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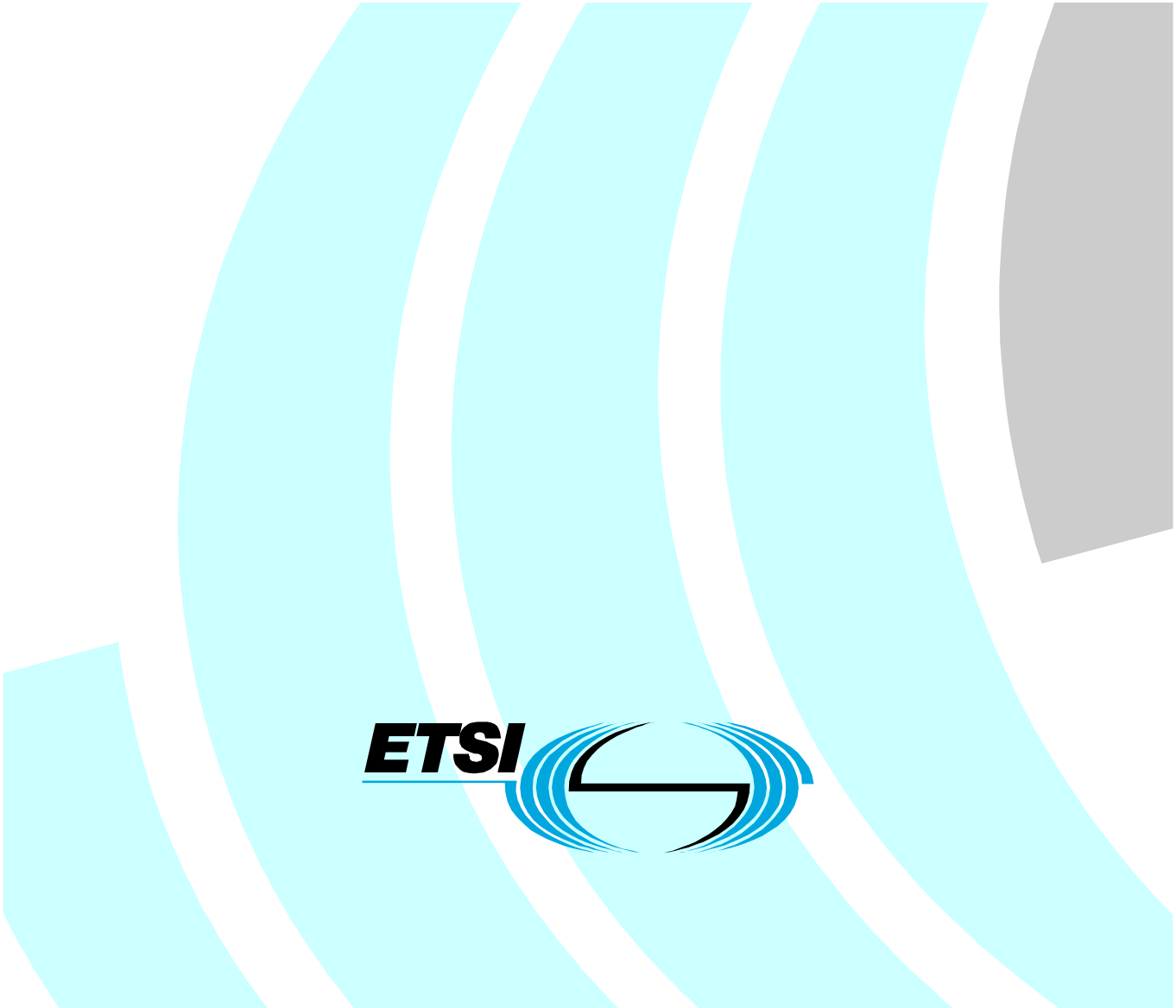
Technical Report

Lawful Interception (LI);
Concepts of Interception in a Generic Network Architecture



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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Lawful Interception (LI).

Introduction

This is an overview description of various aspects of lawful interception requirements, relations to communication services, interface technology and security. The present document is intended to serve as a guide that covers some practical issues regarding implementation of LI systems.

1 Scope

The present document provides a high-level informative overview and principles regarding implementation of LI for telecommunications. Details about these principles is covered in other documents that address specific technologies and network types.

The following areas are covered here:

- A general discussion about the role and position of Lawful Interception related to public communication services.
- Origin of LI requirements - overview of characteristics of national legislation and regulations as well as international cooperation on LI.
- A high-level description of LI related to an abstract model of communications systems (service/control/connectivity layers).
- Discussion of interception at access service level versus application service.
- Discussion of interception of IN services.
- Description of internal interfaces and internal network units involved in LI processing.
- Description of handover interfaces and interface protocols with some practical hints regarding implementation choices.
- Discussion about technical issues regarding access to stored subscriber data.
- Discussion about security issues, related to the standard threat model described in ETR 332 [4].

2 References

For the purposes of this Technical Report (TR) the following references apply:

[1] ETSI TS 101 331: "Telecommunications security; Lawful Interception (LI); Requirements of Law Enforcement Agencies".

[2] ETSI ES 201 158: "Telecommunications Security; Lawful Interception (LI); Requirements for network functions".

[3] ETSI ES 201 671: "Telecommunications security; Lawful Interception (LI); Handover interface for the Lawful Interception of telecommunications traffic".

