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# Local Loop Unbundling in Europe: Experience, Prospects and Policy Challenges (\*)

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**Abstracts:** This paper discusses the development of local loop unbundling in telecommunications markets throughout the European Union. It elaborates on the regulatory framework in Europe and provides an overview of recent experiences in Europe. Different types of unbundling, allowing for different types of entry and services provided by entrants, are discussed. This paper also explores the challenges for policy and regulation that arise because of unbundling and recent, related technological developments in the markets for fixed voice telephony and broadband internet access, particularly the emergence of packet-switched telephony such as VoIP.

**Key words:** local-loop unbundling, VoIP, telecommunications, regulation.

**A** major promise of the liberalization of telecommunications markets was the rollout of local access networks. Somewhat surprisingly, however, local network rollout has been rather disappointing, at least in the light of initial expectations. So far, local network investments have been narrowly targeted, mainly aimed at corporate customers in business districts or metropolitan areas more generally. Residential customers, especially in rural areas, have hardly experienced the rollout of competing local loops to their dwellings. Accordingly, the former monopolists still occupy strong positions in the national markets for local access and fixed telephony.

To a certain extent, residential customers benefited from entry made possible by mandated access to incumbents' networks, as in the case of 'carrier (pre)selection' (CS) and 'local loop unbundling' (LLU). Both types of entry allow entrants without their own local networks to reach end-users by

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purchasing access from incumbents at the wholesale level. Two differences between CS and LLU are that CS requires relatively little investment by entrants, while in order to offer services based on LLU, entrants need to connect to the incumbent's local switches. In terms of required investment levels, LLU-based entry can be seen as an intermediate entry mode between CS and complete facilities-based entry. It should be noted that compared to CS, LLU gives entrants more control over the types and quality of services that they can provide to end-users, since they depend less on the incumbent's facilities.

Whereas CS has been used mainly as a means to offer voice telephony, this turned out to be different for LLU. At first sight, it seems that LLU has failed to give a strong push to competition in markets for fixed voice telephony. Entrants leasing unbundled local lines from incumbents often only use them to offer broadband internet access based on 'digital subscriber line' (DSL) technology. The types of unbundling that are minimally needed to do so – 'line sharing' and 'bitstream access' – prevent entrants from directly offering voice telephony<sup>1</sup>. To offer voice services, entrants traditionally needed a more elaborate type of unbundling ('full unbundling'), giving them full control of the copper pair.

Due to technological developments, full unbundling is no longer the only way to enable voice services. Firstly, entrants offering DSL-based internet access using LLU based on line sharing or bitstream access, can offer 'Voice over DSL' (VoDSL), a packet-switched technology for voice telephony that can be implemented in combination with broadband internet access for end-users. Secondly, consumers with a broadband connection (provided by incumbents or entrants) can install software on their computers, usually in combination with a headset, which allows them to use the internet as an alternative infrastructure for voice telephony. The latter option is a particular example of 'Voice over Internet Protocol' (VoIP). These (and related) developments are important since, despite the limited success of LLU in directly stimulating competition in voice telephony, IP-based telephony may indirectly lead to useful substitutes for switched voice telephony. Even if the uptake of full unbundling (and the supply of voice telephony by entrants using fully unbundled lines) may seem disappointing in several countries, IP-based telephony may drastically change the picture in coming years.

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<sup>1</sup> Line-sharing and bitstream access enable the provision of broadband internet access while the incumbent can continue to offer voice telephony over unbundled lines. Both types of unbundling divide the copper pair spectrum so that it can be used both by incumbent and entrant (OECD, 2003a). See also the following section.

The regulatory challenges and pitfalls of LLU are well known<sup>2</sup>. No matter how advanced the nature of regulatory intervention, there will always be a tradeoff between promoting static efficiency through competition in the short run, and stimulating dynamic efficiency through inducing entrants to roll out their own networks in the longer run<sup>3</sup>. This tradeoff, a 'classic' dilemma in many utility/network sectors, is given an interesting twist though, because of the possibility of IP-based voice telephony. This development is not only important in itself, it may also facilitate competition in telecommunications over different types of networks, such as fixed, mobile and WiFi.

In this paper, we discuss the development of LLU throughout the European Union. We will discuss some countries in more detail, to illustrate specific issues. As a background, the following section recapitulates the regulatory framework in Europe as it pertains to LLU. The section after provides data and country experiences that illustrate the relative success of LLU, both as a direct and indirect way of introducing competition in markets for voice telephony, and as a way of introducing competition in markets for internet access. Then we discuss some challenges for policy and regulation that arise because of LLU and related technological developments.

## ■ Regulatory framework in the EU

We start by providing some background on the technology of local networks and unbundling. A simplified picture of a telecommunications network consists of local loops that connect subscribers to 'main distribution frames' (MDFs), that is, the equipment at the incumbent's premises related to local switches where LLU is implemented, and a backbone which connects different local switches. The local loop refers to the "physical twisted metallic pair connecting the network termination point at the subscriber's premises to the main distribution frame or equivalent facility in the fixed public telephone network" (European Parliament and Council, 2000, p. 4).

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<sup>2</sup> For an overview of the main issues, see e.g. *The Economist*, "Untangling the local loop", Telecoms Survey, Oct. 9th 2003.

<sup>3</sup> This presumes that the social gains from network duplication outweigh its social costs.

Local loop unbundling comes in different versions: full unbundling, line sharing, and bitstream access<sup>4</sup>. With an initial focus on voice telephony, full unbundling was required, as it gives entrants sufficient control of the copper pair to provide voice telephony to their customers. Fully unbundled loops are directly connected from the incumbent's main distribution frame to the LLU operator's equipment – the entrant gets full control of the copper pairs. In contrast, with line sharing, the incumbent remains in control and can still provide (voice) services to consumers, since entrants only lease part of the copper pair spectrum (the high-frequency, non-voice spectrum, which can be used for broadband internet access). Hence, shared access loops remain connected to the incumbent's network and consumers continue to receive voice services from the incumbent. The entrant installs splitters at the incumbent's main distribution frame and the subscriber's premises and connects to the shared local loop<sup>5</sup>. Bitstream access is similar to line sharing in the sense that the copper pair spectrum is also shared by the incumbent and the entrant. The difference is that it is the incumbent that provides the ADSL technology and modems; entrants do not have control over the physical line nor are they allowed to add other equipment. Thus, entrants are restricted to supply services designated by the incumbent (usually broadband internet access).

After the liberalization of telecommunications in the EU 15 countries in the beginning 1990's, European legislation was initially silent with respect to local loop unbundling. However, in the second half of the 1990s, LLU became an important issue. It was seen as a substitute to facility-based entry, particularly in market segments and geographical areas for which an additional access network would be associated with excessively high economic costs. It was also considered to be an important element in giving network operators, who already invested in a backbone, the possibility to directly access consumers.

