

# Intellectual property rights and standardization

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## Intellectual property rights and standardization: the case of GSM

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### Abstract

This paper investigates the role of intellectual property rights (IPRs) in the process of standardization in the telecommunications industry. We take the global system for mobile communications (GSM) case as a highly relevant example, being part of a high-tech industry in which standards play a large role. In the process of designing the GSM standard, a lot of attention has been given to IPRs, mainly to avoid a situation in which a single IPR holder could hamper or even totally block the development of the standard. Nevertheless, the ultimate GSM standard contains a large amount of so-called ‘essential IPRs’, i.e., IPRs without which the implementation of GSM products is impossible.

The paper provides a general discussion of the development of GSM and presents a database on the essential IPRs in the GSM standard. This database has been compiled on the basis of international patent statistics, and the data that manufacturers have supplied to European Telecommunications Standards Institute, the European standardization body responsible for defining the GSM standard. We use this database to assess the dynamic IPR position of firms in the original GSM standard and its subsequent development.

We use the GSM case to underline the importance of a general European policy with regard to IPRs and standardization, and derive several concrete recommendations for such a policy. © 2002 Elsevier Science Ltd. All rights reserved.

*Keywords:* Innovation strategies; Patents; Telecommunications; GSM; Essential IPR

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## 1. Introduction

Standards, intellectual property rights (IPRs) and competition law are all developed to serve public interests. Standardization (whether imposed de jure or emerging from the market) can overcome many disadvantages related to a too wide variety of products, services or methods. Without standardization, a battle between different technological systems may emerge, and users may get stranded in technologies that will appear from the market after a while. Obviously, these consumers may face high switching costs, for example they need to discard old equipment. On the producer side, standardization increases economies of scale, and may hence lower the price of consumer goods associated to the standard.

A system of IPRs is often necessary to ensure that individuals or companies will carry out innovative activities. Without IPRs to knowledge resulting from an invention, imitation (e.g., by reverse engineering of products) will erode the inventor's profit rate, and hence lower the incentive for inventive activities. An IPR, such as a patent, grants the inventor a legal monopoly to the commercial exploitation of the invention. An IPR holder is insulated from market competition and on the same hand seen as a promoter for innovation. Competition law seeks to promote consumer and economic welfare by fostering and preserving competition (Guterman, 1997, p. 11). The tension that is created between balancing the diverse interests of the different actors was well brought forward by Mansell (in Hawkins, Mansell, & Skea, 1995, p. 222) *'From a policy perspective, there is an issue as to whether intervention in the market using available alternatives, including standardization, is likely to enhance a given set of policy goals. It can be assumed, on the one hand, that a mature and fully articulated competitive market is present and that it is in this context that standardization choices are taken. On the other hand, imperfect competition, monopolistic competition or oligopolistic rivalry frequently offers more realistic ways of describing a market'*.

At first sight, standardization and IPRs may serve conflicting interests: an IPR is aimed at appropriation of a right to exploit a piece of knowledge by a single firm, while a standard aims to identify a common pool of knowledge to be used by all parties contributing to or using a standard. Still, standards and IPRs do not necessarily conflict. Philips and Sony license their compact disc patents to hundreds of manufacturers. The widely used Ethernet and Token Ring standards for local area networks are based on patents of Xerox and IBM, respectively. In addition, the *Motion Picture Experts Group* (MPEG) audio and video standards cover several patents too. In some cases, patents even apply to standards that are referred to in regulatory measures. The use of the patented modular telephone jack, which can be found on virtually any device that can be connected to the telephone network, is obligatory in many situations in the US.<sup>1</sup>

Such situations are not problematic if the patent holder waives its rights, or makes licenses available at a reasonable fee to all interested parties. The IPR holder is, however, in no way obliged to do so. The IPR holder is entitled to secure any monetary or other compensation (e.g. a cross-license) that it is able to extract from the licensee, can freely choose any license conditions, or set territorial or other restrictions on its licenses. Besides this, it is also not obliged to treat

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<sup>1</sup> This telephone connector is incorporated in the Federal Communications Commission (FCC) Part 68 rules and also is the basis of an IEC standard (Hanrahan, 1995, p. 496).

applicants alike. One may thus easily imagine that under some circumstances, IPRs may inhibit the success of standards, or even inhibit the formation of standards. This potential conflict is the main topic of this paper.

The so-called *essential* IPRs play a crucial role in the potential tension between IPRs and standards. Essential IPRs are defined as protected knowledge that is indispensable for a product that has to comply with that standard. The definition of the essentiality of a patent used by the European Telecommunications Standards Institute (ETSI) is ‘[...] *that it is not possible on technical (but not commercial) grounds, taking into account normal technical practice and the state of art generally available at the time of standardisation, to make, sell, lease, otherwise dispose of, repair, use or operate equipment or methods which comply with a standard without infringing that IPR*’ (ETSI 1998, Annex 6, Clause 15). Note that the given definition does not cover inventions that are commercially essential but not technically essential (i.e. there are technical alternatives but these are prohibitively expensive to implement). Although there have been discussions in standards bodies to include commercially essential patents in their definition as well, this idea was eventually abandoned (Wilkinson, 1991, p. 197). Standardization bodies would prefer to draw up standards that have no or little essential IPR, but in practice, they may not have much choice. Indeed, ETSI takes the view that having essential patents in their standards is inevitable and unavoidable (Tuckett, 1993, p. 23).

Global system for mobile communications (GSM) has been one of the first cases where a serious clash between IPRs and standardization occurred. Eventually, however, GSM became a successful technological and market standard. We chose the GSM industry as a case study in our treatment of the tension between IPRs and standardization. With the increasingly important role of standards in the telecommunications industry, the understanding of how a successful standard can be set also becomes increasingly important. This is even more so because there has been, for more than two decades now, a (strong) global tendency towards a more liberal and open market approach by policy and lawmakers. The GSM case is, of course, a rather peculiar case. The GSM standard is essentially a *de jure* standard, and the process in which this is reached is quite different from standards that emerge in the market. Nevertheless, we feel that the issue of (essential) IPRs is important for all standards, although in the case of market standards, IPR issues will generally be solved in a different way (negotiations will not be influenced so much by (semi-)public bodies).

GSM emerged in an era when the European Commission put much emphasis on de-regulation in the telecommunications markets (promote pan-European markets and services). The objectives of the EC are outlined in the white paper on telecommunications from 1984, the green paper on telecommunications from 1987 and the green paper on mobile and personal communications from 1994.<sup>2</sup> Standardization was seen as absolutely necessary for this process, and also measures were taken to promote technical competitiveness (the RACE program) and diffusion of advanced technology to areas in Europe that were less developed (the STAR program). Although the importance of (essential) IPRs in this process was acknowledged (in particular in communication on intellectual property rights and standardization, COM(92)445), a clear policy with regard to the role of IPRs in telecommunications standards was never put forward by the Commission. This policy emerged largely within ETSI, the body responsible for drawing up the GSM standard.