[4] ETSI ETR 332: "Security Techniques Advisory Group (STAG); Security requirements capture".

[5] ETSI TS 101 671: "Lawful Interception (LI); Handover interface for the Lawful Interception of telecommunications traffic".

[6] ETSI TS 133 108: "Universal Mobile Telecommunications System (UMTS); 3G security; Handover interface for Lawful Interception (LI) (3GPP TS 33.108)".

[7] ETSI TS 102 232: "Lawful Interception (LI); Handover specification for IP delivery".

[8] ETSI TS 102 234: "Lawful Interception (LI); Service-specific details for internet access services".

[9] Draft-baker-slem-mib00 (2003): "Cisco Lawful Intercept Control MIB".

[10] ETSI EG 201 781: "Intelligent Network (IN); Lawful interception".

[11] EU Council ETS 185: "Convention on Cybercrime", 23.XI.2001.

[12] ETSI TS 133 107: "Universal Mobile Telecommunications System (UMTS); 3G security; Lawful interception architecture and functions (3GPP TS 33.107)".

[13] ETSI TS 133 106: "Universal Mobile Telecommunications System (UMTS); Lawful interception requirements (3GPP TS 33.106)".

[14] ETSI TS 142 033: "Digital cellular telecommunications system (Phase 2+); Lawful Interception; Stage 1 (3GPP TS 42.033 version 5.0.0 Release 5)".

[15] ETSI TS 143 033: "Digital cellular telecommunications system (Phase 2+); Lawful Interception; Stage 2 (3GPP TS 43.033 version 5.0.0 Release 5)".

[16] ETSI TS 102 227: "Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON) Release 4; Functional Entities, Information Flow and Reference Point Definitions; Lawful Interception".

[17] ETSI EG 201 781: "Intelligent Network (IN); Lawful interception".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TS 101 331 [1], ES 201 158 [2] and the following apply:

Access Provider (AP): provides a user of some network with access from the user's terminal to that network

NOTE 1: This definition applies specifically for the present document. In a particular case, the access provider and network operator may be a common commercial entity.

NOTE 2: The definitions from TS 101 331 [1] have been expanded to include reference to an access provider, where appropriate.

authorizing authority: authority, such as court of law, that is entitled to authorize Lawful Interception

(to) buffer: temporary storing of information in case the necessary telecommunication connection to transport information to the LEMF is temporarily unavailable

call: any connection (fixed or temporary) capable of transferring information between two or more users of a telecommunications system. In this context a user may be a person or a machine

Content of Communication (CC): information exchanged between two or more users of a telecommunications service, excluding Intercept Related Information

NOTE: This includes information which may, as part of some telecommunications service, be stored by one user for subsequent retrieval by another.

Domain Name System (DNS): set of network elements, which function as translators between logical names and network addresses on the Internet

NOTE: This type of element is widely used for IP traffic today. It can be anticipated that similar functionality will be introduced also for telephony in the near future.

Handover Interface (HI): physical and logical interface across which the interception measures are requested from an AP/NWO/SvP, and the results of interception are delivered from an AP/NWO/SvP to an LEMF

identity: technical label which may represent the origin or destination of any telecommunications traffic, as a rule clearly identified by a physical telecommunications identity number (such as a telephone number) or the logical or virtual telecommunications identity number (such as a personal number) which the subscriber can assign to a physical access on a case-by-case basis

Intercept Related Information (IRI): collection of information or data associated with telecommunication services involving the target identity, specifically call associated information or data (e.g. unsuccessful call attempts), service associated information or data (e.g. service profile management by subscriber) and location information

interception (or Lawful Interception): action (based on applicable laws and regulations), performed by an AP/NWO/SvP, of making available certain information and providing that information to an LEMF

NOTE: In the present document the term *interception* is not used to describe the action of observing communications by an LEA (see below).

interception interface: physical and logical locations within the access provider's/network operator's/service provider's telecommunications facilities where access to the Content of Communication and Intercept Related Information is provided

NOTE: The interception interface is not necessarily a single, fixed point.

interception measure: technical measure that facilitates the interception of telecommunications traffic pursuant to the relevant national laws and regulations

interception subject: person or persons, specified in a lawful authorization, whose telecommunications are to be intercepted

internal intercepting function: point within a network or network element at which the Content of Communication is made available

Internal Network Interface: network's internal interface between the Internal Intercepting Function and a mediation function

Internet Service Provider (ISP): business entity that offers connectivity to the Internet, primarily for dial-in subscribers

NOTE: The ISP will generally also provide e-mail facilities and other higher-level Internet services.

Law Enforcement Agency (LEA): organization authorized, by a lawful authorization based on a national law, to request interception measures and to receive the results of telecommunications interceptions

Law Enforcement Monitoring Facility (LEMF): law enforcement facility designated as the transmission destination for the results of interception relating to a particular interception subject

lawful authorization: permission granted to a LEA under certain conditions to intercept specified telecommunications and requiring co-operation from a AP/NWO/SvP

NOTE: Typically this refers to a warrant or order issued by a lawfully authorized body.

LEA network: network connections and special protocol functions that are required for delivery of intercept products from a mediation function or delivery function to the LEMF(s)

NOTE: This network is specified by and normally belongs to the LEA domain.

