Local Loop Unbundling in the Italian Network

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ABSTRACT

Unbundling consists of the possibility for a new operator to have special access to an incumbent's network infrastructure in order to provide value-added services without the necessity to duplicate the infrastructure itself. Local loop unbundling has received the most attention in Europe and in Italy. Most Italian operators are interested mainly in physical access to copper loop, which gives the opportunity to offer broadband services pervasively by exploiting the capabilities of xDSL technology. Technical issues to be faced in offering these services are severe and include loop qualification, interference evaluation, and shortage of available loops. Nonetheless, the Italian case, where more than 20 incoming operators are planning to deploy services on unbundled local loops, demonstrates that this opportunity can be a major driver for the development of the broadband services market.

INTRODUCTION

In recent years, Italy, as all developed countries, moved toward liberalization of the telecommunications sector, according to the Directives of the European Parliament and Council [1–6]. Suppressing restrictions on offering telecommunications services and building new infrastructures, together with provisioning licenses to incoming operators, made competition for telecommunications services possible.

Nevertheless, these measures are not sufficient to boost open market development and unrestricted competition, aiming at balanced economic development. An action undertaken by regulation authorities is also necessary in order to guarantee, among other things, efficient utilization of existing infrastructures, avoiding unnecessary duplications, while regulating prices and access rights to those facilities that are necessary for service provisioning (*essential facilities*).

In Italy, the Regulation Authority for Communications (*Autorità per le Garanzie nelle Comunicazioni*, AGC) was established in 1997, to regulate the national telecommunications and broadcast television system. In telecommunications, the Authority grants licenses to network operators and service providers, and assigns concessions for radio frequency band use. Moreover, it regulates interconnection among network operators.

Dealing with interconnection, one of the thorniest issues is *unbundling* [7, 8]. The term conveys the idea of granting access to some network elements without selling additional services in a bundle together with them. In general terms, unbundling is the process by which the former monopolist, or *incumbent operator* (IO), grants incoming *other licensed operators* (OLOs) access to some elements of the network infrastructure, such as copper pairs, digital bitstreams, and frequency bands in a telephone local loop [8], at a regulated price level without releasing ownership. Usually, the unbundling contract includes both the physical use of unbundled network elements and some basic maintenance duties.

Local loop unbundling has received the most attention in Europe and in Italy. According to [6], it means access to the physical twisted pair circuit connecting the subscriber premises to the main distribution frame located at the local switching office. The OLO can have access to either the full-frequency spectrum on the twisted pair (*full unbundled access*) or the nonvoice band of the spectrum (*shared access*). The importance of local loop unbundling lies mainly in two things: on one hand, the massive investments necessary for building alternative infrastructures; on the other, the availability of new digital subscriber line (xDSL) technologies, which make possible to offer pervasively broadband services on copper pair infrastructures originally deployed to provide plain old telephone service (POTS).

Figure 1 shows a typical copper loop access architecture. This figure can be taken to represent the most frequent case for the Italian

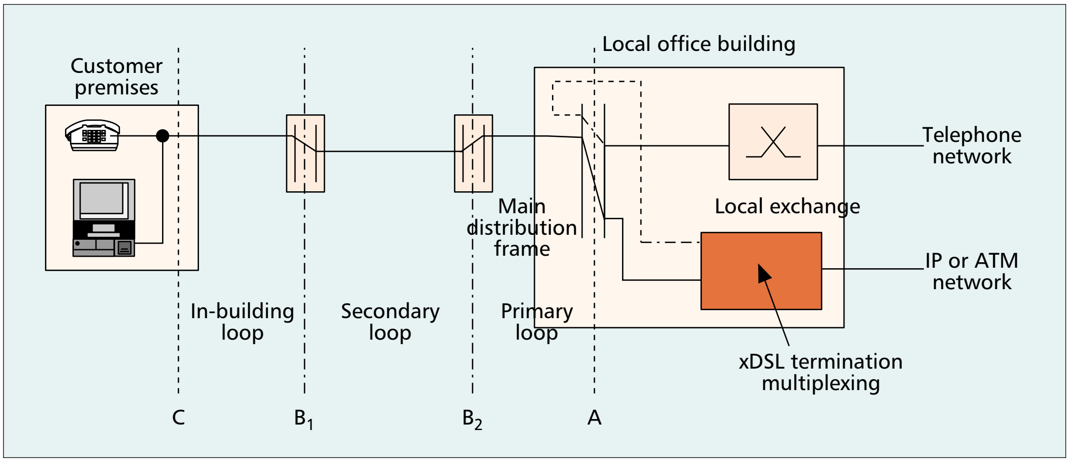

Figure 1. *Typical copper loop access architecture.*

Among the radio solutions, the most interesting are presently those belonging to the LMDS family. Such systems are based on a central antenna serving an area where many other antennas are placed at customer sites.