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<sup>2</sup>COM(84)277, COM(87)290 and COM(94)145, respectively.

Table 1

Estimated suppliers market share of the 33 largest GSM networks in Europe, December 1996, plus world-wide market share of GSM terminals during 1996

Supplier	Market share switching (%)	Market share base stations (%)	Market share mobile terminals (world wide) (%)	Rank on total GSM market
Ericsson	48	37	25	1
Nokia	14	22	24	2
Siemens	21	2	9	3
Motorola	1	13	20	4
Alcatel	10	10	6	5
Lucent	2	4		6
Matra	2	3		7
Italtel	0	5		8
Nortel	1	0	3	9
Philips	0	2		10
Orbitel	0	2		11
Other	1	0	13	—

*Source:* Bekkers and Liotard (1999), pp. 123–124. Ranking is based on the average of all three subsystems market share, assuming that all subsystems are roughly equally important in the total sales of GSM suppliers. Recent market shares are not very different from those in 1996, although for mobile terminals Nokia seems to have won a higher share at the cost of, particularly, Ericsson.

Overall, there are five players (Ericsson, Nokia, Siemens, Motorola and Alcatel) that dominate the GSM market (see Table 1). In each of the three segments switching, base stations and terminals, these five players held  $\approx 85\%$  of the market or more in 1996. We will attempt to provide an answer to the question how these five firms have come to dominate the market, specifically, what role was played in this process by essential IPRs. From the answers to these questions, we are interested in drawing more general (policy) conclusions for the process of technological standardization and the relationship between technology assets and firm success in high-tech markets where standards are important.

The main variables in our research question are interwoven in a complex pattern of causality. For example, at one level of analysis, we find that ownership of essential IPRs may strengthen a firm's position in an alliance network, and this in turn leads to market power. But at the same time, market success will enhance the firm's technological capability (learning effects as well as through availability of resources for R&D investment), and the same can be said about knowledge capital gained through networking. Hence there is a feedback from alliances and market success to knowledge capital and patents (ownership of IPRs). Moreover, there are important factors determining technological capabilities and market success that we cannot take into account in the analysis here (such as historical factors related to the regulation of the market under the PTTs regime). Our intention in this paper is not to disentangle all these causal links in a precise and final way, but rather to provide a narrative interpretation that is well founded in quantitative data and historical analysis of the GSM industry.

## 2. Essential patents in GSM

As a part of the recent IPR policy, ETSI requires its members to notify essential IPRs, and publishes these in the form of a written and electronic document that is regularly updated (ETSI, 1998) (for the earlier development of the ETSI IPR policy, see below). We used the ETSI list published in June 1998 to get an overview of essential patents in GSM. The list contains 380 entries, the large majority of which are individual patents. However, companies use largely different practices in both the filing of patents and the notification to ETSI (see, e.g., Schmoch & Schnöring, 1994). For example, some companies apply for national patents in a few countries (usually countries with large GSM networks); others apply for international patents (European patents or PCT applications filed either at European Patent Office (EPO) or WIPO). Some companies report only patents in Europe or the United States, others also report patents in Asian countries such as China, India and Singapore. In all of these cases, what is one invention may in fact appear as several patents, because of the filing of applications in multiple countries.

We used the EspaceNet webserver of the EPO to eliminate such ‘double counts’.<sup>3</sup> The EspaceNet database is aimed at identifying the so-called patent families, which are exactly the multiple filings of one and the same invention. One may look up a patent document in the database by searching on features such as the applicant or the patent number (we mostly used the patent numbers supplied in the ETSI list). The database will supply a list of all patent documents from other patent offices (and sometimes of the same patent office) that are equivalent to the original hit. Most of the returned patent documents can then be viewed online.

In this way, we reduced the 380 entries in the ETSI list to 140 patents. In the process, we decided to take into account three types of patents only in the final list: European patents, United States patents and International patents (issued with a WO number).<sup>4</sup> The large majority of the original 380 entries can be traced back to an application in one or more of these three systems. The patents from the original list we did not include (89) were patents that were not present in the EspaceNet database (mostly patents in a few Asian countries other than Japan<sup>5</sup>), or French (seven cases) or German (three cases) patents that appeared not to be granted, although they had been filed a long time ago. We dated all patents by their priority date, i.e., the first date of application in any patent system.

By focusing on these three patent systems in the world generally, and for GSM in particular, we feel that the list of 140 patents we have is a fair representation of essential IPRs in GSM. One may argue that the ETSI essential patent database is constructed from notifications of members, and it

<sup>3</sup> We did our searches in the database during the period January–April 2000.

<sup>4</sup> But note that due to the elimination of patent families, we also implicitly consider other patents (e.g., Japanese), which are equivalent to the European, US or Patent Cooperation Treaty (PCT) patents in our list. The order given in the text is also our preferred order, in the sense that if a patent has equivalents in more than one of these three systems, we will preferably note it as a European patent, rather than a United States patent. This is an arbitrary choice, but one without consequences for the conclusions.

<sup>5</sup> It is our impression that most of the Asian patents are in fact covered by equivalent applications under the European or United States system, for two reasons. First, most of the titles of these Asian patents given in the ETSI database are equal to patents we identified as European, United States or international (PCT) patents. Second, patenting in a number of Asian markets only and not in the major GSM market (Europe) would not constitute sensible protection for a firm.

is therefore neither guaranteed that all essential patents are indeed listed in the database, nor that patents present in the database are actually essential to the standard. However, we feel that it is unlikely that many firms that hold essential IPRs in GSM would conceal these IPRs from ETSI, and that therefore the probability that there are many essential patents for GSM that are not in the database is relatively small.

Of the 140 patents in our database, 107 are identified by an EP number (European Patents), 20 are US patents, and the remaining 13 are WO patent numbers (international patents filed under the PCT). 23 firms hold the 140 patents. Fig. 1 gives an overview of the shares of these firms, where we have grouped all firms with only one or two patents under ‘others’. In terms of sheer numbers, Motorola is the largest, with 27 patents. Nokia (19), Alcatel (14), Philips (13) and Telia (10) are the next largest holders of essential IPRs in GSM. It is notable that although operators clearly took the lead in the GSM development and controlled the process, they only hold a minority of the patents (BT, NTT, not shown in the figure are France Telecom and Vodafone, who each have one patent). This is somewhat paradoxical given the usually extensive research facilities they own.

Not all firms have applied for the patents they possess by themselves. In some cases, the original applicants of the patents are subsidiaries, which may have been acquired after the original patent applications. For example, the four Ericsson patents are in fact owned (and applied for) by Orbitel, which was later acquired by Ericsson. Nokia owns patents that were originally applied for by Voicecraft (one patent) and the University of Sherbrooke (four patents). Philips holds patents that were applied for by Felten & Guillaume Fernmeldeanlagen (one patent), and by TRT (one patent). The patents owned by Bull were applied for by CP8 Transpac (in fact, these patents were also registered by CP8 Transpac at ETSI, we have assigned them to the mother company Bull).