LI products: the same as **result of interception**, see below

location information: information relating to the geographic, physical or logical location of an identity relating to an interception subject

mail server: network element which serves as a "point of presence" (POP) for receiving and storing and forwarding e-mail on behalf of a registered mail user on that server

NOTE: A variant of the mail server is the send mail server (SMTP), which dispatches mail from the user to the e-mail network. The POP usually requires login with a password on the application level, while the SMTP can be used after session or link validation only.

Mediation Function (MF): mechanism which passes information between an access provider or network operator or service provider and a handover interface

network element: component of the network structure, such as a local exchange, higher order switch or service control processor

network operator: operator of a public telecommunications infrastructure which permits the conveyance of signals between defined network termination points by wire, by microwave, by optical means or by other electromagnetic means

Open System Interconnect (OSI) model: model with 7 layers for interconnection of network nodes

NOTE: The model implies that nodes are to communicate on equivalent layers, for instance layer 3 (network) to layer 3, or telephone number to IP-address. For the Internet a 5-layer model is more commonly applied, where the OSI layers 5 to 7 are collapsed into a common layer called "application".

Quality of Service (QoS): quality specification of a telecommunications channel, system, virtual channel, computer-telecommunications session, etc.

NOTE: Quality of Service may be measured, for example, in terms of signal-to-noise ratio, bit error rate, message throughput rate or call blocking probability.

reliability: probability that a system or service will perform in a satisfactory manner for a given period of time when used under specific operating conditions

result of interception: information relating to a target service, including the Content of Communication and Intercept Related Information, which is passed by an access provider or network operator or service provider to an LEA

NOTE: Intercept related information shall be provided whether or not call activity is taking place.

service information: information used by the telecommunications infrastructure in the establishment and operation of a network related service or services

NOTE: The information may be established by an access provider, network operator, a service provider or a network user.

service provider: natural or legal person providing one or more public telecommunications services whose provision consists wholly or partly in the transmission and routing of signals on a telecommunications network

NOTE: A service provider does not necessarily need to run his own network.

session: period of interaction with an information or communication system during which the user is authenticated and connected to a user identity with certain authorities

target identity: identity associated with a target service used by the interception subject

target identification: identity that relates to a specific lawful authorization as such

NOTE: This might be a serial number or similar. It is not related to the denoted interception subject or subjects.

target service: telecommunications service associated with an interception subject and usually specified in a lawful authorization for interception

NOTE: There may be more than one target service associated with a single interception subject.

telecommunications: any transfer of signs, signals, writing images, sounds, data or intelligence of any nature transmitted in whole or in part by a wire, radio, electromagnetic, photo electronic or photo-optical system

telecommunication service provider: can be a network operator, an access provider or a service provider

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TS 101 331 [1], ES 201 158 [2] and the following apply:

AAA	Authentication, Authorization and Accounting
ADMF	ADMinistration Function
AP	Access Provider
CALEA	Communications Assistance for Law Enforcement Act (USA)
CC IIF	CC Internal Interception Function
CC	Contents of Communication

CS	Circuit Switched
DF	Delivery Function (delivery to LEMFs)
DNS	Domain Name System
ETR	ETSI Technical Report
EU	European Union
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
HI	Handover Interface
IIF	Internal Intercepting Function
IKE	Internet Key Exchange (protocol)
IN	Intelligent Network
INAP	IN Application
INI	Internal Network Interface
IP	Internet Protocol
IPSEC	IP Security (protocol)
IRI IIF	IRI Internal Interception Function
IRI	Intercept Related Information
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
IUR	International User Requirements (on lawful interception)
LEA	Law Enforcement Agency
LEMF	Law Enforcement Monitoring Facility
LI	Lawful Interception
MF	Mediation Function
NWO	Network Operator
NWO/AP/SvP	Telecommunication Service Provider
OSI	Open System Interconnect
POTS	Plain Old Telephone Service
PS	Packet Switched
PTN	Public Telecommunications Network
PTO	Public Telephony Operator
QoS	Quality of Service
SCF	Service Control Function (in IN)
SCI	Subscriber Controlled Input
SNMP	Simple Network Management Protocol
SSF	Service Switching Function (in IN)
SvP	Service Provider
TLV	Type-Length-Value (encoding)
TSP	Telecommunication Service Provider
VPN	Virtual Private Network (encrypted communication)
XML	eXtended Markup Language

4 Overview of LI requirements and standards

4.1 General

4.1.1 National adaptations

Each country is in sovereign control over which requirements on LI are imposed in the national legislature. It is however recommended to keep specific national requirements to a minimum for two main reasons:

- Cost and time, since special adaptation of LI systems that are built to comply with commonly accepted international requirements will be costly and cause delays.
- Mutual legal assistance, since it will become difficult and costly to handle delivery of LI results between countries, if their form and the scope of data representation differ widely.

4.1.2 Influence from new forms of telecommunication

Facilities for implementing and invoking functions of Lawful Interception are required to be implemented in telecommunications systems and networks. These networks proliferate in type and connectivity. As global networks merge and integrate, they extend across national borders, thereby complicating concepts of Lawful Interception.

The standard model for Lawful Interception is that it is a purely national requirement. It is justified under the telecommunications and security laws of a single national jurisdiction expressed as a condition of national license, and exercised under legal warrant by the appropriate national authorities on national Public Telecommunications Operators under their jurisdiction.

