\text{terminalPC}}
\]

- $\beta_{\text{song-once}}$ – inherent value placed on listening to a song
- $P_{\text{song-once}}$ - price paid for the content for listening once. It is assumed that the property rights are lower, given that the listener won’t be able to keep the file for further use.
- $P_{\text{Tx}}$ – price of transmission. Per usage on wireless networks (traffic dependent costs). For streaming services in wireless UMTS case it uses circuit switched parameters for QoS, and $P_{\text{TxW}}$ its measured in time (seconds). On the PC case, transmission costs ($P_{\text{TxPC}}$) can be absorbed by the flat rate broadband access fee, and tend to be much lower
- $\delta_{\text{mobility}}$ – accounts for the additional utility the user gets from the wireless mobility Tendency of high valuation due to the “time killer” usefulness of listening to music on the move.
- $\delta_{\text{personalisation}}$ – ability to set profiles and be suggested or notified on genres of interest. Present in both services, in the wireless tending to be higher due to the more individual characteristic of the terminal
- $\delta_{\text{library size}}$ – additional differentiator due greater availability of titles and versions on the internet, being possible to be present in is enabled by the storage and property rights on the portal, which can be achieved independently of these delivery methods.
- $\delta_{\text{terminalPC}}$ – for music access, this term is taken as a disutility on PC, which is likely to be higher than the one of wireless. This is due to the lack of mobility and inconvenience on PC operation for listening to songs. On the wireless option, a limiting factor might be the available storage memory, if a higher quantity of songs is desired.

If both utilities are combined for comparison, with equal terms cancelled and the difference in price put in evidence, the condition for the wireless service being preferred over the PC alternative can be expressed as:
This means that the price of the wireless service can set higher than the PC alternative to the extent of the valuations for mobility minus the disutility of PC terminal. The result, though straightforward at first sight, gives an indication on the influence of the possible service attributes to be explored. Since in this case most of the service differentiators can also be implemented by the substitute version, there is little room for price differentiation on the wireless proposition so as to account for it typically higher transmission prices. On the other hand, a limiting factor on the technological readiness for the fixed PC case is the current lack of network QoS guarantees that is required for the commercial exploitation of such service. These features are likely to be firstly implemented completely in the 3G UMTS implementation, through the traffic profiles and signalling abilities.

Music purchasing though background transmission

\[ U_{CD} = \beta_{CD} - P_{CD} - \delta_{\text{shop}} \]

For “physical world” CDs, the basic unit of purchase includes more than one song.

- \( \beta_{CD} \) – inherent value placed on listening to all the songs of a CD
- \( P_{CD} \) - price paid for the CD as property rights and physical delivery
- \( \delta_{\text{shop}} \) – represents the disutility of having to move to the shop in order to purchase the CD, or the delay in delivery of the physical good when this is bought online. Stock availability and risk of not finding the physical piece could be also included as components.

For equivalence between the inherent valuation of purchasing to one song (available online) and purchasing the physical CD, the following relation is constructed.

\[ \beta_{\text{song}} \geq \frac{\beta_{CD}}{N_{CD}} \]

\[ \beta_{\text{song}} = \frac{1}{\mu} \frac{\beta_{CD}}{N_{CD}} \quad 0 < \mu \leq 1 \]

The inequality means that the utility the user gets from purchasing a pin-pointed song online is higher than the average utility per song from a CD. This taking in account by multiplying the inherent valuation of the average CD song for an average factor \( \mu \), which is less than unitity. With this in view, the per-song utility derived from a CD can be expressed as:

\[ U_{CD/\text{song}} = \mu \beta_{\text{song}} - \frac{P_{CD}}{N_{CD}} - \frac{\delta_{\text{shop}}}{N_{CD}} \]

And can be compared to the one derived from wireless purchase online (which can be defined following what was done in the previous example).
If the price difference between the two service is defined as:

\[
\Delta P_{W-CD} = P_{song} + P_{TW} = \frac{P_{CD}}{N_{CD}},
\]

The condition for users preferring wireless over physical CD can be summarised by:

\[
\Delta P_{W-CD} \leq (1 - \mu) \beta_{song} + \beta_{shop} + \delta_{library size} + \delta_{personalisation} + \delta_{mobility} - \delta_{term allW}
\]

This means that the price on a per-song basis including the wireless transmission costs can be set higher than the average price of a CD song to the extent of the valuations the left-hand side of the equation. The valuation components are the selectivity with which the consumer can elect the songs he like on the per-song purchase mode, the disutility of going to a shop or waiting for the physical delivery, and the summation of the wireless service differentiators.