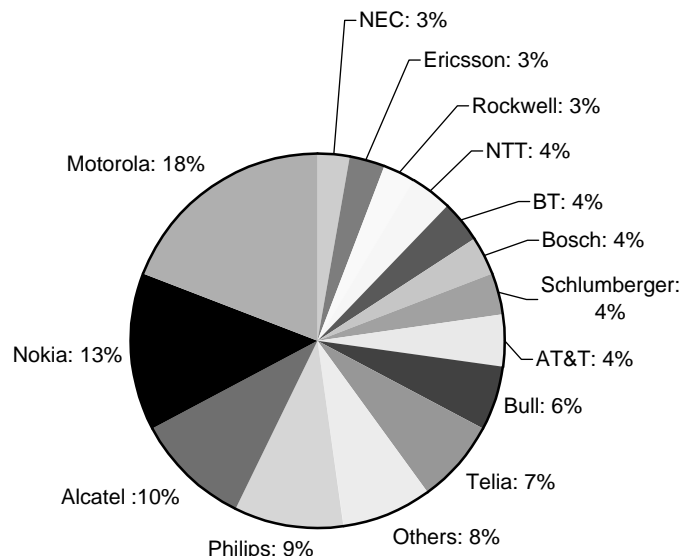


Fig. 1. Shares of firms in essential IPRs in GSM.

### 3. Essential IPRs and the formation of the GSM standard by ETSI

During the period of development of the various technical proposals, actors became increasingly aware of the imminent danger of IPRs for the diffusion of the standard. One of the reasons for the rejection of the main German–French proposal was indeed that it was considered to be ‘too proprietary’.<sup>6</sup> Nevertheless, in 1987, the year that the MoU was signed, it became clear that a substantial amount of essential IPR existed on the chosen design too. After the basic decisions in 1987, some searches had been conducted under the lead of the GSM group to establish which patents were relevant to the standard. These searches were not as comprehensive as they might have been (Garrard, 1998, p. 139). It was soon clear, however, that many existing patents were not simply convenient ways to build GSM equipment, but were absolutely essential to any implementation at all. Companies deeply involved in GSM owned many of those patents, but there also was some uncertainty whether yet undiscovered patents were held by companies not involved in the GSM development at all.

A study from 1988, ordered by the Commission of the EC, showed that unresolved issues associated with the ownership of IPRs, was one of the most serious vulnerabilities of the GSM project.<sup>7</sup> During the procurement activities for GSM networks, in 1988/1989, the real number of IPRs impacted by the GSM standard began to emerge. The single largest IPR holder was Motorola, which claimed to own ‘two dozen to 30’ essential GSM patents (Iversen, 1999a, p. 91). Several holders of essential IPR already stated from the start that licenses would be available under fair, reasonable and non-discriminatory conditions (so-called ‘*license with general declaration strategy*’). When some technology choices had to be made, some IPR holders even declared that they would make their IPR available at no cost, as Philips and IBM did with its IPR for the speech coder that is now being used in GSM. However, some other IPR holders, particularly Motorola, refused to make *general declarations* concerning the licensing of their IPR.

In 1988, under great pressure from the EC, the GSM project was transferred from the CEPT to the newly established ETSI.<sup>8</sup> ETSI, as the first body concerned with standardization, would try to develop a general policy concerning IPRs that went further than just voluntariness (for a comprehensive discussion of the development of this policy, see Iversen, 1999b).

Aware of the risks that IPRs could constitute for them, the main European operators issued an invitation to equipment suppliers in 1988 to tender for network equipment. These operators, acting together as the PG group (procurement group) of the MoU produced a draft procurement

<sup>6</sup>Cattaneo (1994, p. 63). It is not clear whether she refers to property rights owned by members of this main German–French proposal (developed by the SEL from Germany and Alcatel from France), or more generally to the head start that consortium members would have if this technology was selected. Nevertheless, both situations were undesirable for other actors (see also Iversen, 1999a, p. 93).

<sup>7</sup>The PA Consulting Group conducted this study from early 1988 to October 1988, and its confirmation of the good chances for a successful deployment of GSM strongly encouraged all actors (Garrard, 1998, p. 133).

<sup>8</sup>The European Community recognized that the GSM standard would greatly facilitate the strongly wished harmonization in this sector, but regarded the CEPT not as the most appropriate body to set such a standard. One reason was that the CEPT was only open for network operators, not for other actors involved in GSM such as manufacturers and candidate privately owned operators. The CEPT and its member states reacted by transferring the standardization to the ETSI: a newly established standards body that meets all the requirements of the EC. With this new body, the GSM standardization moved to a more institutionalized and more transparent environment.



contract for validation systems. This draft included two specific arrangements (Garrard, 1998, p. 139; Cattaneo, 1994, p. 64; Good, 1991, p. 402; and Wilkinson, 1991, p. 97):

- Manufacturers would be awarded orders only if they were prepared to fully indemnify the operators against patent infringements, even if these were the result of actions by the operator rather than the manufacturers that supplied them;
- It was compulsory for the suppliers to provide *free* worldwide licenses for any patents they held that were essential to the implementation of the GSM system ('compulsory licensing').

Of course, a theoretical objection against both conditions is that they are at odds with general competition rules, as well as they affect the inherent rights of IPR-holders. A practical objection against the first condition in particular is that suppliers were held responsible for actions that were beyond their own powers. By including both terms in their lucrative GSM contracts, the operators hoped that they would turn down the risk that IPR-blocking would prevent the collective launch of GSM. If a supplier did not comply with these arrangements, it was not entitled to bid on any contracts for the supply of digital cellular equipment to MoU members (Wilkinson, 1991, p. 97). The first arrangement, concerning indemnification, was accepted somewhat reluctantly by the suppliers, who were forced to take a pragmatic approach to the costing, estimating the likely level of risk (Garrard, 1998, p. 140). European suppliers were also (reluctantly) willing to accept the second arrangement. Motorola, however, was prepared to run the risk of making a stand against the attempted imposition (Garrard, 1998; p. 140; see also Wilkinson (1991, p. 197), who refers to 'an American company with European operations'). It is exactly the above-described behavior of the telecom operators that illustrates the tension between IPRs and competition law or policy very clear. The agreement on IPR-blocking in contracts with suppliers reached by the operators in the procurement group can be described as a cartel, which is forbidden under EU competition law (Article 81).