This model also assumes that such warrants apply uniformly across the entire telecommunications network of the licensed operator, that national gateways form distinct boundaries between domestic network elements (domestic meaning in terms of the national PTO, the Telecommunications Regulator and Law Enforcement Agencies) and extra-jurisdictional network elements, and that mutual conventions for co-operative cross-border LI assistance can be respected.

Given the proliferation of new forms of communications, such as satellite, third-generation mobile, Internet (IP) and the various ways in which such systems "plug & play", this "national" regulatory model is becoming outdated. Mobile voice and data communications rely on radio-based elements which incorporate network switching functions, and neither user terminals nor radio base-station systems contain any inherent capability to prevent their radio-modulations from reaching cross-border co-respondents, satellite systems perhaps exemplifying an extreme case.

Under these new circumstances a user may be registered in one country, located in a second, using the network facilities in a third, and communicating with correspondent(s) in fourth, fifth, and so on.

Neither in such networks would it necessarily be sensible for a communication traversing a multiplicity of network elements, e.g. IP datagrams of whatever type, to be the target of interception at each and every one of these networks.

Additionally, the implementation of Public Telecommunications Network (PTN) functions for Lawful Interception should never extend to the incorporation of Law Enforcement Network systems directly into the public network architecture. Rather, the design of the PTN should not extend further than the Mediation functions required to support the buffering of PTN and Law Enforcement networks.

Nor should Lawful Interception or other security functions ever be implemented in such a way as to mediate the delivery of public services on behalf of the PTN.

Consequently LI Architecture will have to take a broader look at the principles of LI, particularly as they apply in a trans-national telecommunications environment.

4.1.3 Guiding principles

It must be borne in mind that the Public Telecommunications Network (PTN) is explicitly designed and licensed solely for the provision of telecommunications services to a commercial public market.

To the extent that functions of Lawful interception are required by national law or regulation to be incorporated into a PTN, such functions are secondary and must not intrude on the functionality or performance of the PTN. The design of LI architecture should not involve fundamental design or architectural changes to the PTN.

The proper functioning of Lawful Interception requires network-to-network interworking and mediation between Public Telecommunication Networks and separate Law Enforcement Monitoring Facility (LEMF) networks. The monitoring facilities of a Law Enforcement Agency, complete with handover & handshaking functions connecting to MF/DF for reception of Lawful Interception products comprise a private and separate network, whose architecture is beyond the scope and interest of the PTN.

Mediation and Delivery Functions (MF/DF) required for Lawful interception constitute a Gateway Devices between these two distinct networks. If no protocol conversions or other special measures are required to transform the LI output from the PTN to the LEMF, the MF/DF may be transparent, i.e. not implemented in any separate physical node.

It is the responsibility of TSPs to ensure that internal interception functions are implemented in the relevant network nodes and that the delivery requirements for protocols, formats, etc are met. This responsibility is however operational in nature and does not imply a responsibility for technical interconnection.

Protocols, formats, and specifications for the delivery of Lawful Interception products across the MF/LEMF network interface should not of themselves have a constraining influence on PTN design.

Multiple & duplicated interception in a network should be avoided. That is to say that rather than being applied uniformly across a "national" network, interception should be invoked selectively at a subset of nodes in a network. This implies "marking-up" node(s) at which LI is to be invoked for a given target. Such selection of nodes should not be allowed to restrict how a connection can be routed through a network.

Where a network contains nodes in different jurisdictions, each separate jurisdiction should be capable of marking up a target at any **definable set** of nodes within its territory.

Location dependency (of Lawful Interception) means that the identity of the requesting jurisdiction necessarily influences the selection of the nodes within the PTN at which Lawful interception is to be effected.

Location dependency of Lawful Interception requires also that information of a target's location should be available at each intercepting network node.

