Local Loop Unbundling in the Enlarged European Union

New Challenges for Established Operators

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Synopsis

The opening–up of access to the lines linking the local telephone exchange with individual customers – better known as Local Loop Unbundling (LLU) - is a key requirement of European Union (EU) policy on competition in the telecommunications sector. LLU is seen as a mechanism that will introduce competition into the access network without the need for new operators to make large capital investments in infrastructure. This is regarded as a vital part of the EU’s strategy to make broadband services “universally available” in order to stimulate economic activity in the Small to Medium Enterprise (SME) business sector and enable the public to access broadband services.

Local Loop Unbundling has been introduced, at various stages of development, in all EU Member States. Other countries joining the EU have an obligation to introduce LLU as part of the liberalisation of their telecommunications sector. Whilst it is evident that LLU has a number of positive market and social benefits, it is similarly obvious that its implementation also raises significant operational, regulatory and technical issues that established network operators have little option but to address.

This article gives a high level review of the technical issues regarding provision of unbundled access to loops and sub-loops in the copper access network operated by a typical national (incumbent) operator, and is intended to give an appreciation of the impact that the introduction of Local Loop and Sub-loop Unbundling will have on the planning and operation of such a network.

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Background

Current EU law requires operators of copper access networks considered to have Significant Market Power (SMP) to offer other eligible operators unbundled access to loops and sub-loops along with related facilities such as collocation in exchange buildings owned by the SMP operator. The principal driver behind this Local Loop Unbundling (LLU) is the desire of governments to increase levels of access to Internet and other services through the utilisation of Digital Subscriber Line (DSL) technologies in conjunction with the existing fixed-line network. This, in turn, is an attempt to overcome the operational and financial difficulties of delivering to customers high bandwidths originally intended to be carried over an optic fibre access network featuring Fibre to the Kerb (FTTK) or Fibre to the Customer (FTTC). The development of DSL technologies has enabled copper access networks to deliver relatively high bandwidths, typically 256 kbps to 8 Mbps dependent upon network characteristics, to the end user. As narrow band is used to describe the bandwidths capable of supporting voice services, these higher bandwidths are collectively referred to as broadband.

In most cases, the operator having SMP with regard to LLU will be the national incumbent operator. In most Western European countries, the incumbent will be the former national telephone company which, due to its legal obligation to provide universal voice services, will usually have the only access network offering a high degree of both population and geographic coverage. Despite the competitive status of Western European markets, the construction of alternative access networks has been inhibited by the very high cost of network build and the incumbents’ \textit{de facto} monopoly in access network infrastructure. In Eastern Europe, most countries have inherited legacy access networks originally deployed for political rather than commercial reasons, with the emphasis on providing telecommunications services for government, industry and the military rather than the population at large. This policy has left many of these countries with access network deficiencies in major population centres and significant volumes of spare capacity concentrated in areas where industrial and military installations were located.

In all cases, the introduction of LLU has a significant impact on incumbent network operators. Many perceive LLU as a threat to their existing markets and revenues, especially where they are already providing broadband products and services. There are some practical concerns, however, including the incompatibility of some existing network elements with the requirements of LLU- and DSL-based services, the requirement upon incumbents to offer collocation services for competing LLU Operators’ switching facilities, the need to develop and manage new wholesale products and services with regulatory-subject tariffs, and the requirement for new or upgraded processes, procedures and Operational Support Systems (OSS). In reality, market, political and regulatory pressures favouring LLU are such that incumbents have little choice but to implement it. Crucial to success, therefore, is an understanding of the issues involved and the adoption of solutions designed to minimise negative impact and maximise profitability.
LLU Elements and Services

Before discussing the practical impact of LLU upon an incumbent operator, it is worth considering briefly some of the basic elements and services involved.

Loops and Sub-loops

The basic element of LLU is the Metallic Path Facility (MPF), a twisted copper pair that connects an end user of broadband services to the DSL equipment providing those services. As part of the access network infrastructure, the MPF is provided and maintained by the incumbent operator.

An MPF can consist of a complete copper loop or a sub-loop. A complete loop is a copper pair utilising the primary and distribution networks connecting the end user to the Main Distribution Frame (MDF) at the incumbent’s switch. A sub-loop, by contrast, is a copper pair in the distribution network connecting the end user to a cross connection point. Connectivity from the MDF or the cross connection point to the DSL equipment is provided by means of tie cables which are not elements of an MPF.