In the early days of the liberalization of telecommunications it was left to the member states of the European Union to decide whether and how to

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<sup>4</sup> In some countries, bitstream access is viewed as being outside the scope of LLU policy. Bitstream access has also not been introduced in some countries.

<sup>5</sup> Shared access to the local loop is defined as "the provision to a beneficiary of access to the local loop or local sub loop of the notified operator, authorising the use of the non-voice band frequency spectrum of the twisted metallic pair; the local loop continues to be used by the notified operator to provide the telephone service to the public." (European Parliament and Council, 2000, p. 6)

regulate access to the local loop. Some European countries mandated LLU some time before European legislators became active. For instance, in Germany, unbundling has been required since 1996, in Denmark since 1998, and in the Netherlands since 1999<sup>6 7</sup>.

In 2000, that is, before the New Regulatory Framework adopted in 2002, European legislation with respect to LLU was put in place: European legislators mandated the provision of unbundled access to the local loop (European Parliament and Council, 2000)<sup>8</sup>. The general philosophy behind this regulation was that mandatory access is an effective way of dealing with persistent network monopolies, but as it reduces entrants' incentives to innovate and invest in networks themselves, it should be withdrawn as competition becomes sufficiently mature. In particular:

"The high cost of duplicating the local access infrastructure is ruling out new market entrants. This is affecting the level of competition, which the Regulation is intended to increase by offering unbundled access to the local loop, i.e. by enabling new competitors to offer high bit-rate data transmission services for continuous Internet access and for multimedia applications based on digital subscriber line technology as well as voice telephony services." (European Parliament and Council, 2000, p. 4).

Mandated unbundling only applied to operators that had been designated by their NRAs (national regulatory authorities) as having significant market power (SMP)<sup>9</sup>. Moreover, access prices (the line rentals of the local loop) had to be transparent, non-discriminatory, fair, and set on the basis of cost-orientation.

"Costing and pricing rules for local loops and related facilities should be transparent, non-discriminatory and objective to ensure fairness. Pricing rules should ensure that the local loop provider is able to cover its appropriate costs in this regard plus a reasonable return, in order to ensure the long term development and upgrade of local access infrastructure. Pricing rules for local loops should foster fair and sustainable competition, bearing in mind the need for investment in

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<sup>6</sup> The type of unbundling may be different across countries. See also the following section.

<sup>7</sup> Clearly, whether demanding LLU access is attractive for competitors very much depends on the terms at which access is offered. We address the pricing of access below.

<sup>8</sup> See also DELGADO *et al.* (2004, p. 170).

<sup>9</sup> "This Regulation mandates unbundled access to the metallic local loops only of notified operators that have been designated by their national regulatory authorities as having significant market power in the fixed public telephone network supply market under the relevant Community provisions" (European Parliament and Council, 2000, p. 4)

alternative infrastructures, and ensure that there is no distortion of competition, in particular no margin squeeze between prices of wholesale and retail services of the notified operator. In this regard, it is considered important that competition authorities be consulted." (European Parliament and Council, 2000, p. 4).

To make this happen, NRAs were given the power to intervene in the market. This included the power to set the price for LLU. Cost-orientation of LLU rental is not further specified, but NRAs typically include common cost components and a rate of return on investments for the incumbent (this is also in line with the New Regulatory Framework, see below). In principle, interfering at the wholesale level, in particular with respect to price, is a temporary measure. Indeed, when the local access market is seen as sufficiently competitive, incumbent operators are no longer required to provide access at cost-orientated wholesale prices <sup>10</sup>.

With the approval of the New Regulatory Framework (NRF) in 2002, the European Union has established an updated and broader framework for regulatory interventions.

"In markets where there continue to be large differences in negotiating power between undertakings, and where some undertakings rely on infrastructure provided by others for delivery of their services, it is appropriate to establish a framework to ensure that the market functions effectively. National regulatory authorities should have the power to secure, where commercial negotiation fails, adequate access and interconnection and interoperability of services in the interest of end-users." (European Parliament and Council 2002).

Similar to earlier legislation, unbundled access to the local loop is a regulatory remedy to deal with dominance (BUIGUES, 2004). If the NRA establishes SMP, it must apply appropriate remedies. This has to be done on the basis of a list of obligations formulated in the Access Directive as part of the NRF (European Parliament and Council, 2002), related to transparency, non-discrimination, accounting separation <sup>11</sup>, access (unbundled access and resale of facilities), price control and cost

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<sup>10</sup> "When the national regulatory authority determines that the local access market is sufficiently competitive, it shall relieve the notified operators of the obligation laid down [...] for prices to be set on the basis of cost-orientation." (European Parliament and Council, 2000, p. 7)

<sup>11</sup> Ideally, accounting separation makes it possible to track the relevant costs for providing access. "Accounting separation allows internal price transfers to be rendered visible, and allows national regulatory authorities to check compliance with obligations for non-discrimination where applicable." (European Parliament and Council, 2002, p. 9). However, a full separation of costs is impossible, in particular in the case of line-sharing.

accounting. With respect to the latter, high wholesale prices and price squeezes are explicitly mentioned.

"A national regulatory authority may [...] impose obligations relating to cost recovery and price controls, including obligations for cost orientation of prices and obligations concerning cost accounting systems, for the provision of specific types of interconnection and/or access, in situations where a market analysis indicates that a lack of effective competition means that the operator concerned might sustain prices at an excessively high level, or apply a price squeeze, to the detriment of end-users. National regulatory authorities shall take into account the investment made by the operator and allow him a reasonable rate of return on adequate capital employed, taking into account the risks involved." (European Parliament and Council, 2002, p. 30).

Note that the NRA is not obliged to impose particular obligations. According to several NRAs (e.g. in the Netherlands and Germany), access regulation is typically appropriate, especially in the early stages of competition, when entrants have not yet rolled out alternative infrastructures. With this logic in mind, and in particular, to gradually eliminate distortions in entrants' make-or-buy decisions, OPTA (the Dutch NRA) designed a wholesale, cost-based price schedule for full unbundling, with the cost basis starting at historical costs, gradually increasing over a five-year period, to current or actual costs<sup>12</sup>. After this period, KPN should be free to set a commercially determined line rental. The five-year period was viewed as being representative of a minimum recovery period for substantial investments such as those needed in the telecoms market<sup>13</sup>. After a delay of one year, the pricing scheme was implemented. We are currently approaching the end of year 4. Hence, the level of line rental is approaching current costs (as planned), but interestingly, line rental cost has decreased, due to the fact that the number of lines has been growing and costs can be shared over more lines. It is unclear what will happen after year 5 though, as the outcomes of OPTA's market analyses (as a part of the implementation process of the NRF) are still uncertain.