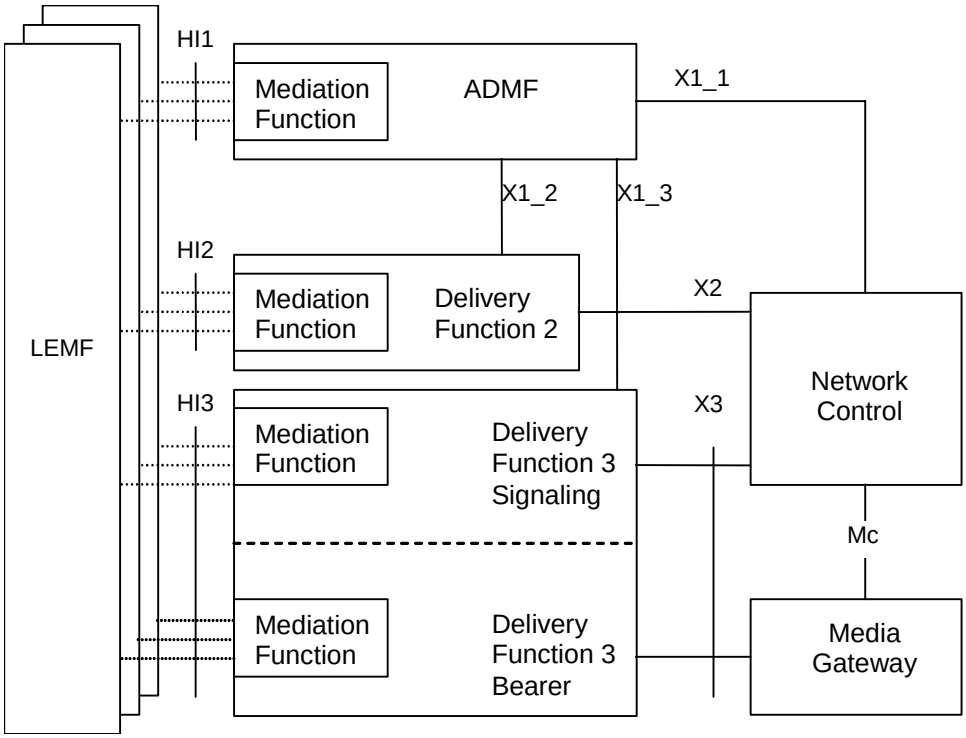

Figure 1: Reference model for LI system

Figure 1 (see TS 133 107 [12]) shows a standard reference model for LI. The interfaces from the PTN are standardized (HI2, HI3), while the internal interfaces within the PTN (X1, X2, X3) are proprietary. The mediation function acts as a gateway from the PTN to the LEA network. There is also a management function (ADMF), which receives HI1 data and sends out commands over X1 to set up communication nodes in the PTN and the LI System MF/DF to perform interception and send the products to the designated recipients.

4.2 Internationally based requirements

Figure 2 shows the hierarchy and relationship between requirements in the LI area.

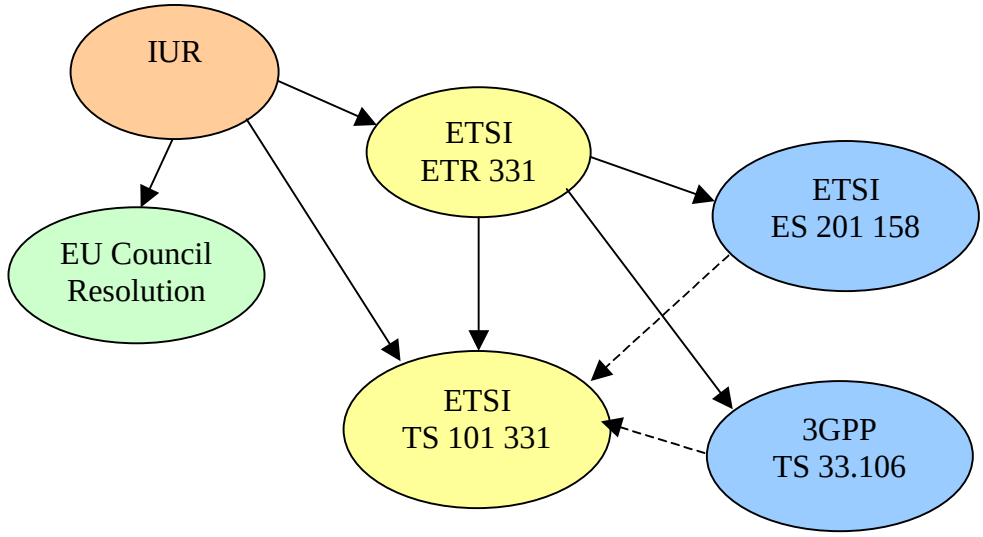

Figure 2: Development of international LI requirements

International User Requirements (IUR) have been worked out on an international basis, stating some basic needs of Law Enforcement for lawful interception. The EU council has adopted a resolution in January 1995, encouraging national governments to include requirements for lawful interception in their respective legal systems. The EU Council resolution has not had any apparent and direct impact on technical LI requirements.

The report ETR 331 was published within ETSI as a summary of LEA needs. This report was later re-issued as a technical standard (TS 101 331 [1]) under influence of the specific technical requirements of ES 201 158 [2] and TS 133 106 [13] as well as considerations of modern communication technology.

4.3 Characteristics of national requirements

4.3.1 General

The purpose of standardization is of course to create a framework for uniform design, thus reducing costs and enhancing interoperability. There are however certain areas that need to be left open due to differences in national conditions, such as how to migrate from legacy LI installations, specialities in national networks, national security requirements and locally preferred protocols for transmission.

4.3.2 Migration from legacy technology

Since lawful interception has been in operation in many countries for a long time before international standards emerged, there is a need to apply a strategy for technical and administrative migration from such legacy solutions. LEAs may not be prepared, or have the funding, for immediate and synchronous transition. Operators may want to align the transition to modern LI standards with a generation shift in their equipment. There may also be legal and business implications that influence the transition. All of this is outside the scope of international standardization and needs to be addressed on a national level.

4.3.3 National parameters

National communication networks may incorporate special services or technologies, which affect implementation of interception. International standards have provisions for this by offering open parameters, which need to be given values according to national conditions. An example of such parameters may be how to handle Subscriber Controlled Input (SCI), or whether or not to intercept transferred calls (see note).

NOTE: The model case for this is that intercepted subscriber A calls B and then C, neither of whom is intercepted. Then A hangs up, leaving B and C communicating with each other. Should interception still be in effect?

Another area, similar to choice of national options, is how to define formats for parameters that are declared as OCTET STRING or other open formats in the data definitions. There are probably national conventions for the format of for instance Lawful Interception Identifier (LIID). This needs to be clarified in national adaptations of the standards.

4.3.4 Security

Most LEAs are likely to have their own requirements on security arrangements for confidential communication, like transmission and storage of LI-data. Such requirements may call for specific encryption procedures, private network arrangements, special hardware etc. When implementing LI systems, such requirements (and the costs for meeting them!) need to be taken into account and planned for.