Shared Access Loops remain connected to the incumbent’s switch and the end user will continue to be supplied with voice service by the incumbent. The Local Loop Unbundling Operator (LLUO) connects to the shared loop and supplies the end user with broadband services by means of splitter units located at the MDF and the end user site. These allow the simultaneous transmission of voice and broadband services on the shared loop. Fully Unbundled Loops, by contrast, are disconnected from the incumbent’s switch and directly connected to the LLUO broadband equipment. The end user is supplied with both voice and broadband services by the LLUO over the fully unbundled loop.

Collocation

Collocation is the term used to describe the housing of DSL equipment owned and operated by an LLUO inside or in the vicinity of an incumbent operator’s MDF site, and covers four basic configurations:

- **Dedicated Collocation** - Dedicated Collocation requires that the incumbent provide a secure equipment room inside the building housing the MDF. An internal tie cable is used to provide connectivity to the MDF, power and environmental controls being supplied by the incumbent.

- **Co-mingling** - Co-mingling requires the incumbent to provide common operational areas within the MDF building where LLUOs can install their DSL equipment. Once again, an internal tie cable is used to provide connectivity to the MDF, with power and environmental controls supplied by the incumbent.

- **Virtual Collocation** - Where the incumbent has no available space within an MDF building, a LLUO may request space external to the building but still within the MDF site boundary, e.g. on an area of land not required for operational use. On this, the LLUO can provide an external enclosure to house their DSL equipment. Connection to the MDF is by means of an internal tie cable, power being supplied by the incumbent if requested.
Distant Collocation - This term is used when the LLUO houses DSL equipment at a site near to (but distinct from) the MDF site and connects the two by means of an external tie cable.

Collocation is an indispensable component of any LLU proposition insofar as it facilitates ready competitive access to the existing local loop infrastructure whilst minimising both the new entrants’ expenditure on infrastructure and the resulting environmental impact. In practice, however, a variety of barriers to collocation may be encountered, including a lack of space for extra equipment, power supply limitations, occupational safety or security concerns and even the geographical location of the incumbent’s existing switch facilities (which may be situated in a city centre location some distance from the suburban residential areas and technology parks likely to provide the strongest demand for DSL-delivered broadband services).

LLU’s Impact on the Access Network

An access network consists of two basic elements; a Primary Network constructed from large capacity cables and connecting the local switch to cross connection flexibility points, and a Distribution Network connecting the cross connection points to the customer. The Primary Network is relatively static from an operational point of view and suffers from few disturbances and manual interventions. The distribution network can be a volatile operational environment with a variety of dynamics impacting directly on network performance. The ability of a copper cable to support the transmission of DSL equipment is primarily determined by the length of the circuit. Transmission characteristics such as signal loss accumulate over distance, and the cable length capable of supporting broadband decreases as the required bandwidth increases. As well as distance, a secondary parameter directly affecting the ability of a network to support broadband is the quality of the transmission medium. The performance characteristics of individual cables are affected by day-to-day activities such as capacity rearrangements and fault location, not to mention environmental factors such as temperature and humidity. Activities that require manual intervention in the network tend to have a detrimental effect on overall quality and are concentrated in areas of high demand.

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The design and detailed planning of copper access networks is usually based upon the requirement to build infrastructure that can enable the provision of narrow band voice services in the most cost-effective way. As liberalisation and privatisation of the telecommunications sector has developed, network build strategies adopted by incumbent operators have become increasingly focused on maximising the return on capital investment and, especially in Western Europe, this has led to the philosophy of “sweating the network”. This has placed emphasis on utilising the existing network infrastructure by such means as retrieving “lost” or unrecorded spare capacity, relieving exhausted infrastructure by diverting spare capacity, and using pair gain and pair concentration equipment. It is worth noting that this philosophy on managing access networks contributed in no small way to driving the development of DSL equipment for the last mile delivery of broadband services and “turning copper into gold”. In practice, access networks continue to be built to specifications based on delivering voice services, with new build seldom planned for DSL enablement. Indeed, it can be argued that the introduction of LLU does little to encourage incumbent operators to deploy access network infrastructure capable of supporting broadband when the asset is available to all operators.
in the form of unbundled loops. The same outlook also removes the need of potential new network operators to build alternative network infrastructure.