By virtue of its extensive R&D activities in several European countries, Motorola had been accepted as one of the manufacturing participants in the GSM standardization process. Still, Motorola was a firm that differed in several senses from the other manufacturers that were involved in the development of GSM. This divergent background can explain to a certain degree why Motorola opted for a different IPR strategy than the other IPR holders involved. First of all, firms from the US, in general, were much more aware of the value of IPR in the late 1980s than European firms. This was especially the case after the demonstration effect of the several lawsuits, including those of Kodak vs. Polaroid, and the successful assertion of an important Texas Instrument patent (see also Hall & Ziedonis, 2000). This resulted in a very pro-patent attitude of US companies. Additionally, Motorola always had to fight for its market. In its domestic telecommunications supply sector, it had to compete with AT&T's vertically integrated manufacturing company, whereas in the foreign telecommunications sector it had to fight against procurement practices that favored national suppliers. Given the existence of such practices, Motorola presumably expected its GSM sales opportunities in the European market to be restricted and saw licenses as its main source of income in return for its research efforts.

Another difference between Motorola and the other suppliers involved in GSM was that the first did not have an existing family of digital switching systems on which it could base GSM switching subsystems. Therefore, for GSM, it was only able to supply terminals and radio base station subsystems, and not switching subsystems. It considered itself to be put at a serious

disadvantage, as the base stations they could supply were merely one-time sales, whereas switching systems can bring in long-term revenues to its suppliers from software licenses and update contracts. As compensation, Motorola hoped to reap revenues from licenses for the radio technology it developed instead (Iversen, 1999a, p. 94).

In the telecommunications sector, Motorola has always followed the strategy of embracing regional (or national) standards. For digital mobile telephony networks, it was involved in GSM in Europe, but another standard in the US (i.e. D-AMPS). As such, it did not agree with the gradually rising worldwide ambitions of GSM, which was initiated as a European effort back in 1982, not as a worldwide one. Motorola continued its support for GSM for Europe, but simultaneously advocated other standards for use in other parts of the world.

A final, but arguably very important difference between Motorola and the other manufacturers involved in GSM was that Motorola heavily patented GSM technology while the standard was being developed (approximately from 1987 to 1991) whereas the other companies believed there was a gentleman's agreement and did not protect their innovations and their contributions to the standard (Granstrand, 1999, p. 204). This difference in patenting does not seem to reflect a difference in R&D intensity; all the large GSM firms are generally assumed to have contributed to the GSM development process with significant research work while developing their products simultaneously. We will discuss the patenting strategy of the various firms in more detail below.

With the strategy of Motorola, and the tacit support that it enjoyed of several other suppliers, the general consensus was that the MoU procurement policy was a failure. Ultimately, the operators decided to revoke their claim for a common IPR policy in their procurement contracts. Thus, licenses for building GSM products or operating GSM networks had to be negotiated individually. A number of operators decided upon a less far-reaching Musketeer's Oath approach. These operators required the supplier of their network to sign a declaration in which it agreed to serve the whole GSM community—suppliers and operators—on fair, reasonable and non-discriminatory conditions. Cattaneo (1994, p. 67) notes: '*[the IPR problem] was not solved, but circumvented by single negotiations among operators and suppliers*'. Most manufacturers agreed to such a statement—though operators had to pay significant amounts to get it. Thus, suppliers were lured into the '*license with general declaration strategy*' to obtain purchase orders. Some suppliers did ask (and received) additional, substantial monetary compensation for agreeing to sign such a statement. Still, Motorola refused to sign any such arrangement that was not related to individual purchase contracts. Some operators did not join the Musketeer's Oath approach, giving Motorola a chance. With its chosen strategy, Motorola opted running the risk of losing a number of procurement contracts to not have to compromise on license conditions, in accordance with the '*license without general declaration strategy*'.

Even though Motorola only won a few initial procurement contracts, all other suppliers had still to succeed in obtaining licenses from this company. Motorola was only prepared to cross-license and not willing to license for monetary consideration (Hansen & Søndergård, 1993, p. 7; Cattaneo, 1994, p. 64; Pelkmans, 1999, p. 12; Garrard, 1998, p. 140). During the 1990–1993 period, four companies entered into such a cross-license agreement with Motorola: Siemens, Alcatel, Nokia and Ericsson.<sup>9</sup> Some observers note that these agreements are confined to Europe

<sup>9</sup> See 'Motorola/Nokia: Austausch von GSM-patenten', in *Funkschau* (12) 1993, p. 50, and the licensing of all Motorola GSM patents to Alcatel in 1992 mentioned in Pan-European Mobile Communications, Issue 9, Spring 1992, p. 7.

(Cattaneo, 1994, p. 68). For the companies involved in these agreements, this cross-licensing reduced market risks. However, for those not involved, it created barriers to enter the market. (To analyze this behavior of cross-licensing from a competition law perspective justifies another article so we will skip the issue here.) Several companies, including Matra from France and Dancall from Denmark, made unsuccessful attempts to secure licenses at an acceptable fee.<sup>10</sup> Japanese suppliers, in particular, were keen to enter the GSM terminal market but the barriers proved to be insurmountable for them for at least some 6 years.<sup>11</sup> Of the many Japanese companies that showed very promising prototypes of GSM terminals around 1992, almost none succeeded to get all the necessary licenses within the first few years of commercial success of the GSM standard. These interests that these firms had in foreign market is also demonstrated by the fact that they did indeed gain a very significant share in other markets, such as that for the American and Canadian AMPS market.

Our essential IPR count above shows that not all of the companies that entered into cross-licensing with Motorola own many essential IPR for the standard itself (and some even have none). But one has to keep in mind that cross-licenses can exchange essential IPR for non-essential IPR, or even for IPR that is not relevant to GSM. Thus, Motorola might have cross-licensed essential GSM patents for non-essential patents, or even for patents that are not relevant to GSM.

New problems surfaced a few years later with another company that suddenly claimed to hold essential GSM IPRs. InterDigital Technology Corporation (IDC) from the US claimed that its patents were infringed in many TDMA-based mobile telephony systems, including GSM. In April 1995, the US Federal Court, however, ruled the claims invalid, making mobile telephone manufacturers around the world breathe a sigh of relief (Electronics Weekly, 5 April 1995, p. 3). InterDigital had already collected 70 million dollars from royalties. One year later, however, German Federal Patent Court upheld one of the InterDigital patents that were found invalid in the US.<sup>12</sup> Still, the company is generally believed to make large sums of money with its GSM patents.<sup>13</sup> The strategy of IDC on this 1991 patent illustrates the ‘*non-disclosure strategy*’.

In March 1993, ETSI put their so-called IPR Policy and Undertaking forward for voting at its General Assembly. The proposal was accepted mainly due to the considerable power that former telecom administrations have in ETSI, compared to that of the manufacturers and other actors (Besen, 1990; Paffen, 1996; and CBEMA, 1993). The approved IPR Policy and Undertaking is best characterized as ‘licensing-by-default’: unless specific actions are taken, an IPR holder *automatically* agrees to license on fair, reasonable and non-exclusive conditions. This was in strong contrast with the practices from other standards bodies, where a firm must explicitly agree to license its IPR.