By following the same reasoning, potential wireless applications can be evaluated against existing alternative offerings. Clearly, successful wireless applications will be the ones for which wireless enabled service differentiators have the greater probability of higher valuations.
5. **Technology Aspects on Service Differentiators**

Third generation wireless systems are perhaps the platforms with most complex interactions between technology elements in order to provide a set of services. Therefore, even high level review of its main aspects would be unviable under the scope of this study. With that in view, this section intends to simply indicate the relationship between the service differentiators and their technology enablers, and to provide an overview of the application platform being employed for their integration.\(^5\)

<table>
<thead>
<tr>
<th>Service Differentiator</th>
<th>Aspect</th>
<th>Technology Enabler</th>
<th>Enabling Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERSONALISATION</td>
<td>Location Awareness</td>
<td>GPS + Cell Identification</td>
<td>Terminal + Wireless Network</td>
</tr>
<tr>
<td></td>
<td>User Profiles</td>
<td>XML Metadata</td>
<td>Content</td>
</tr>
<tr>
<td></td>
<td>Security</td>
<td>SSL, Micropayment Platforms</td>
<td>Content</td>
</tr>
<tr>
<td>MOBILITY</td>
<td>Coverage Continuity</td>
<td>Multi Frequency capability</td>
<td>Terminal</td>
</tr>
<tr>
<td></td>
<td>Connection Reliability</td>
<td>ATM QoS, W-TCP</td>
<td>Wireless Network</td>
</tr>
<tr>
<td></td>
<td>Data Exchange</td>
<td>Bluetooth</td>
<td>Terminal</td>
</tr>
<tr>
<td>TERMINAL CONVENIENCE</td>
<td>Screen</td>
<td>LEP (Light Emitting Polymer)</td>
<td>Terminal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Projection Systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Information Input</td>
<td>Predictive Text Input</td>
<td>Terminal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Voice Recognition</td>
<td>Terminal</td>
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<tr>
<td></td>
<td></td>
<td>Image Capturing</td>
<td>Terminal</td>
</tr>
<tr>
<td></td>
<td>Storage</td>
<td>Hi Capacity Memory</td>
<td>Terminal</td>
</tr>
<tr>
<td>CONTENT EFFICIENCY</td>
<td>Dynamic Formatting</td>
<td>XSLT Tranformations</td>
<td>Content</td>
</tr>
<tr>
<td></td>
<td>Content Synthesisation</td>
<td>MPEG4</td>
<td>Content</td>
</tr>
<tr>
<td></td>
<td>Content Compression</td>
<td>MPEG Codecs</td>
<td>Terminal + Content</td>
</tr>
</tbody>
</table>

Figure 41  Service Differentiators Technology Enablers [C Becker 2002]

\(^5\) Several other technology aspects are importance, but are not directly felt by the end-user. These are of great relevance to the network operator, since they allow increasing network deployment and usage efficiency and can be translated to lower costs ands service prices. For example, the adoption of CDMA in the air interface medium access control of the air interface allows simpler cell planning and better average utilisation of network resources. Some of these aspects were addressed in section 4.6.1, where the technological factors determining the wireless cost structure were analysed. For a complete description of the standards describing 3G systems, the reader is referred to the 3GPP website [www.3gpp.org](http://www.3gpp.org).
The table presented depicts the main service differentiators as considered in the consumer preferences model and relates them to their main technology enablers. As it can be seen through the indication of its enabling elements (wireless network, terminal handset and content processing), the full exploitation of the service differentiators requires, what further draws the attention to the characteristics of complementarity. As addressed in the Information Technology Economics section, complementarity effects between components inherently call for collaboration between their suppliers, as the lack of performance and suitability in one component is likely to cause negative effects in their combined outcome.