See clause 7 for further discussion about security issues.

4.3.5 Protocols

International LI standards define only a limited scope of protocols for transmission of LI products. When implementing an LI system, the full protocol stack will have to be agreed on between operators and LEAs. Security considerations will also play a role here, as discussed further in clause 6.4.

4.4 Requirement implementation process

The development cycle for telecommunication systems from formulation of a requirement until it has been implemented and is met in a system in operation is usually a process spanning over several years. For LI systems there is a number of players in addition to international standards groups: national legislators and regulators, telecom equipment manufacturers, telecom service operators, 3rd party vendors, law enforcement agencies. Each of these players will influence how an LI system is implemented and at what pace new requirements are introduced and complied with.

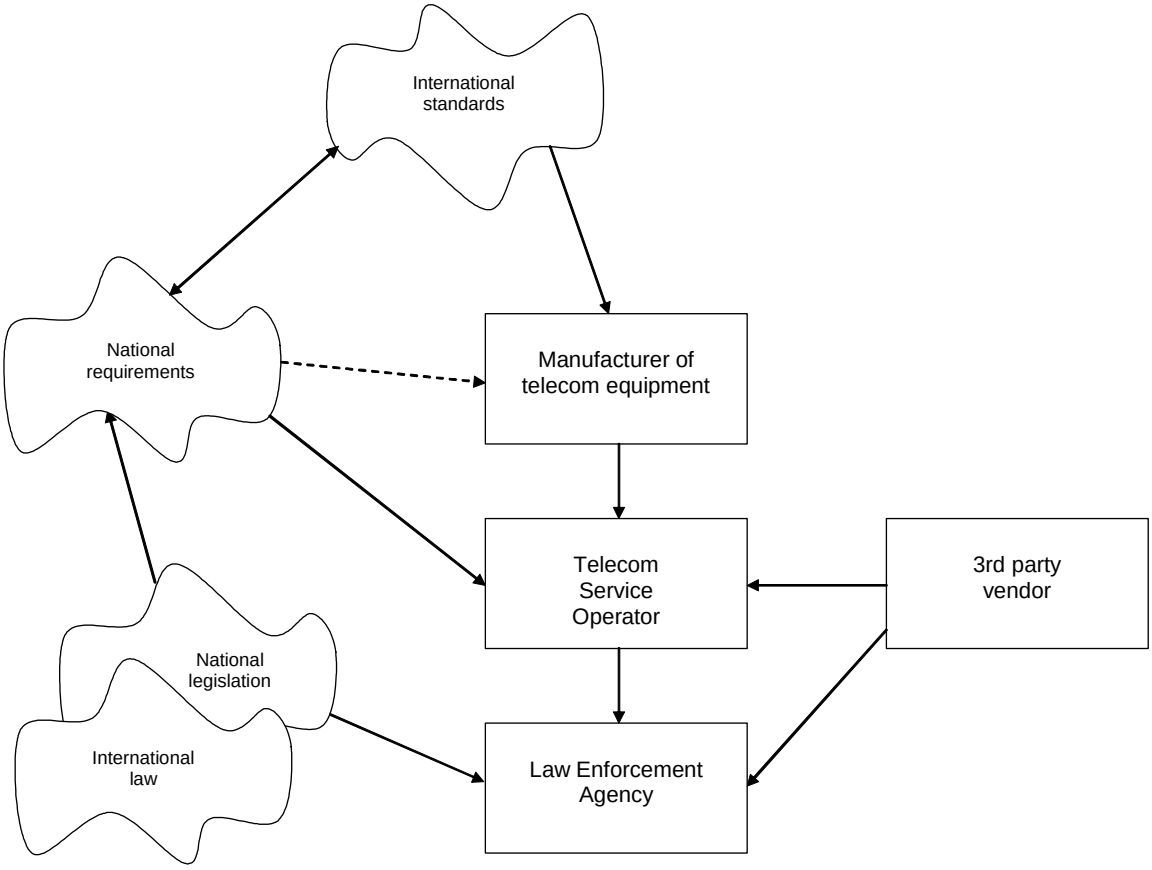

Figure 3: Requirement implementation process

The diagram above is intended to illustrate the process for implementation of requirements on an LI system. International standards will be influenced by national requirements. National requirements, in turn, will be based on national legislation and applicable standards. Telecom equipment manufacturers will build their LI systems for global markets based on international standards and with some consideration of national requirements, although it cannot be expected that telecom systems for a global market will be able to incorporate the union of all national specials. Telecom operators will need to meet national requirements in countries where they run business. Operators may also have their own technical requirements and may be able to tailor the standard products from manufacturers, often by including products (eg mediation functions) from 3rd party vendors. LEAs will be dependent on what operators have implemented and can apply 3rd party vendor equipment to cover special cases, which are not handled in the pre-installed LI functions. Operation of LEAs is of course based on national legislation.

4.5 Overview of LI standards

When referring to standards of various origins, it is important to keep in mind that some of them may be proprietary and thus not immediately available for public use. This overview of current standards is limited to *international standards*, i.e. ETSI and 3GPP. It is common for individual nations to set up their own specific adaptations of international standards, prescribing choice of options, transfer protocols, security provisions, etc. National standards, such as ANS J-STD-025, have been excluded intentionally from this discussion, even though they are important for implementation of LI systems and may even be adopted in countries other than the one which first created them.