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<sup>10</sup>In fact, Dancall filed a complaint with the Commission of the EC, in a desperate attempt to eliminate its competitive disadvantages (Pelkmans, 1999, Section 2.2). When the German firm Bosch acquired the firm, in 1997, the latter decided to withdraw the complaint and start negotiations with the relevant IPR holders.

<sup>11</sup>Cattaneo (1994, p. 68); Garrard (1998, p. 140), and Donegan (1995, p. 3).

<sup>12</sup>*InterDigital Patent upheld in Germany*, a press statement published by InterDigital Communications Corporation, 18 November 1996.

<sup>13</sup>An unnamed telecommunications market analyst stated in 1997: ‘*IDC are a patent company [...] They hold several patents vital for GSM and they’ve made stacks of money from them*’. Source: *Alternative 3rd Generation Technology Bids for UMTS Role* (7 August 1997). Total Telecom.

However, as a result of formal and non-formal complaints, the 1993 IPR policy was not instituted despite the fact that it was officially approved by the General Assembly (for a detailed discussion, see Iversen, 1999, 1999a; and Bekkers, 2001). ETSI then decided to abandon its policy before waiting for the judgment of the Commission of the EC, and decided for a less far-reaching IPR policy. The main arrangements of the new policy are as follows:

- Holders of IPR, member or not, will be rewarded in a suitable and fair manner.
- Members will make a reasonable effort to inform ETSI of IPRs they are aware of. If they propose a technical design to ETSI they will also, in good faith, draw attention to IPRs that could become essential if that proposal is adopted.
- If an essential IPR is identified, the director of ETSI will request its holder, member or not, to make licenses available under fair, reasonable and non-discriminating terms.
- ETSI members can choose not to license an IPR. If no other alternatives exist, the director of ETSI will request the holder to revise its position. If a member refuses to do so, it has to inform the director about its reasons; this explanation will be passed on to ETSI's advisors (which include the Commission of the EC).

In the mean time (especially from 1994 onwards), the GSM standard became a big success in Europe. European regulations required two or more GSM operators to be present in each of the EC member state markets. The companies that took part in the cross-licensing scheme supplied virtually all infrastructure equipment: Ericsson, Nokia, Siemens, Alcatel, and Motorola. Many countries worldwide expressed their preference for GSM, and this forced Motorola to lift the regional restrictions in its licenses. With the use of IPRs, Motorola succeeded in having an interesting revenue stream even though it could not offer switching subsystems and even though it knew that its market prospects were restricted. With the internationalization of GSM, non-European suppliers such as Nortel and Lucent (former AT&T) started to play a more active role, but never surpassed the success of the five champions. The same firms that dominated the GSM infrastructure market dominate the GSM terminal market. Also, it is noted that the distribution of shares on the GSM market is quite different from that of markets of other mobile telephony standards.<sup>14</sup>

In the late 1990s, a number of non-European firms (especially from Japan) finally managed to obtain all the necessary licenses to build GSM terminals, but it will be difficult for them to catch up. For suppliers, the participation in cross-licenses turns out to be essential to obtain a strong market position. First of all, companies that do not succeed in securing all the necessary licenses simply cannot market products. As mentioned above, it is generally held that this kept many

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<sup>14</sup>For the NMT standard, smaller manufacturers such as AEG, Smønsen, Talco, Italtel, Cleartone, Storno, Mobira AP Radio (Philips), and Novatel together held a significant share of the market. In addition, there were several Japanese suppliers (Pelkmans, 1999 and Garrard, 1996, p. 50). NEC and Motorola dominated the AMPS terminal market in the US, for several years having a joint market share of over 50% (Garrard, 1996, p. 46–47). For the American digital cdmaOne standard, there is again a whole different set of terminal suppliers including Qualcomm, Lucent, Nortel, OKI, NEC, Samsung, and Sony, with Ericsson as a striking absentee. For the Japanese PDC standard terminal market, Japanese suppliers such as NEC, Toshiba and Sony have a significant share, together with Lucent from the US and Ericsson and Nokia from Europe. Only the terminal market for the American digital D-AMPS standard shares most of the dominant GSM suppliers (i.e. Nokia, Motorola and Ericsson), although it additionally includes Northern Telecom, while Alcatel and Siemens are not present.

potential Japanese and smaller European suppliers from the GSM handset market. This is also the case for many smaller European suppliers.<sup>15</sup> Secondly, those firms that do succeed in getting all the necessary licenses could be forced to pay a premium price for them. Sometimes, IPR holders are only prepared to sell a full bundle of patents that in fact only contain a few essential ones. Our own research has indicated that the cumulative fee paid for GSM handset licenses is very high, and this was recently confirmed by the actor director of the ETNO,<sup>16</sup> who revealed that royalty fees make up to 29% of the costs of GSM handset.<sup>17</sup> Such prices make competing very difficult for those companies that are not participating in the cross-license fees.

#### 4. Firms strategies with regard to essential GSM patents

Bekkers (2001) has reviewed possible strategies of firms with regard to essential IPRs in a standard. He made a distinction between three phases in the standardization process: the pre-standardization phase, the standard production phase, and the standard diffusion phase. For the GSM case, these phases can be identified as follows. The first sub period runs up to the moment when the choice for the basic technology was made, i.e., February 1987. In this period, different technologies and proposals were being developed, at first without a clear vision of a European mobile communications standard, but later on clearly with such a goal in mind. The second sub period runs from February 1987 to roughly 1991. During this time span, the exact implementation of the standard was decided upon, and product development took place in parallel. Third, during the period after 1991, new services and other additions to the standard were developed and standardized.

The priority dates of the 140 patents range from February 1977 to December 1997, i.e., a period of more than 20 years. In Bekkers, Duysters, and Verspagen (2000), it was shown that the cumulative number of essential IPRs in GSM developed relatively smoothly over time, and that sudden jumps in the number of these patents are absent. This does not imply, however, that there are no differences with regard to timing between firms. Fig. 2 gives an indication of this. The bars, which are displayed on the left axis, give the number of patents for each firm. The dots give the mean priority dates of the patents by the firm, where time is measured in months, and February 1977 is denoted as 1.<sup>18</sup> This variable is displayed on the right axis. The vertical lines that surround the dots indicate a range of  $\pm 2$  standard deviations around the mean timing. A long (short) line thus indicates a broad (narrow) period of technical activity of the firm. The two horizontal lines in the figure indicate the subdivision into three periods that we introduced above. The part below the bottom line corresponds to the pre-standard era. The part

<sup>15</sup> For example, one of the first companies to develop a GSM handheld phone, Dancall from Denmark, is reported to have filed a complaint with the Commission of the EC, in a desperate attempt to eliminate its competitive disadvantages (Pelkmans, 1999).