On the application creation aspect, the integration of these features is heavily dependent on the support of development environments. The application platform that has been increasingly adopted is based on the Java language, and is increasingly becoming a de-facto standard. Its open architecture allows inclusion of support to new features through the specification of APIs (Application Program Interface), while documentation and development kit are provided freely. In the case of mobile handsets and PDAs, because of limited processing and memory resources, an especially cut-down version of the more general environment, Java Micro Edition (J2ME) is defined. Another key capability is the possibility of providing dynamic code for new applications on demand (Java Applets), which can be downloaded from the content providers servers to the handsets on a on-demand basis.

The following points can be pointed out as additional features present in the Java Mobile Environment that complete its suitability for wireless application purposes:

- Implementation encryption capabilities through SSL layer, required for commercial transactions
- Ready availability of Application Programming Interfaces for interaction with Mobile multimedia (MMAPI), Location, XML Hypertext Parsing and Bluetooth
- Application to network signalling implementation for different service profiles (differentiation between packet and circuit switched transmission modes)
- Compatibility to different handsets through different implementation of the lower Java Virtual Machine engines (JVMs)

The combination of these factors has led to a consensus on its adoption by both manufacturers and application creators. Docomo has officially recommended it under the name of i-appli framework, and provides guidance by publicly publishing its API standards and development guides. One example can be i-apply reference[].
On the content representation side, the most relevant developments can be summarised as the separation of information content and format in hypertext languages with the semantic approach (XML - extensible mark-up language), and the support of metadata describing information content.

With information encoded in XML, different functional transformations can be applied the same information source so as to render particular presentation formats suitable to specific terminal limitations. With this technique, as an example, the associated XSLT transformations can be used to transform the same content source in XML to yield plain HTML, cHTML (for the i-mode standard), WML (for WAP). This yields lower costs of application development, as result of the economies of scope enabled by the ability to provide content to different platforms from the same source.

With metadata support, the inclusion of descriptive information can be employed so as improve the efficiency of production and exchange over the content lifecycle. The structured and openness with which XML implements the encoding of information allows inclusion of additional fields indicate possible attributes of interest. These can be used for context searches in order to specify and locate particular pieces of content. As to future developments, the MPEG7 standard defines a framework for describing media in non text format, for example by drawing sketches, voice or sound pattern recognitions. MPEG-7 was created not to provide additional features in the encoding or compression of multimedia data, but rather for developing and standardising advanced content description schemes. Within MPEG-7 content can be described in real time not only by text (e.g. catalogue fields for title, creator and rights as well as semantic descriptions), but also through other media parameters such as histograms, movement patterns, and shapes.

A final note regarding content efficiency, as it was defined for the economic model analysis, is its tendency to match the one of its fixed counterpart, as delivery of richer content is allowed by the improvement of terminal capabilities (screen, storage and memory). The major driver would be actual competition between content providers seeking for product differentiation characteristics through the provision of more elaborated content. At the same time that it would imply the delivery of comparative more volume of data for each piece of content, technology developments in network infrastructure are expected to allow delivery of higher density data at lower costs. A paper presenting predictions for future capacity and cost figure is included in [41]. Nevertheless, the ability to balance the level between richness and objectiveness of content against delivery channel limitations should be amongst the content provider primary skills, especially when users are required to pay for their individual transmission as is the case in wireless delivery.
6. Conclusions and further challenges

6.1. Content delivery over the Internet – Common Part

The following conclusions are drawn from the common work done on the current opportunities and charges of delivering content over the internet:

- In the context in which content is used in this study (i.e., audience-targeted information accessed on a man-to-machine basis) we can assert that revenue from Internet content services is unlikely to surpass that resulting from communication services. To our understanding this could be attributed to the fact that on the average people tend to valuate more person-to-person communication services than others, as these are more likely to have direct influence on their short-term decisions.

- However, given the established expansion and maturity of communication services as a result of deregulation in the telecommunications sector, exploring Internet-based content delivery possibilities is seen as a major service growth area. As an additional indirect effect, the selling of content over the Internet will increase network resource usage, thereby being an important driver for increasing telecoms associated revenues.