NOTE: ANS = American National Standard, ANS J-STD-025 has been developed by the telecommunications industry in the U.S.A. as a joint standard (through TIA and ATIS) to meet requirements according to the CALEA law.

The diagram below shows both the requirements on internal functionality of telecommunications networks, i.e. the Internal Interception Functions (IIF), and the specifications for handover interfaces to LEAs. As can be seen, a considerable number of IIF requirements drive just a few handover interface specifications. It is desirable to keep that number low in order to avoid proliferation of solutions in this area, which would increase cost and reduce reliability.

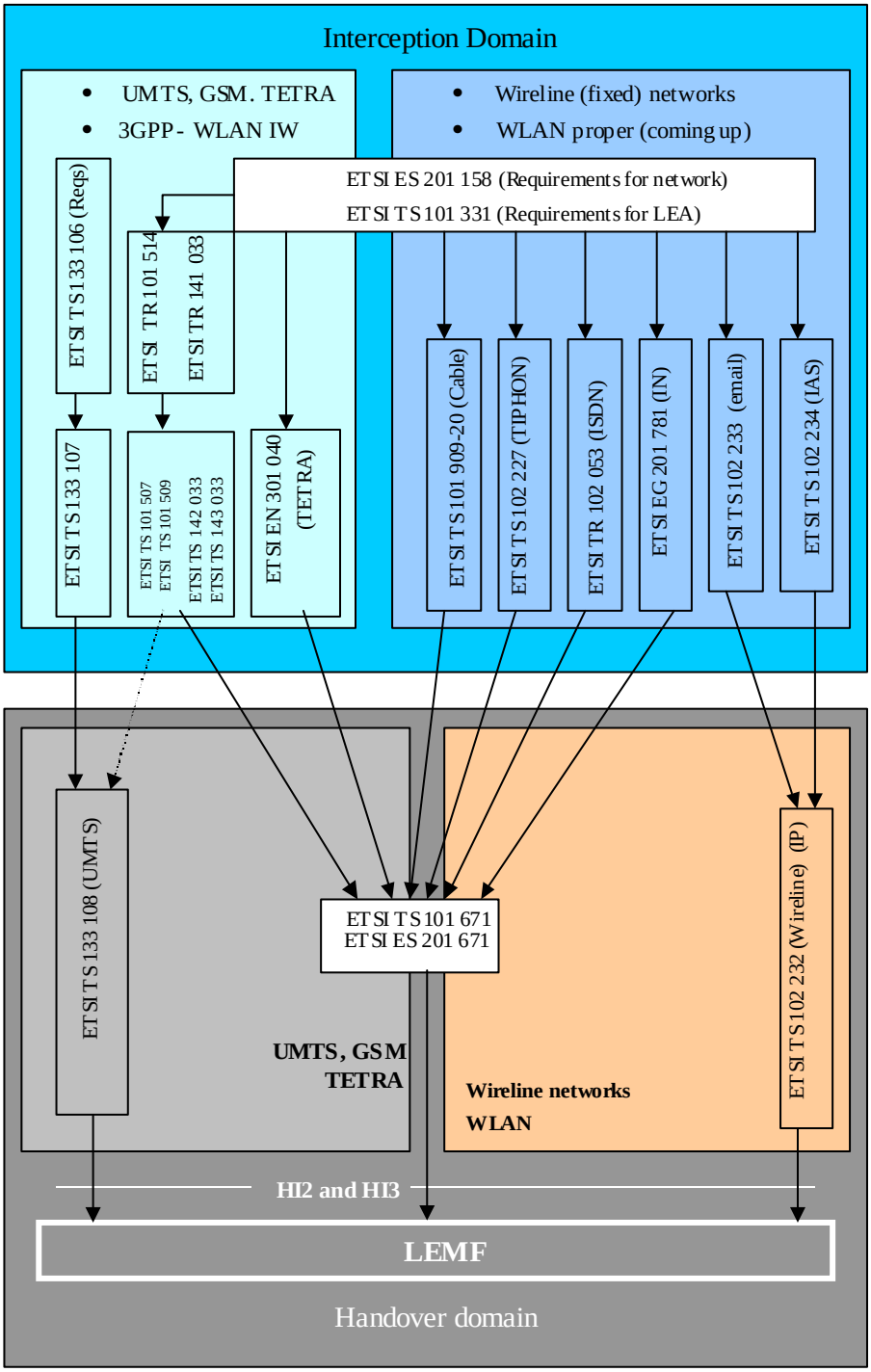

Figure 4: Overview of international standards for interception and handover

5 Interception of communication services

5.1 General

5.1.1 LI requirements related to services

When discussing interception, there is a tendency to focus on technologies and for instance view "IP Telephony" as something different from POTS. From the viewpoint of law enforcement, no such distinction should be made. Public telephony is supposed to be interceptable, regardless of how it is transmitted. In practice there will of course be moderations to this statement, since some technologies (as of yet) may defy interception. One might for instance consider the case where a conferencing system on the Internet is used to set up voice communication between computer users.