<sup>16</sup> ETNO: European public Telecommunications Network Operators' association.

<sup>17</sup> 3G patent initiatives devised to avoid 'Qualcomm-type' disputes (19 June 2000). Total Tele. Retrieved 4 July 2000 from the World Wide Web: [www.totaltele.com](http://www.totaltele.com). Unfortunately, it is not further specified *what* costs this percentage relates to (production costs, wholesale price, retail price, etc.); however, it may be assumed that percentage mentioned relates to the cumulative fees for licensees that do not cross-license any of their own IPR.

<sup>18</sup> A mean value of 13 would thus, for example, indicate that a firm files its patents, on average, during February 1978.

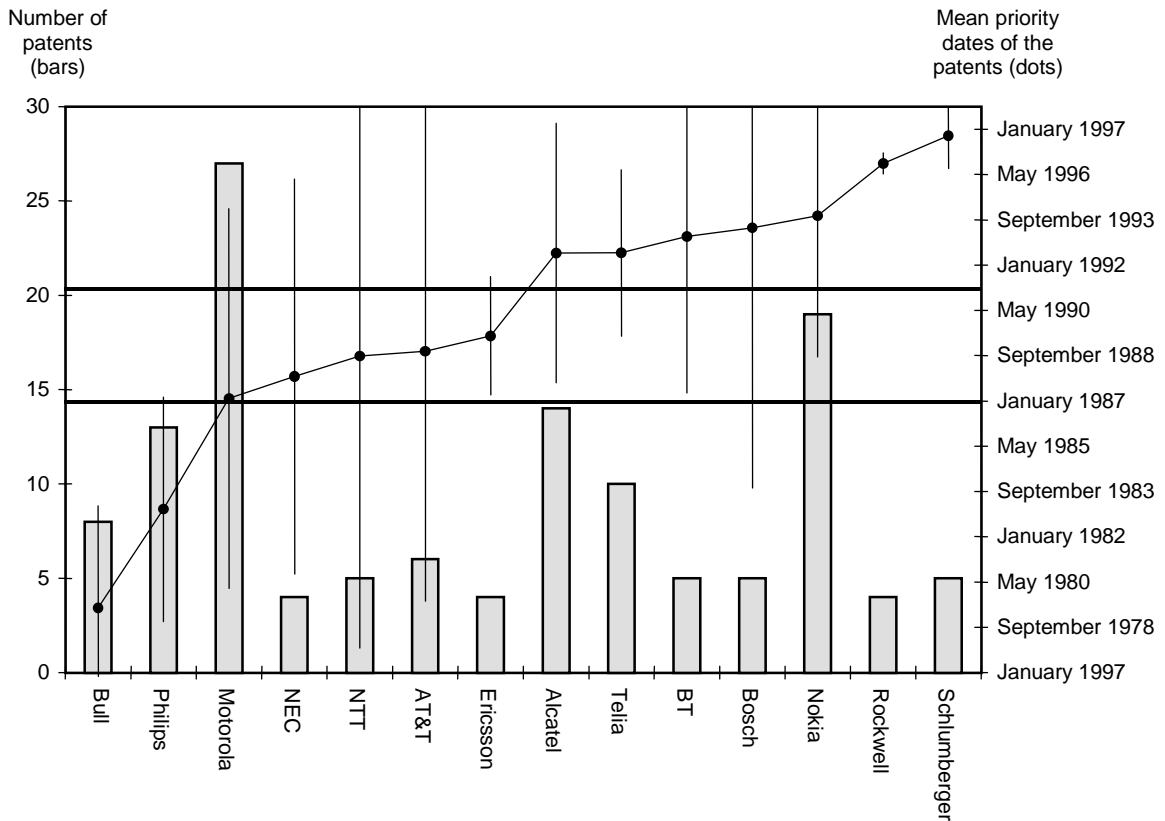


Fig. 2. Timing of firms with regard to essential IPRs in GSM.

in between the two lines refers to the period in which the basic choice for the standard had been made and development took place. The part above the top line refers to the period in which additional services were developed.

The results found here largely confirm a more qualitative interpretation of the role of the various firms in the history of GSM. Bull and Philips are clearly earlier than any other firm. All their patents date from the period before the basic choice for the GSM standard was made, and their inventive activity at the time was therefore clearly made without knowledge of the future standard. For Bull, this is related to the phenomenon that we signaled earlier for the encryption field. Bull, through its subsidiary CP8 Transpac, held a number of patents related to bankcards, which later became relevant for the GSM standard. Philips was initially strongly involved in the GSM development. But Philips did not patent with a very clear intention to exploit essential IPRs once the standard was established, as is illustrated by the fact that it made the licenses for its most valuable patents (the GSM speech coder) available at no costs.

Bekkers (2001) outlines a number of patenting strategies available to firms in the pre-standardization phase. Most of these are concerned with trying to intensify ownership of the standard (e.g., ‘general architecture patenting’, or ‘non-disclosure patenting strategy’). The general conclusion from our data in Fig. 2, and the case description above, is that firms did not

generally apply such strategies in the GSM case during the pre-standardization phase. The clash between essential IPRs and standardization occurred only later in the process.

Motorola has its mean timing value right at the point in time when the standard emerged. As we have already argued above, Motorola's strategy turned out to be rather different than those of the other suppliers involved (see also Granstrand, 1999). Motorola had the advantage that it already had some of its work from the pre-standard period laid down in essential GSM patents. But unlike Philips and Bull, it decided to play a strategy of 'license without general declaration'. Moreover, where other firms refrained from patenting once the basic technical decisions were taken (i.e., during the early phases of the development period), Motorola intensified its patenting activities. In parallel with the gradual work of drawing up the standard and early product development, Motorola applied for numerous patents that turned out to be essential to the standard. It was even accused of stealing ideas of others and applying for patents on them subsequently (Granstrand, 1999, p. 204). Others, in contrast, were also highly involved in the standardization work but did not apply for patents. They were still stuck to the traditional role of IPRs in telecommunications, and believed there was a 'Gentlemen's agreement', in which 'the developers were generous to each other when it came to potential patents' (Granstrand, 1999, p. 204). The licensing strategy that Motorola adopted once GSM products came to the market showed that this firm had two aims with its intensive patenting activities. First, its licenses enabled it to prevent GSM from being adopted in other world regions in which it had different interests. Second, it could set specific license conditions, such as cross-licensing, enabling access to other firms' technology and dictating the structure of the supply market. Around 1990, Motorola to the surprise of many indicated that it held 'two dozen to 30' essential GSM patents. At that time, some Motorola's executives bragged about their firm's patent position.<sup>19</sup>

There are four other companies with patenting activity concentrated in the second period (1987–1991): NEC, NTT, AT&T and Ericsson (Orbitel). It is striking that the majority (three out of four) of these companies is non-European, and that they are all small in terms of the total number of patents. In addition, for NEC, NTT and AT&T, the patents were not primarily aimed at securing a strong position in GSM. The patents owned by these companies were primarily developed for application in other mobile telephony standards such as D-AMPS and PDC, and just happened to be essential to GSM as well. In fact, none of these companies showed particular interest in the GSM standard at the time. NTT and AT&T were planning to use different technologies in their home markets. Although NEC did show some interest in developing GSM terminals (NEC announced GSM products both at the Telecom 91 and CEBIT 92 fair), its interest in this market seems to have waned afterwards. We thus conclude that the in period right after the decision for the basic GSM standard had been taken, Motorola was able to build up a strong position in essential patents, with other firms lagging behind considerably.