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<sup>12</sup> OPTA (1999), in particular § 31. See also OPTA's press release of March 19<sup>th</sup> 1999. DOYLE (2000) discusses the potential commitment problem of this type of regulation.

<sup>13</sup> For an economic analysis supporting this claim that LLU regulation may be needed to stimulate competition, see DE BIJL & PEITZ (2002 and 2004a). As has been recognized by regulators and the academics alike, regulators have to be aware that LLU regulation may make investments in competing infrastructure unattractive (lease price increases over time and sunset clauses are proposed remedies). In addition, cost-based regulation contains the risk that owners of local access networks make inefficient investment decisions. See also BOURREAU & DOGAN (2005).



The European legislator recognizes that short-term competition through mandated access may come at the cost of long-term competition through investments. However, this conflict is not resolved. The Access Directive only states that:

"The imposition by national regulatory authorities of mandated access that increases competition in the short term should not reduce incentives for competitors to invest in alternative facilities that will secure more competition in the long term." (European Parliament and Council, 2002, p. 9).

Hence, although one of the key questions with respect to LLU regulation is raised, the NRF does not provide any indications how long-term investment incentives in alternative access networks can be maintained even though access prices are regulated.

## ■ Recent developments in local loop unbundling

To-date it may appear that LLU has failed to give a strong push to competition in markets for fixed voice telephony. Competition is still mainly based on carrier (pre)selection, also known as 'indirect access'. The percentage of consumers in the 15 pre-accession member states of the EU using direct access, that is, cases in which entrants offer telephony services over their own local lines or unbundled local lines leased from the incumbent, was 6.5% in 2004<sup>14</sup>. Competition through direct access (including own local line, cable and LLU) was strongest in Denmark (18%), Spain (11%) and the United Kingdom (17%)<sup>15</sup>. Table 1 depicts incumbents' market shares by retail revenue in the fixed telephony market, as well as the percentages of subscribers using an entrant for direct access in member states of the EU. We observe that, in terms of overall retail revenues, the incumbent operator's market share is over 50% in all 25 member states. However, a relatively low market share of the incumbent is not necessarily reflected in a large subscribers' share using an entrant for direct access. For instance, in Austria and Sweden, where the incumbent with 55% and 54% respectively has the lowest market share in our sample, 5% and 1% of subscribers respectively use an entrant for direct access. This means that

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<sup>14</sup> European Commission (2004b), p. 60.

<sup>15</sup> European Commission (2004b), p. 59.

there is substantial retail-based competition, but little infrastructure-based competition (including LLU) in these countries.

**Table 1 (\*)**

| <i>Country</i> | <i>Incumbent's market share (%)</i> | <i>Share of subscribers using entrant for direct access (%)</i> |
|----------------|-------------------------------------|---|
| Austria        | 55.0                                | 5.0   |
| Belgium        | 72.6                                | 6.7   |
| Cyprus         | 99.9                                | na  |
| Czech Rep.     | na                                  | na  |
| Denmark        | 63.2                                | 18.0  |
| Estonia        | na                                  | 3.0   |
| Finland        | 95.0                                | 5.0   |
| France         | 74.2                                | 0.5   |
| Germany        | 68.0                                | 4.0   |
| Greece         | 85.9                                | 0.0   |
| Hungary        | 98.8                                | na  |
| Ireland        | 83.0                                | na  |
| Italy          | 68.0                                | 3.6   |
| Latvia         | 94.2                                | 0.0   |
| Lithuania      | 97.1                                | 0.4   |
| Luxembourg     | na                                  | 0.4   |
| Malta          | 100.0                               | 0.0   |
| Netherlands    | 76.0                                | na  |
| Poland         | 88.7                                | na  |
| Portugal       | 88.3                                | 6.0   |
| Slovakia       | 100.0                               | na  |
| Slovenia       | 100.0                               | 0.0   |
| Spain          | 73.6                                | 11.0  |
| Sweden         | 54.0                                | 1.0   |
| UK             | 63.7                                | 16.9  |

(\*) Incumbent's market share in fixed telephony market Retail revenues, December 2003, data for Germany and Lithuania exclude internet, market shares for Denmark and Portugal by traffic minutes; percentage of subscribers using an entrant for direct access, including fully unbundled connection or with cable access owned by an alternative operator (1 July 2004, Austria, Belgium, Greece, Italy, and Sweden: 31 December 2003).

*Source: European Commission (2004c), figures 18, 23.*

Let us now focus on LLU. Table 2 reports unbundled lines supplied by incumbents <sup>16</sup>. Note that this is only a snapshot of the situation in July 2004 because the landscape is changing very rapidly, as broadband access is expanding quickly and NRAs may modify their regulatory policies and decisions.

<sup>16</sup> Note that in several countris there are, in addition, a substantial number of requested unbundled lines which so far have not been supplied (see European Commission, 2004c, p. 73).

It is interesting to note that in several countries, access is of one particular type and other forms do not play a role. This may be due to differences in regulatory decisions. For example, in Germany there are no provisions for bitstream access, and no such lines are effectively available. In Germany almost all lines come as fully unbundled. This is in contrast to, for instance, the Netherlands, where the vast majority of lines are offered as shared access (and bitstream access is also not used). In other countries the vast majority of unbundling is via bitstream access, for instance in the United Kingdom and Belgium. We observe that the four types of wholesale access, full LLU, shared-line access, bitstream access and simple resale access (the latter type is not depicted in table 2), play an important role in the EU. The use of line sharing is the most recent phenomenon: the total number of shared-line access increased from 191,500 for the whole EU in July 2003 to 1,168,828 in July 2004 (European Commission, 2004c, p. 65). This reflects regulatory interventions and the increasing importance of broadband services (see below).