network, although many different configurations are possible across its 24 million loops. In particular, the loop can be divided into three sections: the primary loop between the main distribution frame (MDF) and an intermediate distribution frame located outside the IO premises, the secondary loop that reaches the third distribution frame, which can be at or near the building basement, and the in-building loop. To give some typical figures, in Italy the cable size is 1200–2400 pairs in the primary loop and 50–400 pairs in the secondary loop. Moreover, the distribution frame at B_2 cross-connects 300 ÷ 400 pairs of the primary loop to 400 ÷ 600 pairs of the secondary loop, while the distribution frame at B_1 cross-connects a few dozen pairs. The demarcation points indicated with B_1, B_2, and A are all possible unbundled access points. The configuration where an intermediate point (B_1 or B_2) is used for OLO access is called *subloop unbundling*.

Although the copper local loop is by far the most important case of unbundling, we must notice that the principle itself is very general: several portions of a network may be unbundled, and the concept can be extended to other physical media, such as fiber or coaxial networks. The possibility of offering unbundled access to other networks elements beyond the access connection has been considered, especially in U.S. regulation. In this article the expression "local loop unbundling" refers extensively to different kinds of access networks, not limited to copper twisted pair loop.

This article surveys several technical aspects of local loop unbundling, with special regard to the Italian case. First, its basic features are outlined and various unbundled services detailed. Then the article focuses on unbundling the twisted pair local loop: transmission technologies, electromagnetic issues and pair availability are addressed. Finally, the Italian case is presented in some detail.

The authors collaborated in devising the unbundling services specified by the Italian regulation and in drafting the relative technical specifications [9]. However, the ideas presented in this article are personal and do not necessarily reflect any official position of AGC.

Unbundling the Local Loop

Alternatives to Unbundling the Local Loop

Unbundling the local loop is not the only option OLOs have in order to pursue their goals. However, some of those options are not applicable in Italy (e.g., exploiting cable TV infrastructures, widely deployed in the Netherlands, the United Kingdom and the United States). The following solutions are feasible in Italy.

Carrier Preselection — Admitted in Italy for local telephony since January 2000, it is a possible alternative to unbundling, at least in the short term. Nevertheless, it is only suitable to provide POTS and allows just per-minute and per-call accounting, thus limiting the OLO in devising new pricing mechanisms.

Wholesale Services — In this case the OLO does not control the access network, but uses the services offered by another operator, most likely the IO, which has deployed and manages xDSL access. In most cases this is the fastest way to reach the broadband market, but leaves little technical control and small price margins for the OLO. In Italy at present, the great majority of broadband clients of the OLOs are connected through wholesale services of the IO Telecom Italia.

Deployment of an Alternative Wireline Loop — This solution is not only highly expensive, but also implies unpredictable delays due to difficulties in obtaining excavation concessions. Thus, it may be considered only in areas with high business density. In several Italian cities (Milano, Roma and Torino among others), metropolitan fiber networks have been deployed. A different case regards power line communication (PLC), which consists in offering high-speed (up to 1 Mb/s) data communication through the electrical power distribution lines. This technique is still to be proven extensively in the field, although it is attractive because it exploits an existing alternative cabling infrastructure: in 2002 an OLO using this technology will begin offering its services in Italy.