- Studies presented in the background chapter indicate that people are indeed willing to obtain content through Internet delivery, even if it requires consumer service fees. In this respect, Internet delivery enables attributes that add value to the inherent content characteristics and should be explored in order to make the most of this opportunity. One the one hand, some of the main attributes are timeliness, context, packaging, diversity and accessibility, whose uses have been already developed to a reasonable extent. On the other hand, richness and mobility are attributes that have not been fully exploited for Internet-based delivery mainly due to economical and technological limitations.

6.2. Business modeling techniques – Common Part

- From the research done on a large variety of possible business model techniques that could be used in the context of Internet business modelling, we consider that Gordijn’s and Akkemars’ [14] e³-value methodology serves as an effective means to formally state Internet business ideas in a short-time window. In addition, the sequential process to derive value models followed by this methodology is thorough enough to produce an accurate value system including all relevant players and value exchanges. Furthermore, its graphical representation and its standardized notation represent a notorious advantage over previous approaches, as these are explicit enough to summarize the main Internet
business idea and its implications in a diagram. Nonetheless, the notation and service scenario techniques it uses could be complex to grasp when first encountering them.

- By applying the business modelling methodology to a case study, we could identify a correlation between some value-enhancing content attributes and business players’ roles. For example, a content packager adds value to raw content by performing three main functions: ensuring that the content is ready for retail by testing it against QoS guidelines; contextualizing content by aggregating it into packages targeted to particular market segments and making content available through standard formats. Likewise, the actors identified as CDN provider and wireless access provider enable the delivery of rich media content and mobility capabilities in accessing Internet content, respectively.

- The resulting value network diagram worked out in the business case study allowed the detailing of the necessary value exchanges (economic interfaces) and the chain of players that place for the provision of a particular Internet-based delivery service. This was essential for stating the most determinant sources of revenue and costs influencing the business player chosen for an economic analysis.

6.3. Business Case Study – i-mode FOMA – Individual Work

- I-mode case study suggests that generalization of reluctance for paying for electronically delivered content can be questioned. However, no single factor should be pointed for as the unique responsible for success from the commercial point of view. The two more tangible reasons are associated with the premium characteristic of mobility added to content services or with the convenience of unified billing combined with reasonable subscription prices. A third factor, which seems to be the dominant in the cautious standpoint normally taken by investment analysts, is related to the idiosyncrasies of the Japanese market, such as appreciation for gadgets and restricted fixed internet access. Furthermore, it is also argued such opportunities are also related to the relative immaturity of the wireless internet market, and that natural increase in competition between providers will tend to decrease the space for paid content.

- Application development and platform standardisation must be encouraged, as was already and rightly performed by the i-mode policies, for example through the adoption of the Java Mobile environment. Because of the existence of positive system externalities or “chicken-and-egg” effects, application developers will be more willing to produce applications where the target market is bigger, and users will be more willing to join the service platform where application diversity and availability is higher. Standardisation on
application and open implementation platforms can adopted as an incentive to reduce development costs.

6.4. Economic Aspects on Mobile Delivery – Individual Work

- The cost structure presented by wireless cellular technology does not present significant returns to scale when compared to fixed network alternative. This occurs mainly to the fine-grained modularity with which network capacity can be increased, which is achieved by the process of cell-splitting and sectoring. The dominant nature of traffic-related variable costs therefore favours a per-usage charging scheme.

- The utility analysis for different wireless and fixed alternative plans without budget restrictions points out that there are different usage regions where each wireless plan is likely to dominate. While such analysis is useful to illustrate the influence of utility preferences as a result of service differentiators, it cannot provide a complete indication on possible consumer choices, as it does not take into account the occurrence of budget restrictions.

- Under budget restriction cases, the analysis of user choice considering the flat rate fixed broadband alternative revealed that the per-usage wireless charging plan faces significant competition in the form of barriers for adoption. This is due to the fact that the user attempting to maximise his utility will generally prioritise the flat rate service, given its theoretical possibility of obtaining unlimited utility. The customer would generally act by firstly spending on the flat rate services, and only then proceeding to spend the remaining fraction of their budget on the per-usage service alternative.