Table 2 (\*)

| Country     | Supply of fully unbundled lines | Supply of shared lines | Supply of bitstream access | Total supply of unbundled lines |
|-------------|---------------------------------|------------------------|----------------------------|---------------------------------|
| Austria     | 45,862                          | 18                     | 71,300                     | 117,180                         |
| Belgium     | 4,750                           | 2,635                  | 86,539                     | 93,924                          |
| Czech Rep.  | 10,035                          | 10,247                 | 0                          | 20,282                          |
| Denmark     | 53,602                          | 26,630                 | 56,163                     | 136,395                         |
| Estonia     | 2,652                           | 0                      | 0                          | 2,652                           |
| Finland     | 96,600                          | 31,600                 | 29,500                     | 157,700                         |
| France      | 13,066                          | 717,654                | 854,205                    | 1,584,925                       |
| Germany     | 1,627,846                       | 1,141                  | 0                          | 1,628,987                       |
| Greece      | 932                             | 160                    | 21,845                     | 22,937                          |
| Hungary     | 0                               | 0                      | 41,064                     | 41,064                          |
| Ireland     | 305                             | 1,195                  | 10,990                     | 12,490                          |
| Italy       | 697,530                         | 158                    | 750,000                    | 1,447,688                       |
| Latvia      | 0                               | 0                      | 0                          | 0                               |
| Lithuania   | 0                               | 0                      | 2,249                      | 2,249                           |
| Luxembourg  | 2,376                           | 0                      | 0                          | 2,376                           |
| Malta       | 0                               | 0                      | 0                          | 0                               |
| Netherlands | 39,625                          | 281,504                | 0                          | 321,129                         |
| Poland      | 0                               | 0                      | 0                          | 0                               |
| Portugal    | 4,845                           | 0                      | 32,525                     | 37,370                          |
| Slovakia    | 0                               | 0                      | 0                          | 0                               |
| Slovenia    | 0                               | 0                      | 911                        | 911                             |
| Spain       | 40,302                          | 2,142                  | 495,966                    | 538,410                         |
| Sweden      | 10,972                          | 87,795                 | 3,200                      | 101,967                         |
| UK          | 7,466                           | 5,949                  | 224,941                    | 238,356                         |
| EU total    | 2,658,766                       | 1,168,828              | 2,681,398                  | 6,508,992                       |

(\*) DSL unbundling with fully unbundled lines supplied by the incumbent; shared access lines supplied by the incumbent; bitstream access lines supplied by the incumbent; total number (sum) of access lines (July 2004). No data available for Cyprus.

Source: European Commission (2004c), p. 73.

We will now look more generally at the deployment of unbundling throughout the European Union. In addition to data provided by the EU, exhibited in table 3, we calculated the ratio of the total supply of unbundled lines to the total number of available local lines. This penetration ratio is a measure of the current potential for competition through unbundling in the overall market for fixed telecommunications (broadband internet access and voice telephony, either directly offered or by means of IP-based technology, offered by entrants without their own local access networks). The reader should keep in mind that country differences can have very different causes. For instance, a high take-up of LLU can sometimes be explained by the absence of alternative local networks (e.g. cable) or differences in the availability of wholesale service (e.g. bitstream access or wholesale line rental).

**Table 3 (\*)**

| <i>Country</i> | <i>PSTN local lines (million)</i> | <i>Total supply of unbundled lines</i> | <i>Agreements with entrants</i> | <i>Unbundling penetration (%)</i> |
|----------------|-----------------------------------|--|---------------------------------|-----------------------------------|
| Austria        | 2.99                              | 117,180                                | 78                              | 3.92                              |
| Belgium        | 4.50                              | 93,924                                 | 26                              | 2.09                              |
| Cyprus         | 0.42                              | na                                     | na                              | na                                |
| Czech Rep.     | 3.52                              | 20,282                                 | 4                               | 0.58                              |
| Denmark        | 2.11                              | 136,395                                | 22                              | 6.46                              |
| Estonia        | 0.43                              | 2,652                                  | 7                               | 0.61                              |
| Finland        | 2.73                              | 157,700                                | 0                               | 5.79                              |
| France         | 33.83                             | 1,584,925                              | 32                              | 4.69                              |
| Germany        | 37.50                             | 1,628,987                              | 95                              | 4.34                              |
| Greece         | 5.60                              | 22,937                                 | 13                              | 0.41                              |
| Hungary        | 3.60                              | 41,064                                 | 18                              | 1.14                              |
| Ireland        | 1.59                              | 12,490                                 | 13                              | 0.79                              |
| Italy          | 26.60                             | 1,447,688                              | 225                             | 5.44                              |
| Latvia         | 0.60                              | na                                     | na                              | na                                |
| Lithuania      | 0.82                              | 2,249                                  | 17                              | 0.27                              |
| Luxembourg     | 0.24                              | 2,376                                  | 6                               | 0.97                              |
| Malta          | 0.21                              | na                                     | na                              | na                                |
| Netherlands    | 7.80                              | 321,129                                | 25                              | 4.12                              |
| Poland         | 11.12                             | na                                     | na                              | na                                |
| Portugal       | 3.99                              | 37,370                                 | 11                              | 0.94                              |
| Slovakia       | 1.20                              | na                                     | na                              | na                                |
| Slovenia       | 0.70                              | 911                                    | 4                               | 0.13                              |
| Spain          | 16.88                             | 538,410                                | 48                              | 3.19                              |
| Sweden         | 5.50                              | 101,967                                | 246                             | 1.85                              |
| UK             | 29.60                             | 238,356                                | 99                              | 0.81                              |
| EU total       | 204.08                            | 6,688,992                              | 983                             | 3.28                              |

(\*) Incumbent's PSTN activated main lines; total supply of unbundled lines by incumbent to entrants (full unbundling, shared lines, and bitstream access); total number of agreements with entrants (full unbundling, shared lines, and bitstream access); unbundling penetration as total supply of unbundled lines by incumbent over incumbent's PSTN activated main lines (July 2004).

*Source (except the unbundling penetration): European Commission (2004c), p. 73.*

Note from table 3 that one of the frontrunners of deregulation, the UK, has one of the lowest unbundling penetration rates. There is also a large variation in the relative uptake of fully unbundled lines and shared lines across member states (implicit from tables 2 and 3). Countries like Germany and Italy show high shares of full unbundling. The Netherlands and Sweden show substantial numbers of line sharing. In Finland and France, line sharing and bitstream access are both important, in roughly equal proportions.

Tables 2 and 3 may both give the impression of a relatively low level – compared to initial expectations – of unbundled lines by entrants in 2004. According to OECD (2003a), this slow progress is due to the detailed requirements related to implementing LLU, which have slowed down actual implementation arrangements. Another reason may be the fact that incumbents have been slow to upgrade their main distribution frames<sup>17</sup>. This type of upgrading by the incumbent is necessary to make unbundling possible. However, the relatively low deployment statistics discussed above pertain to a single year, and hence contain no information on growth rates over time. Actually, the growth rate of LLU deployment has been quite high in some countries. In Germany, for instance, the ratio of unbundled loops to the total number of local loops increased from 0.27% in 1999 to 1.2% in 2001, while in Denmark, it rose from 0.4% in 2000 to 1.0% in 2001.<sup>18</sup> European Commission (2004a) reports an increase of 110% in unbundled local loops (fully unbundled and shared lines) from 1.8 million (mid 2003) to more than 3.8 million (mid 2004) in the 15 pre-accession member states of the EU, which, according to the Commission, can be explained by 'decisive regulatory action', in particular related to pricing. A more recent illustration of the promise of a fast take-up of LLU is provided by France. In France, there were more than 1 million unbundled lines (primarily line sharing) in December 2004, which contrasts to 360,000 at the beginning of March 2004, and only 3,000 at the beginning of 2003 (Ofcom, 2004a, b). Overall, uptake was initially slow, but this was not necessarily a regulatory failure and, given the high growth rate, penetration may become much higher in the near future.