From an operational standpoint, the connection of DSL technologies to the copper access network introduces transmission frequencies that are in the lower ranges of the radio spectrum and considerably higher than any copper cable or network was originally designed to carry. The introduction of these frequencies into the copper access network raises the possibility of interference and interaction between pairs carrying broadband services, which will have a detrimental effect on quality of service. Interference is most likely in cables carrying concentrations of broadband services and these are usually located in the most volatile parts of the network. A possible way of reducing the potential for interference would be to keep broadband circuits within a cable sheath as separate as possible. However, keeping track of the proliferation of broadband circuits in the access network is extremely difficult and managing the pairs within a cable sheath would be almost impossible. When interference does occur the fault conditions created are very difficult to locate and, where this is possible, it must then be established which circuit is causing the interference. This circuit must then be moved to a pair that does not interact with other pairs or, if possible, moved to another cable. In the event that manual intervention cannot rectify the interference, the offending circuit must be ceased.

The unbundling of sub-loops in the network presents the greatest potential for interference. As stated previously, a sub-loop is an unbundled pair in the distribution network connecting the cross connection point to the customer site. The DSL equipment used by the LLUO to provide service to their end-users will be located close to the cross connection point and the sub-loops accessed using an external tie cable. This enables LLUOs to supply broadband services to customers located at distances from the incumbent’s MDF that would render a complete loop unusable for this purpose. Sub-loop unbundling allows introduction of broadband transmissions at power levels higher than would be present on any pairs in the distribution cable carrying broadband from DSL equipment housed at the MDF site. The differences in power levels would increase the potential for interference significantly.

If implemented in significant volumes, LLU also raises network management issues that need to be addressed, such as utilisation of network capacity. One example would be the management of limited spare capacity in the distribution network, especially in areas of high demand for fully unbundled sub-loops, whilst another would be the utilisation of pairs on the exchange side of a cross connection point made spare by the provision of fully unbundled sub-loops. Shared access on unbundled loops presents less significant network management problems as the copper pair between the end user and the incumbent’s MDF remains in place. It must also be noted that the efficient utilisation of capacity in the access network to support LLU will depend upon the accuracy of forecasts supplied by the LLUO. Several European incumbents express concern that they have been required to invest considerable amounts in increased capacity on the basis of new entrants’ forecasts, only to find that contracted demand for such services has failed to match expectations.

Lastly, network planners will need to be aware of the requirement for spectrum management in the network to protect existing services when broadband equipment is connected at an intermediate point.
Organisational Impact

In addition to the ramifications for the access network itself, incumbents embracing LLU will be faced with a number of significant organisational commitments. All of these will impact in some way upon the operator’s bottom line.

Provision of Service

The provision of LLU services requires the coordination of activities that involve a number of the incumbent’s planning and operations functions. For example, the provision of collocation facilities in MDF site buildings requires expertise in civil engineering, building facilities planning, equipment planning and installation, and network planning and installation. The incumbent will also need to adopt and develop new processes, procedures and work practices to ensure that the deployment of LLU is carried out efficiently and as cost effectively as possible, especially where charges for the provision of wholesale LLU services are subject to regulatory intervention.

In EU Member States, operators designated as having significant market power (SMP) must set out their LLU products and associated tariffs in a formal Reference Unbundling Offer (RUO), which has to be approved by the national regulatory authorities.

Maintenance and Repair

The incumbent’s area of responsibility in the LLU maintenance and repair process is confined to locating and repairing any electrical faults on the unbundled loops and sub-loops reported by the LLUO.

The practical issues around maintenance and repair of loops and sub-loops differ according to the type of LLU service they provide, i.e. Fully Unbundled Service or Shared Access Service:

- Fully Unbundled Loops – Carrying out maintenance and repair activities on fully unbundled loops is severely affected by the fact that there is no physical path to the incumbent’s MDF. Remote line tests cannot be applied to the sub-loop pair unless the incumbent operator installs a test head on the MDF for this purpose. The application of remote line test on a fully unbundled loop will temporarily affect the operation of broadband equipment connected to it. In cases where a test head has not been provided, a technician will need to visit the MDF, the cross connection point and the end user site to test and, if a fault exists, locate the fault.