In the third period, several of the 'lagging behind' companies strongly increased their inventive activities and the patenting thereof. Especially Nokia and Alcatel were able to gain a large portfolio of essential patents in GSM. For these two companies, the 'Gentlemen's agreement' not to patent inventions that was in force during the period 1987–1991 was not the most important

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<sup>19</sup>There is an interesting statement by Motorola's cellular infrastructure director Bernard Smedley with respect to Motorola's patents: 'I believe it is our birthright. We ought to have 100 per cent [of the market share]' (Financial Times of 26 February 1990, quoted in Pelkmans, 1999, Section 2.1.3).

reason behind their relatively late entry in the patenting field. For Nokia, the main reason is the fact that up to the early 1990s, mobile telecommunications were only a small activity of this firm. In fact, telecommunications and electronics played only a minor role in Nokia up till this period, and strategic research did not have a very high priority. For Alcatel, the explanation is rather different. Alcatel and its predecessors (of which SEL from Germany is of particular importance here) have been very active in R&D for digital mobile telephony systems. Their first projects date from around 1981 (e.g., the government-subsidized ‘Autotel’ study from 1981). The Alcatel technology for mobile communications became the basis for the German–French proposal for a standard in the field that was discussed above, and which became rejected in the negotiations. Alcatel was therefore forced to make a technological re-start, in which the company had to focus on product development and not on the more fundamental mechanisms underlying the technology. The data show that despite this late re-entry, Alcatel made up its lag with an impressive range of patents that turned out to be essential to new GSM services.

## 5. Conclusions and discussion

The GSM case is a highly relevant case providing insight into the tension between IPRs and standardization. The GSM market has become dominated by five major firms (Ericsson, Nokia, Siemens, Motorola and Alcatel) in the late 1990s. Together, these five firms control more than 85% of the GSM market, which is estimated to be worth more than 100 billion US\$.<sup>20</sup> One may thus argue that from a generic point of view, EC policy succeeded in making the GSM(-standard) the dominant technology and market standard. But the policy did not succeed in creating a competitive and open market at least not as seen from the equipment supply side.

The relationship between market power (inclusion in the top-5 equipment suppliers) and essential IPRs is not a one-to-one relationship: our empirical research shows that only two of the five dominating firms hold exceptionally strong positions in essential IPRs. One must thus conclude that a pure quantitative analysis of essential IPRs leaves important parts of the story of how these five companies came to dominate the GSM market untold. The key to understanding these ‘missing links’ largely lie in the activities of one company, Motorola, during the period just after the technical GSM standard had been set.

We identified three periods in the history of GSM. The first is a pre-standard period (until February 1987). In this period, there was huge technological uncertainty on which of the competing technologies would be adopted as the standard. Thus, what later became ‘essential’ IPRs (patents) to the GSM standard from this period, were at the time just one of a number of options for the future. A high number of (with hindsight, essential) patents during this period did not necessarily lead to later dominance in the industry, as is shown by the evolution of the market position of Motorola and Philips.

Philips was the company with most essential patents from the pre-standard period. However, it did not play a major role in the production and sales of GSM equipment afterwards, mainly because the firms’ management suddenly decided to withdraw from this market (Metze, 1991). Its

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<sup>20</sup>Note 1, Communication from the Commission on strategy and policy orientations with regard to the further development of mobile and wireless communications (UMTS), COM(97)513, Brussels.



strong early position in terms of technology and patents did, however, lead to early dominance of the technology alliances network. But this position waned when other players started to develop the GSM standard later on.

Motorola, on the other hand, was able to use its relatively strong position in the pre-standard age in the period in a more vigorous way afterwards. During the period until 1991, which we characterize as the period in which the basic standard was developed, Motorola built up a strong portfolio of essential patents in GSM. Other firms, including those in Europe most involved with the development of GSM (e.g., Ericsson, Siemens, Alcatel), did not follow an aggressive patenting strategy, basically because they were used to manners of conduct in a pre-liberalization European market (Ericsson), or simply because they did not have the inventions yet (Alcatel, Nokia).

By using the negotiation power that came with its patent portfolio, Motorola could dictate its licensing conditions to all firms. The company thus imposed a market structure by conducting exclusive cross-license agreements with a selected number of other parties on the market. These parties were selected because their IPRs were valuable to Motorola (not only essential patents, but also others), or because their product line complemented that of Motorola. Also, Motorola took the position of firms in the alliance network into account when selecting its cross-licensing partners (Ericsson). As a result, the importance of Motorola in the network of strategic alliances increased drastically in the late 1980s.

Firms that took part in the cross-licensing agreements (i.e. Ericsson, Nokia, Siemens, Motorola, and Alcatel) dominate the market for GSM infrastructure and terminals. Only 5 years after the first commercial products were introduced on the market, other companies, including those from the far east and from the American continent, gradually succeeded in capturing some part of this huge market. In the field of technology and essential patenting, this process of catching-up took the form of a number of additions to the standard in the form of more enhanced equipment or services. We denote this as the third phase in the history of GSM. This is the period when some of the major European firms (most notably Alcatel, Nokia and Telia) took out large amounts of essential patents in GSM. This is also the period during which Nokia and Ericsson greatly improved their position in the alliances network.

The play with the essential GSM IPRs, and the strategy of Motorola in particular, dramatically changed standardization processes in the telecommunications industry. From 1992 onwards, many firms have intensified their patenting activities, hoping to obtain essential IPR for future standards or additions to existing standards. Where IPR was considered a non-issue in this sector for many decades, it is now among the main issues to be resolved for any new standard, as has recently been shown with the standardization of third-generation mobile networks.<sup>21</sup> Thus, within the major telecommunications firms, managers seem to have learned their lesson on the strategic importance of IPRs. However, at the level of the public interest in standard setting, the increasingly sharp negotiations about essential IPRs are not necessarily a positive development.