- Under some circumstances, the consumer decision between spending all her budget in wireless quantities or prioritising the flat rate service as a first choice will depend on the relative individual valuations of the wireless service over the fixed. These circumstances occur when the user achieves a satiation point represented by a saturation quantity on the fixed service usage, or his budget for content services is just above the flat rate fee for fixed broadband delivery.

- A unique condition when the consumer the individual user preferences is likely to choose only wireless service regardless of its preferences it when his budget is lower than the flat rate broadband fee. In this case he would choose the wireless plan without upfront payment. This plan has a strategic importance for acquiring the unattended lower budgets market segments, and its availability is a competitive advantage resulting from the absence of significant individual fixed costs for user infrastructure maintenance, as it happens on fixed networks (e.g. local loop).
• The comparison shows that in order to better compete with the flat rate service competitor, the wireless service should ideally be also charged on a flat rate basis. Flat rate is also preferred by personal or residential markets because of the predictability on monthly spending, and this effect could be pointed out by the results from the section of utility maximisation under budget constraint. However, given the survival condition for providers that, in the long-term, prices (without cross-subsidies) must be higher than their average costs, the unlimited access charge situation could result in an excessively high fee. This can be observed on the existing FOMA access plans, where the higher usage plan requires an arguably excessively high upfront fixed fee (reaching €68, 45% higher than the UK's unlimited fixed broadband fee). In cases where even with initial unfavourable cost structure the service was offered in a flat rate basis, it has been verified that the provider will tend to act to alter its cost structure as to minimise their dependency to usage rates, even if it requires further investment. One example of such is the FRIACO flat-rate dialup offering in the UK, where because of an imposition from the regulator, local exchange circuit switched data for internet access had to be offered on a subscription basis. The provider soon started to invest on its packet switched fixed infrastructure so as to bring interconnection points to the packet network as close as possible to the local exchange, therefore offloading its PSTN cost structure from data generated traffic. Even though, as it can be seen from the table of service rates in section 4.6.3, the resulting flat rate fee for unlimited access is almost as high as (83%) the ADSL broadband service.

• Advertisement levels in wireless delivery face a restraining incentive due to the occurrence per-usage transmission charges. Such effect can be understood under the economic notion of complementary goods applied to the composition of communication and content fees. When goods or services are complements, the decrease in attractiveness of one (say because of higher prices) has a negative effect in the demand for the other. In the wireless delivery case, the occurrence of transmission charges on a per-usage basis acts as discouragement for the demand for advertisement embedded content. This consequence can also be extracted from the consumer preferences model, if the level of advertisement is represented by a lower relative content efficiency factor $\beta$, as included in the wireless utility definition. Such tendency has already been verified at the NTT i-mode policy for advertisement restriction on official sites. Lower advertisement embedded in content generated increased efficiency, and its effect was taken in account in the utility models. Another enabler for increasing content efficiency is found on the content encoding methods (XML and XSLT transformations), where different formats transformations can be defined for varying levels of representation richness.
Wireless terminal utility is still likely to be a limiting factor for a number of applications, where it will tend to assume negative valuations. Applications have to be developed in accordance to terminal restrictions so as to minimise its influence. On the other hand, the higher terminal cost for the PC + broadband device competitor, together with its limited penetration and relative disutility arising from complexity on its usage (operational systems, software costs) might act as incentive to penetration of wireless delivery services in unattended markets.