- Fully Unbundled Sub-loops – Carrying out maintenance and repair activities on fully unbundled sub-loops is also severely affected by the lack of a physical path to the incumbent’s MDF. In this case, however, remote line tests cannot be applied to the sub-loop pair even if a test head has been provided. In all cases, a technician will need to visit the cross connection point and the end user site to test for and locate any fault that may exist.

- Shared Access Loops and Sub-loops – Shared access loops and sub-loops are accessible to remote line test equipment because the pair is still connected to the MDF. The application of these tests to a loop or sub-loop will temporarily affect the operation of the broadband equipment connected to it. In addition, any intrusive activities by the field staff may also affect the broadband transmissions.

The most efficient way to rectify interference faults - by means of rearranging pairs within a cable until the interference is eliminated - becomes increasingly more difficult as broadband is deployed in significant volumes.
Where the reported faulty loop or sub-loop is tested and no electrical fault conditions are detected, the probability is that interference between circuits is causing the service to fail. Fault conditions caused by interference and interaction between loops and sub-loops carrying broadband services and other circuits require more sophisticated and time-consuming methods to identify the cause of a fault, rectify the fault and restore service. To reflect this, a two-stage LLU maintenance and repair process will be required, the first stage of which will address the occurrence of electrical faults, whilst the second will address situations where tests cannot detect any faults but the service-affecting conditions persist.

In practice, the most efficient way to rectify interference faults will probably be by means of manual intervention in the network to rearrange pairs within a cable until the interference is eliminated. This becomes increasingly more difficult as broadband is deployed in significant volumes and cables begin to contain multiple pairs carrying broadband services. At this point, it may prove necessary to implement a policy of removing the last broadband service to be installed before problems were reported.

**Work Practices and Process Management**

The provision and maintenance of LLU services will have an impact on work practices in the incumbent’s Planning Groups and in the Operational Field Force. Modifications to existing practices and the introduction of new practices to support the provision and maintenance of LLU services will be required, and training will be required for personnel involved in a range of activities. In order to meet both regulatory and corporate management requirements, it is important to ensure that work practices enable all the costs of providing LLU services to be identified and recorded.

Various new management processes will also require development and implementation, most notably to deal with service requests and fault reports:

- **Requests for LLU Services** – The management of requests for LLU services will require a process enabling the service provision activity to be managed in defined stages. Close co-ordination between the incumbent’s planning and operational groups will be essential to ensure that the LLU services are provided on time and to estimated costs, especially when providing services that have defined order stages associated with a bespoke charge such as collocation. The management process should ensure that, at the completion of works to provide the requested sub-loops, all costs incurred in the build and rearrangement of network infrastructure will be captured. These costs are recoverable from the Sub-Loop Unbundling Operator (SLUO) and will form part of the bill for SLU services.

- **Fault Reporting** – The fault reporting activity sequence on unbundled loops and sub-loops will depend upon whether the faulty circuit is used to provide Fully Unbundled or Shared Access service. The management process must be able to deal with both situations, as well as being configured to differentiate between electrical faults and interference faults. An essential part of the management process will be to initiate and maintain an ongoing dialogue with the SLUO in order to confirm the requirement for each stage of the maintenance process.

**LLU Operator Interface**

The operational interface between the incumbent and LLUOs can take a variety of forms. At its most basic, the interface will require the creation of a single point of contact with formal lines of communication to those operational groups within the incumbent dealing directly with the provision, operation and maintenance of unbundled loops and sub-loops. Transactions can initially be paper and/or e-mail-based with automated systems developing as demand for unbundled services escalates. This single point of contact will deal with all requests for service and fault reports from the LLUO and help manage the incumbent’s internal operational relationships.
Impact on Operational Support Systems

It is inevitable that Operational Support Systems (OSS) will require development in order to facilitate the provision of LLU services. Aspects typically requiring attention include:

- **Customer Records** - The introduction of LLU, whether to provide collocation, fully unbundled or shared access services, will require customer records to reflect the new definitions of these wholesale services. This is essential in order to provide accurate data for billing. Where customer records are computer-based the incumbent will need to confirm that the system has sufficient functionality to accommodate the requirements of LLU.