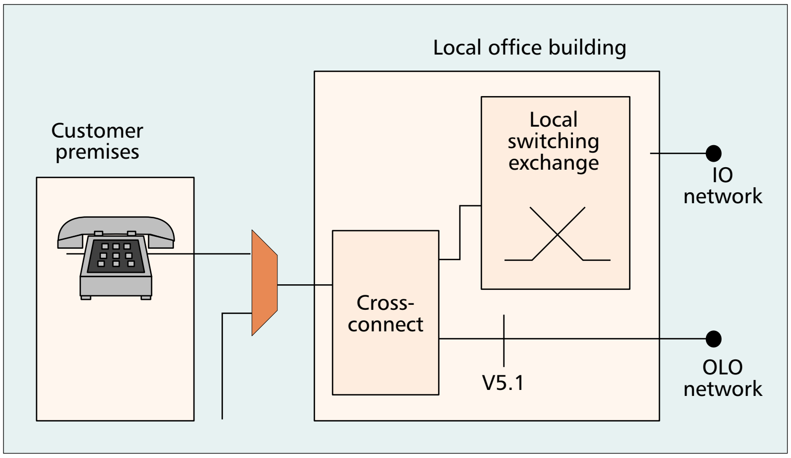

Figure 2. *Logical unbundling via a V5.1 interface.*

Deployment of a Wireless Local Loop — Among the radio solutions, the most interesting are presently those belonging to the local multipoint distribution system (LMDS) family. Such systems are based on a central antenna serving an area where many other antennas are placed at customer sites. The overall system capacity may vary, depending on the particular commercial product and the frequency bands available in concession, but typically a few hundred megabits per second can be allocated flexibly to customers. In Italy, seven licenses in the frequency band 24.5–26.5 GHz and three licenses in the frequency band 27.5–29.5 GHz have been granted in each of the 100 administrative areas in which the country is divided.

Unbundling Schemes and Services[1] in the Local Loop

Physical Medium — In this case, the OLO rents some section of continuous physical transmission medium between two access points. The most notable example is unbundling a section of twisted pair in a copper local loop, according to the architecture shown in Fig. 1.

Considering this architecture, the possible interconnection points that may be considered for unbundling the local loop are A, B_1, and B_2. In the most common scheme, nevertheless, the IO leases the section of twisted pair from the customer premises to the main distribution frame in the local office building (at point A). From the distribution frame, a cable connects to the OLO equipment, usually collocated in the same office building, which is connected to the OLO network by a dedicated line.

In shared access, the voice-band signal is fed back from the splitter positioned before the asymmetrical DSL (ADSL) modem to the MDF by another cable (dotted path in Fig. 1).

In Italy, another unbundling configuration was considered in the first regulation document [9]: section A–B_1, intended for an OLO willing to deploy Digital Enhanced Cordless Telecommunications (DECT) services, in order to connect the radio stations to a centralized equipment located in the switching office. More recently [10], the opening of intermediate access points (B_1, B_2) for sub-loop unbundling has been mandated by the regulation, in accordance with the European regulation [6].

Unbundling the twisted pair local loop poses important technological and procedural issues. Having on the same bundle and connecting on the same frame many twisted pairs yields problems of electromagnetic compatibility. Moreover, the transmission quality of the pair itself cannot be guaranteed a priori, but depends on several unpredictable circumstances, such as the number of frames on the path, the wire diameter and interference issues. In other terms:

- The OLO cannot know in advance the quality of the copper pair requested for unbundling, which may be adequate for POTS but not for xDSL systems.
- Both IO and OLO are concerned about safeguarding the electrical environment of the access loop against interference due to inappropriate use of leased pairs.

Although copper pair networks are undoubtedly the most important in access unbundling, other physical elements can be considered, such as optical fiber or coaxial cable networks.

In full-optical local loops, optical fibers go from the fiber termination frame (FTF) in the local office building to the network termination (NT) at the customer premises, sometimes through an intermediate distribution frame. Unbundled access can be given to a free optical fiber belonging to a bundle partially used by the IO. This case has been considered in Italy, where the full section from the FTF to the NT has been included in the regulation (no access to intermediate points is possible).

In hybrid fiber coax (HFC) access networks, optical fibers and copper coaxial cables are integrated to distribute broadband signals (e.g., video): a passive optical network (PON) connects the local node at the local office building to fiber nodes, which convert the optical signal to electrical form for distribution on a tree-shaped coaxial copper network. In Italy, HFC loops were deployed five years ago by Telecom Italia within its SOCRATE project. The PON section has been included in the unbundling regulation in Italy.

Frequency-Separated Channels — In this case, the OLO rents a frequency band on the physical medium between two access points. The channel may be specified in terms of technical parameters such as bandwidth and signal-to-noise ratio. It is independent of the type of modem the OLO uses for voice or data transmission.

The most important case of access to a frequency-separated channel is the access to the ADSL broadband channel from the customer premises to the local office building, accessed by the OLO at the POTS splitter. The baseband channel carrying voice services is still handled by the IO. As mentioned before, this possibility is called a shared access service and it was introduced recently in Italy among the services required by the regulation. The baseband signal can carry either analog voice or integrated services digital network (ISDN) signals.