To comment further on the growth of unbundling, we provide recent time-series information for the Netherlands. See figure 1 for data on unbundled lines from January 2003 to December 2004. In the Netherlands, line sharing

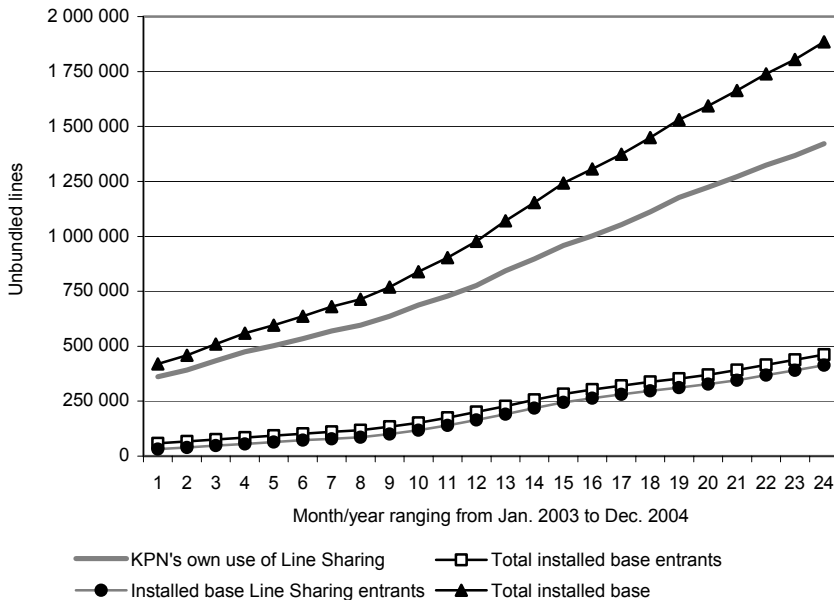
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<sup>17</sup> OECD (2003a), table 8, p. 22.

<sup>18</sup> See data on the 'unbundled ratio' in OECD (2003a), table 3, p. 20.

is the dominant type of LLU-access. Bitstream access is not used, while a relatively small number of lines are of the fully unbundled type.

**Figure 1: Unbundling in the Netherlands in the period January 2003-December 2004 (monthly data)**



Source: OPTA (non-confidential information obtained through private communication)

One can see from figure 1 that, over a period of two years, penetration by entrants using LLU increased from close to zero to over 400,000 unbundled lines. The figure also illustrates the large gap between the number of 'unbundled' lines (a misnomer) used by incumbent KPN itself, in order to offer broadband internet access as a retail product, and those (i.e., truly unbundled lines) used by its competitors. In absolute terms, this discrepancy has widened during the years 2003-2004: from the underlying data it can be seen that the gap grew from 328,778 in January 2003 to over 1 million unbundled lines in December 2004, if we restrict ourselves to line sharing. In relative terms, however, this is not the case, since entrants' share of the total installed base in line sharing increased from 12% to 20%. Nevertheless, KPN still has a strong lead in the broadband internet access market (if we ignore the position by cable companies, about which the figure does not provide any information). At this point, it is too early to say anything about the state of competition in the broadband market in the near future, also

because it is still uncertain which technologies will exhibit the highest take-up<sup>19</sup>.

Since, to-date at least, entrants are using unbundling mainly as a means of offering broadband internet access, let us now focus more on this type of service. Table 4 gives a break-down of broadband retail lines.

**Table 4 (\*)**

| Country     | Incumbent's<br>broadband lines | Of which<br>DSL lines | Entrants'<br>broadband lines | Of which<br>DSL | Of which<br>LLU |
|-------------|--------------------------------|-----------------------|------------------------------|-----------------|-----------------|
| Austria     | 249,400                        | 249,400               | 456,325                      | 106,325         | 106,325         |
| Belgium     | 731,825                        | 731,809               | 712,848                      | 157,485         | 85,669          |
| Cyprus      | 14,520                         | 14,490                | 0                            | 0               | 0               |
| Czech Rep   | 30,000                         | 30,000                | 46,000                       | 6,000           | 0               |
| Denmark     | 539,343                        | 427,322               | 299,807                      | 134,790         | 134,790         |
| Estonia     | 51,876                         | 50,780                | 50,895                       | 126             | 51              |
| Finland     | 411,800                        | 306,600               | 160,300                      | 93,400          | 93,400          |
| France      | 2,358,200                      | 2,270,407             | 2,557,287                    | 2,220,080       | 1,584,925       |
| Germany     | 4,704,906                      | 4,700,000             | 710,341                      | 586,141         | 586,141         |
| Greece      | 10,245                         | 10,245                | 15,686                       | 12,692          | 12,692          |
| Hungary     | 111,228                        | 101,197               | 111,751                      | 41,064          | 41,064          |
| Ireland     | 45,360                         | 43,060                | 20,210                       | 12,490          | 12,490          |
| Italy       | 2,475,881                      | 2,455,802             | 1,043,916                    | 767,386         | 766,673         |
| Latvia      | 27,427                         | 26,815                | 6,477                        | 0               | 0               |
| Lithuania   | 31,986                         | 31,825                | 56,293                       | 2,249           | 2,249           |
| Luxembourg  | 18,630                         | 18,101                | 6,704                        | 4,027           | 2,376           |
| Malta       | 4,511                          | 4,511                 | 9,227                        | 6,915           | 0               |
| Netherlands | 1,053,000                      | 1,053,000             | 1,319,529                    | 321,129         | 321,129         |
| Poland      | 181,501                        | 181,501               | 10,806                       | 10,806          | 0               |
| Portugal    | 530,422                        | 260,341               | 137,128                      | 37,383          | 37,383          |
| Slovakia    | 9,900                          | 9,900                 | 11,785                       | 7,200           | 0               |
| Slovenia    | 54,236                         | 52,929                | 22,103                       | 911             | 911             |
| Spain       | 1,536,148                      | 1,535,179             | 1,231,479                    | 550,993         | 550,993         |
| Sweden      | 439,000                        | 434,000               | 647,167                      | 251,967         | 101,967         |
| UK          | 1,117,474                      | 1,114,974             | 3,278,087                    | 1,638,087       | 238,356         |
| EU total    | 16,738,819                     | 16,114,188            | 12,922,151                   | 6,969,646       | 4,679,584       |

(\*) Incumbent's broadband retail lines; incumbent's DSL lines; entrants' broadband retail lines; new entrant's DSL lines; new entrant's DSL unbundled lines (full LLU, shared line, or bitstream access) (July 2004).