By reasoning over the nature of wireless usage, it would be fair to expect a more equally distributed network traffic pattern throughout the day than the one for fixed networks, or the one of wireless voice calls. Fixed internet experience high peak times at the evening period, when users look for entertainment at home after working hours. Wireless voice networks experience peak times during the morning and in the end of the afternoon as a result of its use for work and social appointments. These factors are not likely to be present with the same intensity as far as mobile wireless internet access is concerned. Given its very value propositions of mobility, availability and personal convenience, wireless access peaks should expected to occur more smoothly throughout the day, in the form of shorter sessions. Being this the case, conditions and policies for time-of-day dependent discounts so as to provide user incentives for utilization during off-peak times could be explored. This would in term optimise the peak-to-average utilization ratio, yielding to lower average traffic related costs. However, if traffic is indeed more equally distributed and there is lack of such external constraints, such incentives could have an adverse effect on the network, as consumers could react by changing their usage pattern. Since the cost of implementation of networks is heavily dependent on capacity and traffic requirements, I believe that verifying the actual traffic distribution of mobile internet data for any deviations from existing networks should be an issue of concern. This is an important characteristic and is proposed as a point for further study.
An important overall conclusion was achieved by trying to apply the concepts here developed so as to compare communications and content services. In my understanding, communications and content can be seen jointly, in the form of complements. With that view, “communications” pure services, taking place on a man-to-man basis, can be still seen as the joint service where one person provides “free” content to the other. The content in this case is originated from social or work interactions, and is paid for indirectly in other forms not associated with the service. Also, in man-to-man interactions people are fairly sure of the relevance of the “content” they exchange, and are therefore assured of its valuation. They will be then willing to financially pay for the complementary “delivery” part of it, hence the inherent high valuation for communications service. “Content” pure services, on the other hand (under the entertainment or informational view) have a higher uncertainty for their valuation, since one source produces the same content for the consumption by a number of individuals. Also, the “content” in this case often requires an additional form of payment, either directly or indirectly (in the form of being exposed to advertisements). Such uncertainty, together with the need to commercially pay for the additional “delivery” part gives rise to a lower average willingness to pay for the content-pure portion, as compared to the communications. From the content provider’s point of view, such uncertainty is translated to a value-based pricing approach. As risks are higher, so is the possibility for higher margin gains. Bundling processes, as examined in the report sections, are a useful tool to help the provider reduce such uncertainty in their offerings. From the communications provider point of view, as risks are lower and the cost components more significant, the commercialisation strategy is translated to a cost-based pricing approach. Bundling in this case is also a helpful instrument, but with its application focused on taking advantage of infrastructure economies of scale. As a result, in my understanding, the successful commercial exploration of content services in the converged communications platform relies on exploring the content attributes to increase its average convenience and attractiveness, and to reduce provider and user uncertainties in their valuations. Increasing attractiveness was explored by the possibility of provision of rich content through streaming services, and user convenience was explored by enabling mobility (and therefore accessibility and availability) of content services. Reduction of uncertainty was proposed in streaming services in the form of enabling a larger online content library, and on the mobile delivery, through exploitation of its customisation and personalisation characteristics.
6.5. Future Work

- Estimate figures for user service valuations and verify the occurrence of fixed and wireless usage saturation points. The study should be undertaken on a market segment base (age, gender, profession, social strata) so as to provide more information on parameters for the consumer preferences model, which would contribute to defining optimal charging models. A method as the Stated Preferences suggested in section 4.3.2 could be employed. As an objective, the study should evaluate to what extent people will regard wireless 3G terminals and broadband fixed access as substitutes. A second point of work could be to estimate actual content efficiency ratios for sample wireless content versions. Such figures, together with user valuations results, would allow for an analysis on to what extent less rich content being delivered to limited handset terminals can be compensated by its mobility feature.

- Develop a study to determine the likely behaviour of wireless internet data traffic. Analyse the assumption of more equal distribution of mobile internet traffic, due to low influence of factors determining peak times, as in other networks. In wireless or fixed networks serving voice calls, two peaks of usage are normally found: one due to working relations in the morning typically from 10 to 12 am and another due to social interactions in the evening, from 4 to 6pm. On internet traffic, because of entertainment and informational home use in the after working hours, peaks occur in the period from 7 to 9pm. As the mobility features of wireless access will free the users from such restraints, it could be expected that wireless traffic would follow a more equal distribution throughout the day. A probable candidate for peak time could be the idle period after lunch, for example. The determination of wireless data traffic distribution would serve as a starting point for determining conditions and policies for time-of-day dependent discounts so as to provide user incentives for utilization during off-peak times. This would in term optimise the peak-to-average utilization ration, yielding to lower average traffic related costs. However, if traffic is indeed more equally distributed and there is lack of such external constraints, such incentives could have an adverse effect on the network, as consumers could react by changing their usage pattern. Since the cost of implementation of networks is heavily dependent on capacity and traffic requirements, I believe that verifying the actual traffic distribution of mobile internet data for any deviations from existing networks should be an issue of concern.