Other examples of analog channels that could be considered for unbundling may be frequency-division multiplexing (FDM) channels on HFC

[1] *The term* service *is used in the Italian regulation to refer to the provisioning, leasing, and maintenance of the unbundled facility.*

infrastructures, from customer premises to the local node, and wavelength-division multiplexing (WDM) channels on a single fiber in optical access networks. In the latter case, the IO might rent either single WDM channels to OLOs or the whole fiber to a consortium of OLOs, which will deploy and maintain WDM equipment. This possibility was discussed but never introduced in the regulation in Italy.

Digital Channel — In this case, which is a kind of *logical* unbundling, the OLO rents a semi-permanent digital channel between the customer termination and a second access point, for the transmission of constant-bit-rate digital streams. The digital channel may be specified by the bit rate, the physical interface, frame structure, functional characteristics (e.g., the way in which user signaling is transported), and various quality parameters (e.g., bit error rate, slip rate, jitter limits).

Digital access interfaces of choice for this purpose are the V5.1/V5.2 interfaces, according to International Telecommunication Union — Telecommunication Standardization Sector (ITU-T) Recommendation G.964 and ETSI ETR 242, which allow connecting telephone subscribers with associated signaling (POTS and basic/primary ISDN access). This model was proposed for Italy, but most transmission equipment deployed in the Italian access network does not provide such interfaces yet: therefore, plain digital channels without specification of associated signaling were also considered, at speeds 64 kb/s, $N \times 64$ kb/s, and 2.048 Mb/s. In this case, signaling must be managed by *ad hoc* OLO equipment.

This type of access may be proposed whenever the unbundling of the copper pair is unfeasible, for example due to the presence of access multiplexers, as shown in Fig. 2. In this example, some subscribers connected at the remote multiplexer are visible at the V5.1 interface via digital channels with associated signaling.

Virtual Channel — In this second case of logical unbundling, the OLO may rent an asynchronous transfer mode (ATM) permanent virtual channel (PVC) between the customer and its network. More specifically, the IO offers access to an ATM user–network interface (UNI), as specified by ITU-T Recommendation I.432, through which several broadband subscribers can be reached via ATM PVCs; subscribers use xDSL systems previously deployed by the IO, who handles the system property and maintenance. An architectural scheme for this service is shown in Fig. 3.[2]

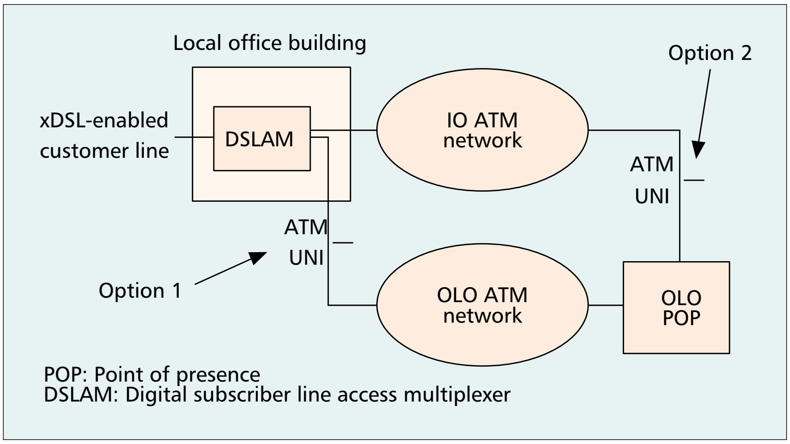

Figure 3. *The architectural scheme for the virtual channel service.*

ACCESSORY SERVICES

Accessory services are services that must be provided by the IO together with the unbundled services. Without the provision of these accessory services, unbundled services may be neither practically useful nor convenient. A better understanding of the usefulness of these services in the Italian case requires a look at the telephone switching network of the Italian IO (Telecom Italia), which is organized in three levels:

- 66 transit exchanges (*Stadi di Gruppo di Transito*, SGT). A pair of transit exchanges collects/terminates long-distance traffic from/to one of the 33 areas in which the country is divided.
- About 630 local exchanges (*Stadi di Gruppo Urbano*, SGU) switch local calls.
- About 10,000 local exchange modules (*Stadi di Linea*, SL), connected with star topology to SGUs, switch calls among subscribers that are connected to the same SL; SLs may be either remote or co-located with their SGU.