- **Line Plant Management** - In many countries, line plant records are predominantly paper-based although, in almost all cases, work is in progress to develop computer-based systems. Conventional line plant management systems developed to record copper access networks are normally configured to recognise a logical series of discrete analogue connections, e.g. from MDF to Primary Connection Point (PCP) to Distribution Point (DP). Due to the requirement to record shared service lines, most systems will have the capability to record the dual utilisation of a single customer circuit and may enable the recording of Shared Access Services. Not all conventional line plant management systems, however, are able to record fully unbundled loops and sub-loops or remotely-located multiplexer equipment, and it is important to confirm that existing or new computer-based systems will offer the necessary levels of functionality.

- **Remote Line Test** - Where installed, the functionality of an incumbent operator’s remote automatic line test will be affected by the introduction of fully unbundled LLU services. A solution would be to deploy test access modules at strategic MDF sites that will enable the remote line test equipment to access fully unbundled loops. Where a fully unbundled LLU service is provided on a sub-loop, the remote line test will have no physical access to the loop or sub-loop and all testing activities will have to be manual and carried out on site.

- **Billing** - The incumbent’s billing system data will have to be updated to include the new LLU and collocation products and their associated charges, whilst the system must be configured to be able to bill LLU Operators for bespoke network rearrangement and civil engineering activities.

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The cost of any new hardware or software directly attributable to the requirement to introduce LLU should be recoverable (though not necessarily in a one-time charge) from the LLU and SLU Operators. That said, many European incumbents developed their existing OSS to cope with the demand forecasts and functionality specifications put forward by LLUOs but, whilst the costs of these improvements were significant, sometimes running to millions of Euros, the demand forecasts on which they were based proved to be somewhat optimistic. As a result, many of the sophisticated systems deployed are currently running at a fraction of the capacity they were designed for, and the question of how their development costs are to be recovered is the subject of ongoing debate.
Political and commercial issues aside, the introduction of Local Loop Unbundling impacts significantly both the physical access network and the incumbent operator’s activities in that network. Whilst DSL technology is a viable means of utilising copper cables to cost effectively deliver broadband services to end users, the deployment of broadband in significant volumes raises the possibility of interference problems which are notoriously difficult to locate and rectify. In addition, there is reason to speculate that there is a finite number of broadband circuits that an access network cable can support without interference and interaction conditions affecting customer services.

LLU also raises a number of important operational issues for incumbent operators to address. From a typical incumbent’s viewpoint, it is relatively easy to see all work generated by the requirement to support LLU as non-productive and diverting resources from revenue-generating activities. The need to provide collocation facilities for LLUOs raises security concerns and undoubtedly disrupts strategic plans for the administration of building facilities and property. Similarly, tactical plans for local switches and access network development have to be adjusted to take LLU into consideration.

Within the European Union, LLU is a mandatory requirement and failure to comply with relevant regulation can have potentially serious consequences for incumbent operators. Dependent upon the regulatory regime adopted by any given country, the charges for LLU services and, by default, the profit margin, will be decided by the regulator. Having said this, LLU offers the opportunity for incumbents to add value to the basic LLU products required by regulation in order to maximise potential revenue. In addition, by working closely with the National Regulatory Authority and LLUOs, an incumbent can minimise disruption to network operations and develop processes and procedures that introduce efficient work practices and utilisation of resources. Finally, it is vital that players identify and adopt appropriate instances of industry best practice. Whilst each operator will have specific business propositions and needs, there is nevertheless much that can be learnt from the experiences of others in this field.

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About...

The Author

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InterConnect Communications offers a variety of solutions to assist network operators in fulfilling their Local Loop Unbundling requirements, including:

- Development of a Reference Unbundling Offer;
- Representation to and liaison with the National Regulatory Authority;
- Development of LLU Service Definitions;
- Costing and Tariffs;
- Identification of Collocation Requirements and Options;
- Development of processes, including OSS requirements.

For more details of InterConnect’s LLU services, please visit http://www.icc-uk.com/local-loop-unbundling.php