- On a general perspective, a proposed sequence for further investigation would be to explore the economic characteristics and possibilities of applications where content is merged with connectivity services. By doing so, basic content services can have their attractiveness enhanced by connectivity features, and vice-versa. For example, what can
be considered a basic content service as videogames, can attain a much higher valuation when interactivity with other people through communications connectivity is explored. On the other side, basic communications applications such as chat rooms achieve a higher attractiveness when additional enhanced character and context features are added. These services are becoming increasingly available as telecommunications and internet convergence move forward, although little evidence of existing economic studies on the subject were found during our study.
7. Appendices

A - Effects of inclination toward combined choices

As a consideration on the preferences model, an additional effect is suggested. It accounts for the characteristic that display a tendency to place more valuation in a combined bundle of goods than in extreme quantities. Graphically, as a result, this implies that the indifference utility curves acquire a curved concave shape. This means that less quantities of each good are needed in the region where these are of similar amounts in order to yield the same resulting utility. A general mathematical form to take these effects in account is given the name of Cobb-Douglas utilities, and is presented in equation (43). However, this effect has more importance the more distant the goods under analysis are from being perfect substitutes, as for example when maximising the utility derived from quantities of ice-cream and olives, where (if viewed in monthly purchases), the consumer value more having a moderate quantity of both [28]. For the case under analysis, though, both access mediums should be perceived to a greater extent as substitutes, providing a similar service (accessing internet content).

\[ U_T = q_{PC}^a \cdot q_W^b, \]

where

- \( a \) is a function of the PC utility parameters, namely \( \beta \)
- \( b \) is a function of the Wireless utility parameters and differentiators, \( \eta.(\beta + \Sigma \delta) \)

Indifference utility curves for different ratios between the relative valuations \((a \text{ and } b)\) between the both services are pictured below. It can be seen that a graphical analysis to find the maximisation point under these circumstances would no be indicated.
However, if quantities are seen in a logarithmic scale, the indifference utility curves turn linear again. The problem is then shifted to plotting the budget restriction lines. In this case, since PC quantities are charged on a flat rate basis, the budget line is independent of its quantities (for $q_{pc}>0$) and still takes the same form. A persisting difficulty though would be including the budget lines for zero PC quantity (the single separate point), where mathematical problems with the general logarithmic function and zero arise.

Nevertheless, [46]in general terms a conclusion can still be drawn. In logarithmic scale, if correct bounds or approximations are provided for the zero PC quantity budget point, it will be situated closer to the remaining budget line for higher PC quantities. As seen in section 4.6.3, this would make more infrequent or less likely the situations where the choice of pure wireless quantities with no PC units is the maximising utility choice. This is in agreement with the very reason that led to the inclusion of the concave functional form, which is to include the effect that intermediate combination of goods are often more attractive than extreme quantities of a single option.

As to the problem under analysis, this has the implication of making the consumer still more inclined to make a combined purchase, where he would first spend on the flat rate fixed access and the remaining on wireless quantities, as in many of the cases on the previous table. The only case where the user would clearly and definitely adopt only wireless is when it is offered the wireless plan with no upfront payment fee, and his communications budget is not sufficient to afford the flat rate fee for fixed access.
### Billing Plans Overview

**Start-Up Cost**
There is no contract handling fee if you subscribe to FOMA before August 31, 2002.

- Contract Handling Fee: ¥3,000 (Free until August 31, 2002)
- FOMA Terminal
- Accessories (batteries, chargers, cables etc.)