Source: data reported in or calculated from European Commission (2004c), p. 74.

One can make several observations from table 4. Compared to voice telephony (mentioned above), the market for broadband looks much more competitive. In a number of countries, incumbents serve less than half the broadband market. This includes countries with broadband penetration above the EU average, such as the United Kingdom, Austria, Sweden, the

<sup>19</sup> In some cities, alternative local broadband networks based on WiFi are constructed as a means to bypass the incumbent's and cable companies' networks.

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Netherlands, and France. Note that incumbents mostly offer DSL lines. In a few countries the incumbent also owns a cable operator and offers broadband by means of cable modems (notably in Denmark and Portugal). The type of competition from entrants is heterogeneous across countries. The entrants' access is overall more evenly spread between DSL and other means than for incumbents. At the EU level more consumers subscribe to entrants' DSL lines than to broadband access via other means.

The other dominating form of access is cable. With respect to the entrants' DSL lines, resale of these lines plays an important role only in a small number of countries, most notably the United Kingdom. As can be seen from comparing the last column of table 4 with the second column, unbundling access currently constitutes an important role for competition in, for example, Denmark, the Netherlands, France, and Italy, to name a few countries. The European Commission (2004c) also provides data on the type of unbundling access for broadband. A similar pattern across countries emerges, as with respect to the availability of wholesale access, which is documented in table 2.

With respect to broadband, we shall now discuss some national experiences in more detail <sup>20</sup>. Denmark was an early mover with respect to LLU. Fully unbundled lines were mandated in 1998, and line-sharing in 2001. By October 2001 entrants had gained a market share of 44% of DSL lines. Just over a year later (December 2002), their market share was down to 21%. Note that this does not imply that a large number of consumers switched back to the incumbent because the total market was increasing fast. However, the incumbent priced more competitively and entrants were no longer able to gain a large share of subscribers. Note also that in Denmark, LLU was not the only way for operators apart from the incumbent to offer broadband services. In addition, broadband is provided by upgraded cable television networks. Hence competition for the incumbent operator came from facility-based (cable operator Telia Stofa, a subsidiary of TeleSonera), as well as unbundling-based operators (in particular Tiscali and Cybercity) <sup>21</sup>.

Belgium has also experienced the important role of competition played by cable in the broadband market. Actually, it was cable operator Telenet that first offered high-speed internet access in 1997, followed by other players in

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<sup>20</sup> A large part of the information presented below is taken from ISMAIL & WU (2003).

<sup>21</sup> The other big cable operator is owned by the incumbent telecommunications operator.



1998 and 1999, and ahead of the incumbent telecommunications operator Belgacom, which only started to offer DSL services in 1999. Since almost all households have access to cable and DSL services, facilities-based competition is essentially in place in all geographical areas. In line with European regulation, LLU access was mandated in 2000. By 2002, some ISPs gained a combined 15% share of DSL subscribers through broadband access from Belgacom.

The early success of cable operators in Belgium, and partly Denmark, contrasts with developments in the same period in Germany. Although a large majority of households (86% in 2002) also had access to cable in Germany, most of these cable networks did not offer high-speed internet access simply because the incumbent telecommunications operator Deutsche Telekom owned most cable networks. Any success in Germany with respect to LLU therefore has to be seen in light of the failure to establish facilities-based competition.

Certainly, the regulated wholesale price, in relationship to actual costs, is an important factor determining different penetration rates in different countries and across different types of access. We therefore examine wholesale prices and, since we do not have cost data, draw some inferences from the incumbent's retail price. The most relevant price for LLU is the monthly line rental (or lease price) of a local loop charged by the incumbent, which is typically regulated. In addition, there may be co-location costs (e.g. the cost of renting space and power usage in the incumbent's premises) and a one-off cost for a line connection. As outlined previously, according to the New Regulatory Framework, the line rental should be cost-oriented. However, 'costs' are open to interpretation. Depending on the country, the line rental may include certain administrative, common and refurbishment costs. The line rental also depends on the type of unbundling (full unbundling, line sharing or bitstream access).

Table 5 depicts the levels of line rentals and retail subscription fees for the cases of full unbundling and line sharing<sup>22</sup>. As before, the international comparisons should also be interpreted with caution here. For instance, price differences may be caused by differences in service levels.

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<sup>22</sup> Data for bitstream access were not available.

Table 5 (\*)

| Country     | Rental of fully unb. line | Average total cost fully unb. line | Rental of shared line | Average total cost shared line | Residential subscr. fee |
|-------------|---------------------------|------------------------------------|-----------------------|--------------------------------|-------------------------|
| Austria     | 10.9                      | 15.4                               | 5.5                   | 14.5                           | 15.98                   |
| Belgium     | 11.6                      | 16.3                               | 1.7                   | 6.5                            | 16.80                   |
| Cyprus      | 11.7                      | 17.0                               | 7.3                   | 14.0                           | 9.97                    |
| Czech Rep.  | 15.5                      | 42.0                               | 8.7                   | na                             | 9.44                    |
| Denmark     | 8.6                       | 12.5                               | 4.3                   | 7.4                            | 16.00                   |
| Estonia     | 8.9                       | 13.7                               | na                    | na                             | 6.26                    |
| Finland     | 11.3                      | 25.3                               | 5.7                   | 15.5                           | 11.77                   |
| France      | 10.5                      | 17.1                               | 2.9                   | 9.4                            | 13.00                   |
| Germany     | 11.8                      | 15.8                               | 2.4                   | 7.5                            | 15.66                   |
| Greece      | 10.4                      | 13.4                               | 5.2                   | 9.1                            | 12.38                   |
| Hungary     | 11.8                      | 24.4                               | 4.3                   | 16.9                           | 12.86                   |
| Ireland     | 16.8                      | 26.9                               | 9.0                   | 19.3                           | 24.18                   |
| Italy       | 8.3                       | 11.6                               | 2.8                   | 7.1                            | 14.57                   |
| Latvia      | 9.0                       | 13.4                               | 4.5                   | 8.9                            | 6.34                    |
| Lithuania   | 12.5                      | 20.4                               | 6.7                   | 16.8                           | 6.66                    |
| Luxembourg  | 15.8                      | 31.3                               | 7.5                   | 23.9                           | 18.40                   |
| Malta       | na                        | na                                 | na                    | na                             | 6.56                    |
| Netherlands | 9.6                       | 12.0                               | 1.9                   | 5.0                            | 18.16                   |
| Poland      | na                        | na                                 | na                    | na                             | 9.71                    |
| Portugal    | 12.0                      | 19.0                               | 3.0                   | 10.3                           | 15.07                   |
| Slovakia    | na                        | na                                 | na                    | na                             | 7.39                    |
| Slovenia    | 15.3                      | 21.5                               | 7.0                   | 12.8                           | 10.70                   |
| Spain       | 11.4                      | 13.2                               | 3.0                   | 5.5                            | 15.28                   |
| Sweden      | 11.4                      | 25.3                               | 5.4                   | 15.4                           | 13.75                   |
| UK          | 13.3                      | 24.4                               | 3.4                   | 13.9                           | 16.84                   |
| EU average  | 11.2                      | 17.5                               | 3.3                   | 10.0                           | 14.40                   |