Co-location — To use some unbundled service, it is usually necessary that the OLO be allowed to place its equipment in the IO building. Co-location management is a thorny matter, because, in spite of how detailed are the rules agreed, there are innumerable potential causes of contrast:

- The *price* of the room preparation for the co-location service is the main up-front cost that the OLO has to bear and thus should be controlled by the Authority, based on estimating actual costs for IO.
- Often, the IO office building may have *not enough room* to host OLO equipment. In the Italian network, this is often the case when unbundled pairs are terminated in remote SLs, which are mostly located in very small sites or even in containers.
- Co-located equipment needs *additional power supply* and sometimes air conditioning.
- *Regulating the access* of OLO personnel to co-location rooms is troublesome; a cooperative approach to this issue between IO and OLO is definitely necessary.
- The *type itself of OLO equipment* may be a cause of contrast. While the OLO typically finds natural to be allowed to install any kind of equipment, provided that given size and power dissipation specifications are met, the IO may ask to fix additional limitations (e.g., no switching functions in co-located OLO equipment).

Information Services — In order to plan investments, an OLO needs detailed information on the IO network, such as room availability for

[2] *It must be noted that the difference between this service and the wholesale case mentioned earlier is not technical or architectural, but due to the price basis and commercial practice. In the wholesale case, the price is based on the retail-minus principle (a discount on the price of the service for the end users, justified by lower commercial and accounting costs) and often the OLO purchases ahead of time blocks of PVCs, each to be activated when the contract with the customer is made.*

The first factor considered, before planning xDSL deployment in a certain area, is the average pair length. From this point of view, Italy is favored, because the average loop is very short and 80 percent of the loops are shorter than 2 km.

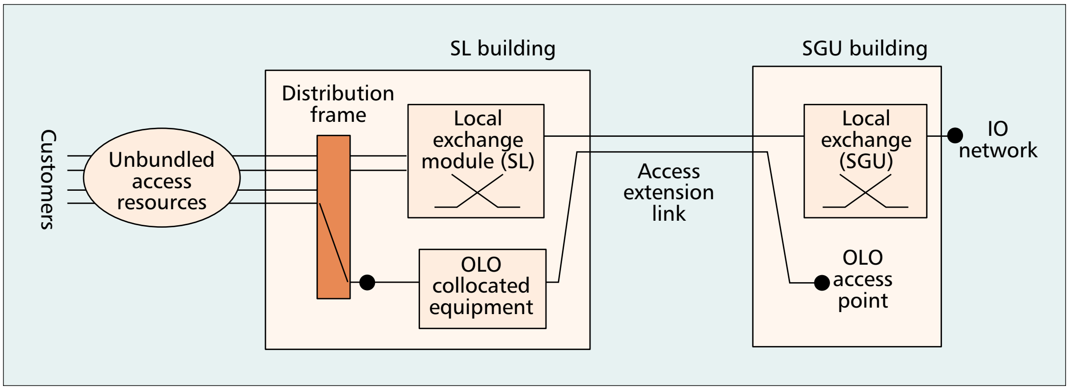

Figure 4. *Access extension service from a peripheral network location (SL building) to a more central office (SGU).*

collocation, average length and quality of subscriber links in specific areas, and so on. On the other hand, IOs are not willing to reveal strategic asset information, such as the penetration of various services in all geographical areas. Obviously, it is the duty of the authority to find a suitable compromise.

Access Extension — Pursuing the economical goals of unbundling implies also the need of relieving the infrastructure costs that OLOs must carry to reach interconnection points. In Italy, reaching 10,000 remote SLs through lines leased from the IO at commercial tariffs may yield excessive initial costs. With access extension, as shown in Fig. 4, OLOs that have access to some unbundled service at a peripheral network location (typically an SL) can interconnect with the IO network at a more central office (SGU), taking advantage of a link between the two sites, rented from the IO at a special tariff supervised by the authority, provided that it is used only to extend unbundled access links and not for other purposes.

The access extension service has been included in the regulation as a temporary provision during the early stage of market development.

Technical Issues in Unbundling the Twisted Pair Local Loop

Transmission Technologies

The term *xDSL* denotes a family of techniques for the transmission of digital channels on copper twisted pairs (cf. ITU-T Recommendation G.995.1).

Asymmetric DSL (*ADSL*) was standardized by ITU-T in Recommendation G.992.1 in 1999. It allows transmission of asymmetrical signals on a single pair. The bit rate attainable by commercial systems, in ideal electrical conditions, is 6 Mb/s downstream and 640 kb/s upstream. All ADSL products are rate adaptive, that is, they adapt the transmission bit rate according to the line noise, number of intermediate permutation points, and length and diameter of the wires.[3] The standard modulation technique is discrete multitone (DMT), which leaves the baseband available for a POTS or ISDN channel. This technique has been studied for asymmetrical services, such as broadband access to the Internet. If POTS or ISDN services are offered on the same pair, filters called *POTS* or *ISDN splitters* can separate the narrowband signal from the data signal on both the customer and office ends, as shown in Fig. 5. In Italy, the short average length of the subscriber loop creates an ideal situation for high-speed services deployment. However, commercial offers, by both the incumbent and its main competitors, are presently limited in speed to 640 kb/s downstream.