### FOMA Plans

<table>
<thead>
<tr>
<th>Billing Plan</th>
<th>Monthly Charge</th>
<th>Communication Charge</th>
<th>Short Message Charge</th>
<th>Packet Pack Description</th>
<th>Monthly Charge</th>
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<tr>
<td><strong>FOMA Plan 39</strong></td>
<td>¥3,900</td>
<td>¥700</td>
<td></td>
<td></td>
<td>¥2,000</td>
<td>¥0.1/packet</td>
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<td><strong>FOMA Plan 49</strong></td>
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<td>¥2,000</td>
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<td>¥4,000</td>
<td>¥0.05/packet</td>
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<td><strong>FOMA Plan 67</strong></td>
<td>¥6,700</td>
<td>¥4,000</td>
<td></td>
<td></td>
<td>¥8,000</td>
<td>¥0.02/packet</td>
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<tr>
<td><strong>FOMA Plan 100</strong></td>
<td>¥10,000</td>
<td>¥7,300</td>
<td></td>
<td></td>
<td>¥15,000</td>
<td>¥0.02/packet without Packet Pack.</td>
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<tr>
<td><strong>FOMA Plan 150</strong></td>
<td>¥15,000</td>
<td>¥11,600</td>
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<td></td>
<td>¥20,000</td>
<td>¥0.02/packet</td>
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<tr>
<td><strong>FOMA Data Plan 22</strong></td>
<td>¥2,200</td>
<td>¥0</td>
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**Voice communications charges are not available.**

Discounts:
- Long-Term Subscriber Discount
- Lehren Discount
- Japan Discount
- Family Discount
- Business Discount
- Yu Yu Call Discount
- E-Billing Discount
- Bulk LIna Discount

*Note: Charges apply only for voice communications.*
C - Contribution and Documentation Detail

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# D - Definition of Terms

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<tr>
<td>3G</td>
<td>Third Generation Mobile Service</td>
</tr>
<tr>
<td>ADSL</td>
<td>Asymmetric Digital Subscriber Line, Broadband Access Technology</td>
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<tr>
<td>API</td>
<td>Application Programming Interface</td>
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<tr>
<td>ATM</td>
<td>Asynchronous Transfer Mode</td>
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<tr>
<td>CDMA</td>
<td>Code Division Multiple Access</td>
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<td>CDN</td>
<td>Content Delivery Networks</td>
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<tr>
<td>cHTML</td>
<td>Compact Hypertext Mark-up Language</td>
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<tr>
<td>DWDM</td>
<td>Dense Wavelength Division Multiplexing</td>
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<td>EoS</td>
<td>Economies of Scale</td>
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<td>FOMA</td>
<td>Freedom of Mobile Access, NTT Docomo 3G Mobile Service</td>
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<td>FRIACO</td>
<td>Flat Rate Internet Access Call Origination, Dial-up service in UK</td>
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<td>GPRS</td>
<td>General Packet Radio Service</td>
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<tr>
<td>GSM</td>
<td>Groupe Speciale Mobile or Global Service for Mobile Communications</td>
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<tr>
<td>HCSD</td>
<td>High Speed Circuit Switched Data</td>
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<tr>
<td>HTML</td>
<td>Hypertext Mark-up Language</td>
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<tr>
<td>ISP</td>
<td>Internet Service Provider</td>
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<tr>
<td>LRAIC</td>
<td>Long-run Average Incremental Costs</td>
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<td>MC</td>
<td>Marginal Costs</td>
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<td>Multipurpose Internet Mail Extensions</td>
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<td>MMAPI</td>
<td>Mobile Media API</td>
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<td>MPEG</td>
<td>Motion Picture Expert Group</td>
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<td>NTT</td>
<td>Nippon Telephone and Telegraph</td>
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<td>PSTN</td>
<td>Public Switched Telephone Network</td>
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<td>SMS</td>
<td>Short Message Service</td>
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<td>SRAIC</td>
<td>Short-run Average Incremental Costs</td>
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<tr>
<td>SSL</td>
<td>Secure Socket Layer</td>
</tr>
<tr>
<td>TDMA</td>
<td>Time Division Multiple Access</td>
</tr>
<tr>
<td>UMTS</td>
<td>Universal Mobile Telephone Service, 3G Standard</td>
</tr>
<tr>
<td>VPN</td>
<td>Virtual Private Network</td>
</tr>
<tr>
<td>WAP</td>
<td>Wireless Access Protocol</td>
</tr>
<tr>
<td>WML</td>
<td>Wireless Mark-up Language</td>
</tr>
<tr>
<td>XML</td>
<td>Extensible Mark-up Language</td>
</tr>
<tr>
<td>XSLT</td>
<td>XML Style-sheet Transformation</td>
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8. References


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