(\*) Monthly line rental of fully unbundled lines; monthly average cost per fully unbundled line; monthly line rental of shared lines; monthly average cost per shared line; monthly residential subscription fee (in EUR, August 2004).

Monthly average total costs are equal to the monthly rental plus 1/12 of the one-off connection fee. Prices exclude co-location costs.

Source: European Commission (2004c), figures 76-79, 83

Note from table 5 that the line rental of a shared line is typically less than half the price of a fully unbundled line. Related to this observation is the fact that line sharing allows the incumbent to remain active as a supplier of voice telephony, contrary to the case of full unbundling. Furthermore, in some countries (Czech Rep., Estonia, Cyprus, Latvia, Lithuania, Slovenia), the line rental for full unbundling is higher than the retail subscription fee for residential customers. Such a situation, which can be characterized as a 'price squeeze', makes it impossible for a LLU-based entrant to make positive profits from (only) selling voice telephony subscriptions to end-users (provided that it sets similar per-minute prices to those charged by the incumbent). Price squeezes seem to be becoming less common, however, due to ex ante regulatory intervention or ex post control by the competition authority. Indeed, we do not find indications for a price squeeze in the 15 pre-accession member states of the EU. In particular, the price squeezes in

Germany and the UK, which were present in 2002 (OECD 2003b, table 6.20, p. 189), have now disappeared <sup>23</sup>.

Clearly, a price squeeze is not very promising for entrants to profitably penetrate the market. However, it would be wrong to conclude that the difference between the incumbent's retail price and the wholesale price it is allowed to charge for access adequately explains the penetration across countries. A 'well-behaved' example is Italy, where the uptake of fully unbundled lines has been quite high, in combination with a relatively low level of the line rental for this type of unbundling. The uptake in Germany, however, seems to be higher than one would expect by considering the level of the wholesale price. Similarly, some countries with a high take-up of line sharing have had a low line rental (for example, France, the Netherlands), while others (such as Sweden), had known a relatively high wholesale price <sup>24</sup>. Indeed, several additional factors, particularly the availability of alternative direct access, are important in explaining cross-country differences.

## ■ Challenges for policy and regulation

Most of the regulatory challenges and pitfalls of LLU are well known. According to *The Economist*:

"How best to promote competition over the local loop is by far the most controversial topic in telecoms regulation. Ideally, competitors would put an end to the incumbents' local-loop monopoly by building their own networks. But building a competing network with the same reach is hugely expensive and time-consuming. [...] over the past few years, most of the developed world has been asking incumbents to share their networks with rivals—technically known as "local loop unbundling" (LLU). This means treating the incumbents as a special case and regulating them in an "asymmetric" way, at least until competing networks have been constructed. By allowing competitors to lease or resell lines, regulators have been able to foster competition in both telephony and broadband access." (*The Economist*, "Untangling the local loop", Telecoms Survey, Oct. 9th 2003).

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<sup>23</sup> In 2003, the European Commission fined Deutsche Telekom for eliminating the margin that entrants need to compete for end-users (see the Commission's press release "Commission fines Deutsche Telekom for charging anti-competitive tariffs for access to its local networks", IP/03/717, 21/05/2003).

<sup>24</sup> See also OFCOM (2004a, b) for cross-country comparisons.

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While LLU-access certainly is a means for entrants to offer direct access, we have seen in the previous section that no simple conclusions from the European experience emerge with respect to the effect of lease prices on competition. Clearly, if LLU is not offered and there are no alternatives for direct access, competition cannot result. Hence, from a short-term perspective, regulatory intervention to guarantee direct access at reasonable rates furthers competition. However, when speaking of competition, we mainly refer to retail prices or the level of market penetration by entrants. The latter seems a more appropriate indicator to us, because the lack of competitors is often accompanied by retail price regulation, meaning that the level of retail prices contains little information about the degree of competition in a market. The question is then to what extent LLU lease price regulation affects market penetration. Again, the data presented in the previous section does not give a clear answer. From a theoretical perspective, we would expect a lease price increase that is at least partly shifted to the retail segment. In the extreme case that the entrant does not generate additional demand for subscriptions (only creating cannibalization effects as in the case of fixed voice telephony), the theoretical prediction is that a lease price increase translates one-to-one into higher retail subscription fees (DE BIJL & PEITZ, 2004b). This implies that lease price regulation is actually neutral to competition in the sense that the market share of the incumbent is not affected and that the entrant is indifferent to the level of the lease price, provided that the total number of subscribers remains constant. This may be a reasonable approximation for fixed voice telephony and implies that LLU is rather ineffective in stimulating competition for voice telephony. Our understanding is that current demand for broadband access by end-users is much more price-elastic. This means that lower broadband prices draw additional consumers into the market. If this is the case, LLU regulation has a greater impact on penetration by entrants for broadband than for voice telephony (DE BIJL & PEITZ, 2004b). Therefore, it seems important for regulators to explore the difference in regulatory impact between voice and broadband.

Apart from understanding the effectiveness of LLU lease price regulation, it is important to understand the direction of LLU-regulation and how it fits into the more general picture of regulation within telecommunications. There are several reasons why we would like to stress this.

Firstly, suppose for the sake of the argument that narrowband is for voice and broadband for data, and that fixed and mobile telephony are two separate markets. With respect to broadband, regulators should consequently ask: do most consumers wish to have fast broadband

connections that can increasingly be used to demand innovative services, such as movies on demand? Or is there perhaps little need for such advanced products, and do consumers care more for decent speed at low prices? The answer to these questions is of major importance for unbundling policy. To address these questions, the regulator needs to develop an understanding of the preferences of end-users, potentially even about services which do not yet exist. If the answer to the first question, but not the second one, is affirmative, wholesale regulation of the local loop should encourage full unbundling and line sharing and discourage bitstream and simple resale access. However, if the answers are the opposite, then regulation should respond accordingly and, in particular, make bitstream access and simple resale access (e.g. wholesale line rental) available at low wholesale prices.