ADSL Lite (or *splitterless ADSL*), specified by ITU-T Recommendation G.992.2, allows avoiding the deployment of POTS splitters at customer premises (Fig. 5), at the cost of lower transmission capacity: 1.5 Mb/s downstream and 512 kb/s upstream. The operational costs due to "truckroll" (i.e., sending technical personnel to customer homes) are eliminated.

High-speed DSL (*HDSL*), specified by ITU-T Recommendations G.991.1/2 and ETSI TS 101 135, allows the transmission of 2.048 Mb/s symmetrical signals on one to three pairs, over distances ranging from 2.5 to 7 km, depending on a number of factors such as cable diameter and line disturbances. Line coding is normally 4-level pulse amplitude modulation (PAM), but carrierless amplitude phase (CAP) modulation is also used. HDSL systems are commonly used to bring leased lines or primary rate access (PRA) ISDN signals to subscribers.

Symmetric DSL (*SDSL*) is an ETSI standard that can be considered an evolution of HDSL (although the term SDSL is still used sometimes to indicate proprietary systems at different speeds). ETSI TS 101 524 specifies 16 trellis coded PAM line coding and bit rates up to 2.3 Mb/s over distances up to 2 km.

Very high-speed DSL (*VDSL*) was recently developed and allows transmission at much higher rates, although over shorter distances: 50 Mb/s downstream and 2 Mb/s upstream, or 26 Mb/s symmetrical bit rates, up to 500 m. Particularly in this case, electromagnetic compatibility issues affect the achievable rate.

Electromagnetic Issues

Two main factors affect the maximum bit rate achievable by an xDSL system: the electrical characteristics of the copper pair and the interference.

[3] *Examples of attainable bit rates for 0.5 mm wires in a good electrical environment are 6 Mb/s up to 3.7 km and 1.5 Mb/s up to 5.5 km.*

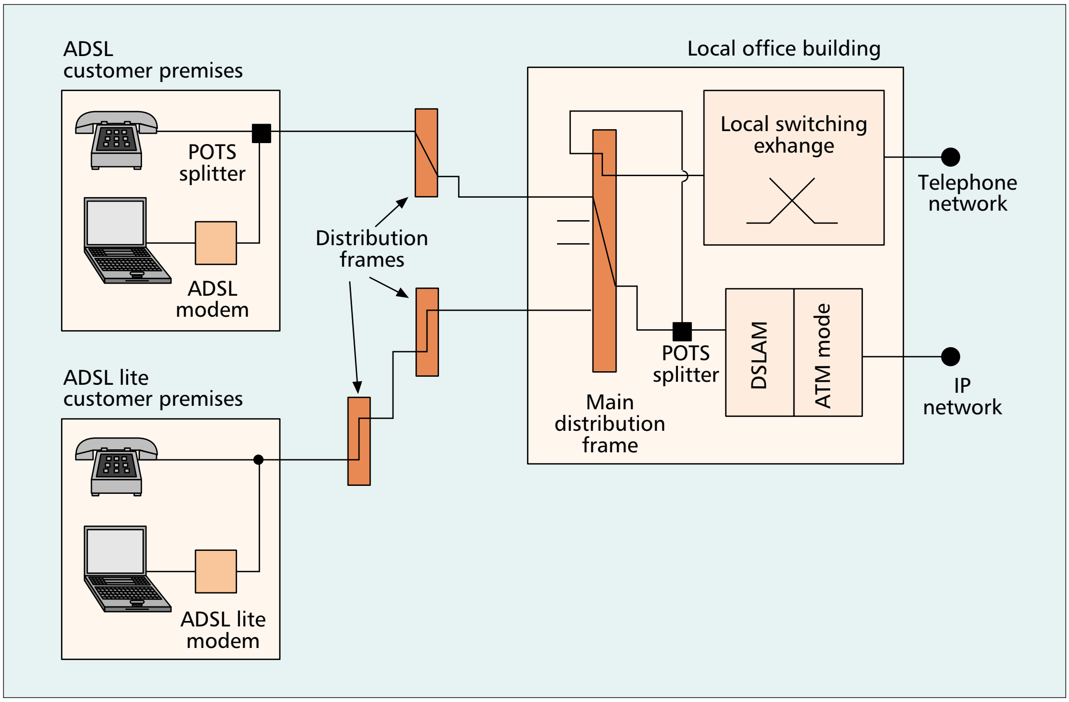

Figure 5. *ADSL and ADSL Lite systems in the copper twisted pair local loop.*

Even if the percentage of pairs on single bundles that can be assigned to xDSL systems may be high, potential pair availability issues are foreseen even in the short term, especially in the primary loop.