The final question that remains then is how European policy may be applied to avoid the type of oligopolistic market structure that resulted in the GSM case. The research described in this

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<sup>21</sup> For example, the European third-generation mobile standard, Universal Mobile Telecommunications System (UMTS), was threatened to be blocked for over 1 year by the US firm Qualcomm. This firm owns essential patents to the CDMA technology that is employed in UMTS.

paper shows that IPRs play a decisive role in this process. Below, we make two recommendations: one for ETSI, and one for the EC.

The first recommendation relates to a clearer operationalization of the concept of ‘a suitable and fair reward’ for holders of IPRs that are relevant to a standard, or that of ‘fair, reasonable and non-discriminatory conditions’ as mentioned in the ETSI IPR policy. Each standardization process should start from the notion that such a reward must be given to holders of (essential) IPRs. What is suitable and fair cannot be fully defined at a general level, but must be determined on a case-by-case (or standard-by-standard) basis. To ensure an open and competitive market, the cumulative effect of license fees for a standard should particularly be taken into account here. One important step would be that the existence of license agreements and their conditions would be made public, resulting in a most favored nation (MFN) type of construction (the MFN-clause stems from the World Trade Agreement). This would make it much more realistic for a licensee to check whether a licensor meets the non-discriminatory condition of the ETSI or not. Such a transparency would also prevent double payment of royalties (i.e. when both a terminal manufacturer and its component supplier pay for the same patent). A second step would be that a maximum is set to the cumulative license fees for essential patents for a given standard. Licenses should include conditions that allow renegotiations of royalty rates once the cumulative fee exceeds this maximum. A third step would be a set of provisions that prevent licensors to generate considerable delays in reaching agreements, thus creating serious barriers for market entrants. It seems realistic to make these three steps by adding provisions to ETSI’s IPR policy, among other things to prevent rules that are incompatible with rules concerning intellectual property. Although no party is obliged to commit itself to the provisions in this ETSI IPR policy, the consequences for not doing so are severe and almost all parties in the past have chosen to make such commitments.

The second recommendation we make relates to the factual discrimination between formal and non-formal telecommunications standards (read: ETSI standards and others). This discrimination lies, among other things, in the allocation of radio frequency spectrum, network operator licensing practices in EC member states, terminal equipment type approval rules, and procurement rules (see Bekkers, 2001). Altogether, formal standards have much higher chances for success than other standards, and is thus fuelling extreme strategies for those that hold essential IPR for these formal standards. If the EC would further work towards a fully technology-neutral policy, IPR-holders will be prompted to be more modest, as a decision not to license their IPR at all, or only at high costs, will simply result in an alternative standard being embraced. Licensing for modest fees is still more attractive than not licensing at all.

## References

- Bekkers, R. N. A. (2001). *Mobile telecommunication standards: GSM, UMTS, TETRA and ERMES (doctoral dissertation)*. Boston, MA: Artech House.
- Bekkers, R., Duysters, G., & Verspagen, B. (2000). *Intellectual property rights, strategic technology agreements and market structure: the case of GSM*. Paper presented at the Swedish international symposium on economics, law and intellectual property. Chalmers University of Technology, Gothenburg, 26–30 June 2000.
- Bekkers, R. N. A., & Liotard, I. (1999). The tense relation between mobile telecommunications standards and IPR. *European Intellectual Property Review* (3), 110–126.
- Besen, S. M. (1990). The ETSI: A preliminary analysis. *Telecommunications Policy*, 512–530.

- Cattaneo, G. (1994). The making of a Pan-European network as a path-dependency process: the case of GSM versus IBC (integrated broadband communications) network. In G. Pogorel (Ed.), *Global telecommunications strategies*. Amsterdam: Elsevier.
- Donegan, P. (1995). *A priority for the EU review (Editorial)*. Mobile Communications International, Issue 25, p. 3.
- ETSI (1998). *Intellectual Property Rights (IPRs); Essential, or potentially essential IPRs notified to ETSI in respect to ETSI standards* (Version SR000314 V 1.3.1, 1998-6).
- Garrard, G. A. (1998). *Cellular communications: worldwide market development*. Norwood, MA: Artech House.
- Good, D. (1991). 1992 and product standards: a conflict with intellectual property rights? *European Intellectual Property Review* (11), 398–403.
- Granstrand, O. (1999). *The economics and management of intellectual property: towards intellectual capitalism*. Cheltenham, UK: Edgar Elgar.
- Gutterman, A. S. (1997). *Innovation and competition policy: a comparative study of the regulation of patent licensing and collaborative research & development in the United States and the European community*. London: Kluwer Law International.
- Hall, B. H., & Ziedonis, R. H. (2000). *The patent paradox revisited: an empirical study of patenting in the US semiconductor industry, 1979–1995*. Paper presented at the Swedish international symposium on economics, law and intellectual property. Chalmers University of Technology, Gothenburg, 26–30 June 2000.
- Hanrahan, W. F. (1995). Standards for the information infrastructure. In B. Kahin, & J. Abbate (Eds.), *Standards policy for information structure* (pp. 487–501). Cambridge, MA: MIT press.
- Hansen, O. E., & Søndergård, B. (1993). *Does GSM make sense? An assessment of GSM as an example of Paneuropean technology development*. Paper presented at the European conference of international telecommunications society. Göteborg, Sweden, 20–22 June 1993.
- Hawkins, R., Mansell, R., & Skea, J. (1995). *Standards, innovation and competitiveness: the politics and economics of standards in natural and technical environments*. Aldershot, UK: Edward Elgar.
- Iversen, E. (1999a). Standardisation and intellectual property rights: conflicts between innovation and diffusion in new telecommunications systems. In K. Jakobs (Ed.), *Information technology standards and standardization: a global perspective* (pp. 80–101). Hershey, PA [etc.]: Idea Group Pub.
- Iversen, E. J. (1999b). *Standardization and intellectual property rights: ETSI's controversial search for new IPR-procedures*. Paper presented at the first IEEE conference on standardisation and innovation in information technology. Aachen, Germany, 15–17 September 1999.
- Metze, M. (1991). *Kortsluiting: Hoe Philips haar talenten verspilde* [Short circuit: How Philips wasted its talents]. Nijmegen: Sun.
- Paffen, T. (1996). The role of strategic standardization in the context of successful telecom innovations. In *Proceedings of the Third annual EURAS conference on standards and society*, 3–5 May, Stockholm.
- Pelkmans, J. (1999). *The GSM standard: explaining a success story*. Manuscript, submitted for publication.
- Schmoch, U., & Schnöring, T. (1994). Technological strategies of telecommunications equipment manufacturers: a patent analysis. *Telecommunications Policy*, 18(5), 397–413.
- Tuckett, R. (1993). *ETSI's IPR policy: the implications for companies using European telecoms standards*. Patent World, September 1993 (pp. 23–28).
- Wilkinson, S. L. (1991). They're stealing our diamonds: the standards assault on patents. *Revue Canadienne de propriété intellectuelle*, 8(2), 193–205.