We should add that the regulatory problem may be somewhat different. It seems likely that entrants will opt for a 'dual play' strategy, namely a strategy offering a bundle of voice and broadband internet access services. In itself, voice may not be sufficiently profitable, but coupled with broadband it is a means to fully break consumers' ties with the incumbent. As a result, there may even be a strong increase in the number of fully unbundled lines used by entrants in countries that have so far known an uptake of mainly line sharing or bitstream access, as it allows them to offer such bundles and completely take over end-users. Moreover, the picture becomes more complex as 'triple play' may become the nature of the game, consisting of bundles of voice, broadband internet access and video. In the Netherlands, for instance, incumbent KPN is already active in the provision of all three services (offering digital TV, as an alternative to cable, by providing an antenna to consumers for a wireless connection).

Secondly, unbundling is part of the broader issue of infrastructure-based versus retail-based competition. That is, an important question for regulation is whether full network duplication, no duplication of the local access network but investment duplication in technology at the local loop (DSL by entrants), or not even this type of investment duplication is desirable. Again, the answer to this question should depend on the preferences of end-users and, of course, the economic costs of undertaking such investments. The current economic costs depend on general country factors (such as geography, GDP etc.), as well as telecommunications specific factors such as whether cable networks are already in place. In the longer run, infrastructure-based competition is likely to require less regulatory intervention and, therefore, the social costs of regulation appear to be smaller. However, it is not clear whether competition between two (or three) operators with full-access

networks (say the incumbent and a cable operator) is seen as sufficiently competitive<sup>25</sup>. If not, even with infrastructure-based competition, regulation may be desirable so that the regulator has to stay active with respect to LLU even in the long run. To summarize, access-based entry modes (LLU and CS) may remain important as a means to increase the intensity of competition at the retail level. As a downside, such regulation may reduce investment incentives<sup>26</sup>.

Thirdly, the distinction between voice and broadband (for data) is becoming less useful as IP-based voice telephony gains ground. An important question for regulators is consequently how regulation is affected by developments related to IP-based voice telephony (VoIP, VoDSL). Should VoIP be subject to the same regulations as voice telephony? At the time this paper was written, the European Regulators Group (ERG) had decided, for the time being, to abstain from intervening at a European level in the IP-based voice telephony<sup>27 28</sup>. The ERG expects that VoIP, if not hindered by regulations (such as those designed for 'traditional' telephony services), will lead to strong reductions in the price of voice services. Similarly, cheaper VoIP-based services may have a strong effect on the uptake of broadband internet access. It is worth noting that low line rentals for line sharing and bitstream access indirectly facilitate the uptake of VoIP, and hence may act as an accelerator for competition in voice telephony. Clearly, the emergence of VoIP will pose a whole range of regulatory challenges.

Fourthly, there is a fundamental way in which VoIP relates to the static versus dynamic efficiency tradeoff. In addition to competition through LLU,

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<sup>25</sup> In several European countries cable operators have partly upgraded their network to offer high-speed internet access (see also the previous section). Other networks such as Ethernet LAN are available only for few households in the EU. Hence, without LLU, only one or two operators (the incumbent or incumbent plus one entrant) could offer direct access.

<sup>26</sup> Recall that LLU-regulation of operators with SMP is in general cost-oriented. As mentioned in section 2, the lease price should include a reasonable return on investment. Note that innovative and risky new services require a higher rate of return than less risky, less innovative services. This means that even cost-oriented access regulation leaves room for the regulator to decide whether it wants to encourage or discourage infrastructure investments. The regulator simply has to adapt its definition of cost-orientation.

<sup>27</sup> ERG (2005). See also the ERG press release of February 11th, 2005.

<sup>28</sup> Exceptions are that the issue of telephone numbers must be technology-independent (so that VoIP-providers cannot use region-independent codes), and that emergency numbers must be accessible through VoIP. NRAs are still free to intervene, so the development of VoIP may follow different paths among member states, if different regulations are applied throughout the EU.

wireless local access networks (WLANs), wireless local broadband networks based on the WiFi protocol, and also the third generation of mobile telephony (UMTS), can also help to introduce local competition in the broadband market. Given that these types of networks are packet-switched broadband networks, they can also be used for VoIP-based telephony.<sup>29</sup> Hence, the emergence of VoIP stimulates the growth of different types of ways of reaching end-users. At some point, it may happen that the local access networks of incumbents cease to be the primary way of connecting customers, but just one out of a whole variety of equally effective ways. LLU-regulation has to respond to this type of convergence.

## ■ Conclusion

Unbundling of the local access network has sometimes been called a failure. Looking at the deployment of full unbundling to allow entrants to (directly) offer fixed voice telephony to their customers, this may indeed be the case. Presumably, the profitability of plain voice telephony is just too low, compared to the total cost associated with leasing (fully unbundled) local lines from an incumbent.

Unbundling, however, has a large potential as a means to offer broadband access to end-users for entrants without local networks. Line sharing and bitstream access are types of unbundling that allow entrants to offer this service, while keeping the incumbent in sufficient control of its local lines so that it can continue to use them to offer voice telephony. The uptake of these forms of unbundling has been relatively successful. Moreover, as VoDSL and VoIP gain ground, the intensity of competition in voice telephony can be expected to increase in the near future, despite the 'failure' of full unbundling to break open the market for fixed voice telephony.

Overall, unbundling is likely to lead to more competition in telecommunications services, probably faster than would have happened without regulatory intervention. The question is, however, whether this is good for welfare not only in the short run, but also in the longer run. Does mandatory unbundling create a path for entrants to build up market share quickly during the time that they need to roll out their own networks? Or does

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<sup>29</sup> For the sake of the argument, here we primarily view UMTS as a local access network for broadband Internet.

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it eliminate their incentives to connect end-users themselves? If the latter is true, is this good or bad for welfare? What kind of competition and what sort of innovation and variety offered by operators, does society value most? This fundamental question should underly policy and regulation on unbundling. It could also be very interesting, as well as important for policy makers, to compare the European regulatory model with a fundamentally different approach, such as the one in South Korea, namely without network-sharing regulation <sup>30</sup>. Overall, despite considerable experience with unbundling of the local loop throughout Europe, some fundamental dilemmas and uncertainties are still to be resolved.

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<sup>30</sup> Apparently, in South Korea this has led to fierce facilities-based competition, characterized by substantial investments in fiber-optic cables as well as a fast adoption process, in the Korean broadband market. See "Bringing the Broadband Miracle to Europe", *The Wall Street Journal*, October 11th, 2004.



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