Electrical Characteristics of the Copper Pair — The first factor to take into account is the *line resistance*, which depends on wire diameter and length. Therefore, the first information needed, before planning xDSL deployment in a certain area, is the average pair length. From this point of view Italy is favored, because the loop length is usually very short. The average loop length is 1.5 km (half that in the United States of America and less than in most European countries), while 80 percent of the loops are shorter than 2 km. On the other hand, wire diameter is highly variable: in Italy, it ranges from 0.4 to 0.9 mm, and may change along different sections of the local loop. As shown in Fig. 1, in Italy there are normally two intermediate distribution frames between the customer site and the local office. Old lines not in use anymore but still connected in parallel (*stubs*) further complicate the situation. Hence, it is evident that it is not possible to estimate the actual bit rate of an xDSL system before some preliminary tests.

Interference Issues — The most important interference sources for xDSL systems are other high-speed digital systems using pairs that are on the same bundle. In particular, other xDSL systems or legacy 2 Mb/s systems with HDB3 line coding cause major problems. Various other sources of interference are possible in a network, including the effect of modems on analog leased lines and legacy services such as analog music distribution (still existing in Italy).

In Italy, in order to cope with the problems of mutual interference, a detailed set of compatibility rules has been defined by the IO, taking into account the characteristics of standardized systems. For planning purposes, a rule of thumb for limiting interference may be to specify the maximum percentage of xDSL systems that can be accommodated on the same cable, but the actual availability of a twisted pair for xDSL must be checked considering the specific cable situation.

Because the compatibility rules are based on the electrical characteristics of standard systems, it is sometimes felt that they can be a limitation to the deployment of innovative proprietary systems. Therefore, it has been proposed to move toward a *spectrum management plan* based on the spectral characteristics of the systems to be deployed, independent of their compliance with standards.

Twisted Pair Availability

Even if the percentage of pairs on single bundles that can be assigned to xDSL systems may be high, potential pair availability issues are foreseen even in the short term, especially in the primary loop. For example, pair-gain systems may multiplex several telephone channels on the same pair in the primary loop, thus making impossible the transport of signals that are outside the telephone baseband.

Regulation and Market Development in Italy

The Italian Authority mandated local loop unbundling in March 2000, with a regulation considering a large number of possible technical options [9]. The regulation stated that the IO Telecom Italia had to provide both unbundled physical access to copper and fiber loops and a digital channel service, as a fallback solution in cases of technical difficulties in offering the unbundling of a specific line. Moreover, collocation service was required, and access extension was mandated for an interim period of three years.

The crisis that is presently affecting the telecommunication market has somewhat slowed down the effective roll-out of commercial services: although 20 operators asked for sites, at the time of this writing only four of them are offering alternative access solutions based on unbundling.

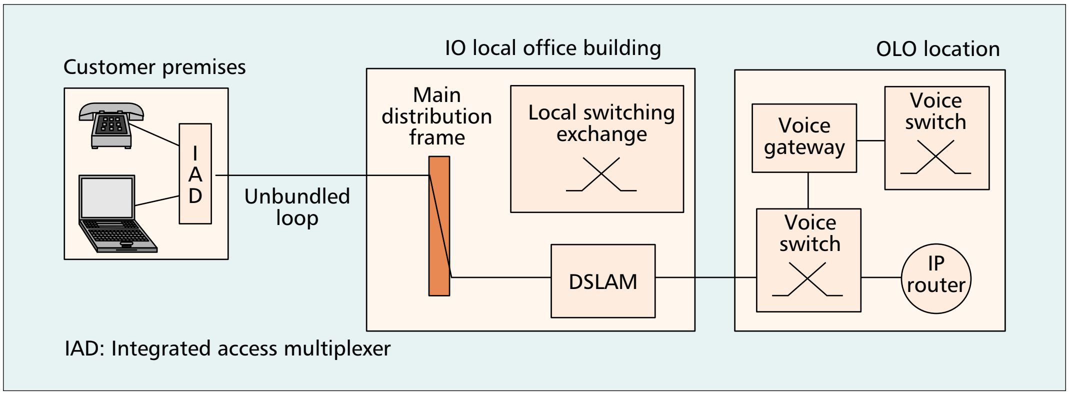

Figure 6. *SDSL configuration integrating voice access.*

From that moment, a negotiation phase regarding the definition of the detailed technical and procedural rules for unbundling implementation took place, with the Authority mediating the requirements of the interested OLOs and the IO. An experimental phase, in the last quarter of 2000, involved 15 OLOs interested in unbundling together with Telecom Italia and permitted acceptable settlement of many controversial issues.

With the beginning of 2001 the implementation of commercial services began. The collocation sites have been granted to requesting operators in successive rounds, according to a complex procedure that entails a feasibility study and determination of the setup cost that an OLO must pay for accessing a specific location. This cost may vary significantly, depending on the number of operators requesting the same site and the conditions of the site itself.

In mid-2001, the first two rounds were completed successfully, resulting in 1080 IO sites granted to OLOs for collocation.[4] This implies that about 14 million subscriber lines (50 percent of the total) are now potentially accessible to OLOs: a remarkable result, especially because it gives the first real alternative to Italian customers who do not have access to other alternative infrastructures such as CATV networks.

Unfortunately, the crisis presently affecting the telecommunication market has slowed down the effective rollout of commercial services: although 20 operators asked for sites, at the time of this writing only four of them are offering alternative access solutions based on unbundling. On the other side, the wholesale offer of the IO has been very successful, accounting for the large majority of ADSL subscribers of OLOs in Italy; another wholesale operator is beginning to address this market.

Another significant event occurred when, in December 2001, shared access and subloop unbundling were included in the regulation in compliance with the European regulation [6]. Subsequently the IO Telecom Italia had to develop a wholesale offer for the shared access service. Both options (unbundling with collocation and wholesale) are expected to be successful.

Turning to the impact that this opportunity is having on the market for telecommunication services, it is interesting to consider the service offerings of the various operators, which show significant commonalities and can be grouped in the following basic models:

- *Traditional ADSL-based offerings*, with broadband Internet access plus analog or ISDN voice services on the baseband channel.
- *Data-only ADSL-based access* (an ideal candidate for shared access), including broadband Internet access and often other services such as IP virtual private networks (VPNs), a convenient alternative to leased lines, and in some cases voice over IP.
- *SDSL-based accesses*, with data services (both broadband Internet access and VPNs) and voice-over-ATM access to traditional voice switches (Fig. 6 depicts a typical configuration).

Other services, such as video on demand (VOD), are foreseen by some operators, but do not seem to attract great interest for the time being.

The overall number of xDSL customers in Italy reached about 470,000 in mid-2002: this continuous market expansion process is boosted by the action of OLOs exploiting unbundling and ADSL wholesale services, and by the contemporary intensive marketing action of the IO, which aims at selling its own ADSL services. Although the IO still holds a dominant share of broadband customers (more than 80 percent), it can be said that in Italy the liberalization of the access infrastructure appears to be a key factor in boosting the development and diffusion of advanced broadband services.

Conclusions

In this article, local loop unbundling is surveyed under several technical aspects, with special regard to the Italian case. Various unbundled services identified in Italy are detailed, focusing on the twisted pair local loop: transmission technologies, electromagnetic issues, and pair availability were addressed.

In Italy, most incoming operators are interested mainly in physical access to copper loop, which gives the opportunity to offer broadband services pervasively by exploiting the capabilities of xDSL technology.

In Italy, at present, in spite of the market crisis, more than 20 operators have asked for collocation sites, and four are offering services on unbundled loops. Moreover, wholesale opera-

[4] *The early steps of the process also gave promising indications about the impact of some factors potentially impeding collocation, such as space availability: more than 90 percent of the requested sites have actually been granted.*

tors offering broadband access to service providers are emerging. In Italy, therefore, this experience is proving that unbundling the access infrastructure is, as expected, a key factor in boosting open market competition and the development and diffusion of advanced broadband services.

ACKNOWLEDGMENTS

The authors wish to thank the reviewers for their thorough comments and criticisms, which helped to improve this article substantially.

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BIOGRAPHIES

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In Italy this experience is proving that unbundling the access infrastructure is, as expected, a key factor in boosting open-market competition and the development and diffusion of advanced broadband services.