Interception of speech communication assumes adherence to the basic call model, so IRI messages are tailored to reflect state transitions in that model. When the implementation is moved out from the intercepting node and into user premises equipment, it will not be possible to generate standard IRI messages, unless the intercepting node performs some sort of interpretation based on lower-level protocols. It may for instance be possible to look into IP packets to determine that they contain phone call data and then watch for contents that correspond to signalling information in the basic call model. This would however be an attempt at second-guessing whatever a LEMF might conclude based on CC contents and involve TSPs in the role of a LEA.

5.1.2 Migration to separate service platforms

Traditionally, communication services have been provided in what might be called "aggregated form" - technology and service were combined on several levels: network access, speech or modem communication, communication protocols, hardware, etc. In POTS, for instance, the service is both speech communication and access, the target-id is the phone number, the protocols are integrated with the speech communication concept and the hardware consists of integrated function mainframe switches.

In modern systems, services have been made more independent of technology, such that each service may be provided over several different technologies. Three layers of abstraction can be defined according to this model.

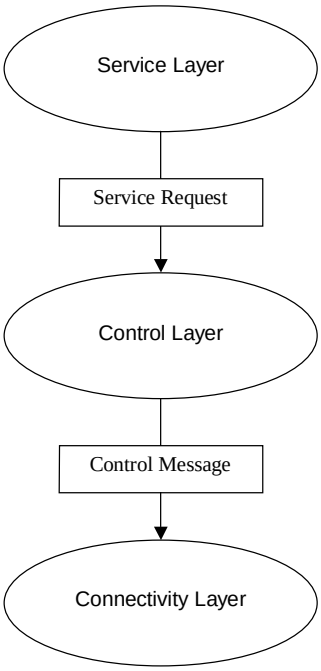

Figure 5: Three-layer model for communication system

The *Service Layer* will provide some specific service, such as Internet access, telephony or e-mail. That layer will also be responsible for AAA (Authentication, Authorization and Accounting) functionality. The Service Layer will send a request to the *Control Layer* to set up the technical means for providing the service. The Control Layer in turn will issue messages to the *Connectivity Layer* to set up the connections to provide the service.

5.1.3 Layered model related to LI functions

An application for lawful interception will use the Service Layer to identify the user, the Control Layer to provide IRI and the Connectivity Layer to get a copy of the CC.

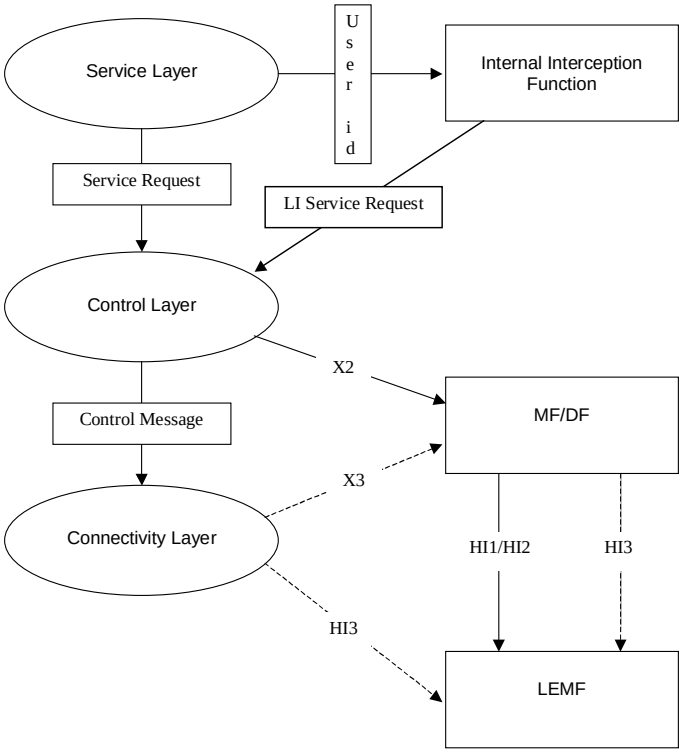

Figure 6: Mapping between LI service and communication system

In the mapping of LI services onto the three-layer model, it is assumed that the Service Layer holds the user-id, which would be used to identify a target for LI. In case the IIF finds a match between user-id and the list of targets held in the IIF, a request for LI services is sent to the Control Layer. The Control Layer will then be set up to report IRI to the MF/DF. In case CC is to be included in the interception, the Control Layer will send a message to the Connectivity Layer do deliver a copy of the communication. It is a matter of implementation choice whether to deliver the CC over an X3 link to the MF/DF for conversion to HI3, or to deliver directly in HI3 format to the LEMF(s).

5.2 Access services

Higher-level services are dependent of there being a service to gain access to the network. This makes the access service the lowest common denominator for provision of lawful interception. In lieu of being able to intercept for instance an e-mail server, a LEA may intercept access to the network that connects to the e-mail service.

Traditionally, access to a network for general services was provided over the phone line through modems or over special data networks, such as X.25. Today there is a multitude of technologies for access to the Internet.

When intercepting an access service, the point of interception needs to be close to the user, such that all contents of communication can be caught. As an alternative, there may be requirements for all traffic to pass through a point where it can be intercepted. The interception related information for an access service will not contain much more than the time when access is granted, to what user and with what network identity (eg IP-address). There may also be information about when access is discontinued. Network address translations may make it unfeasible to discern the traffic coming from a specific user. This has some similarity to interception of PABX users (the group number may be intercepted, but not the local extensions).

The functional architecture for interception of access service involves several functions, as shown in figure 7.

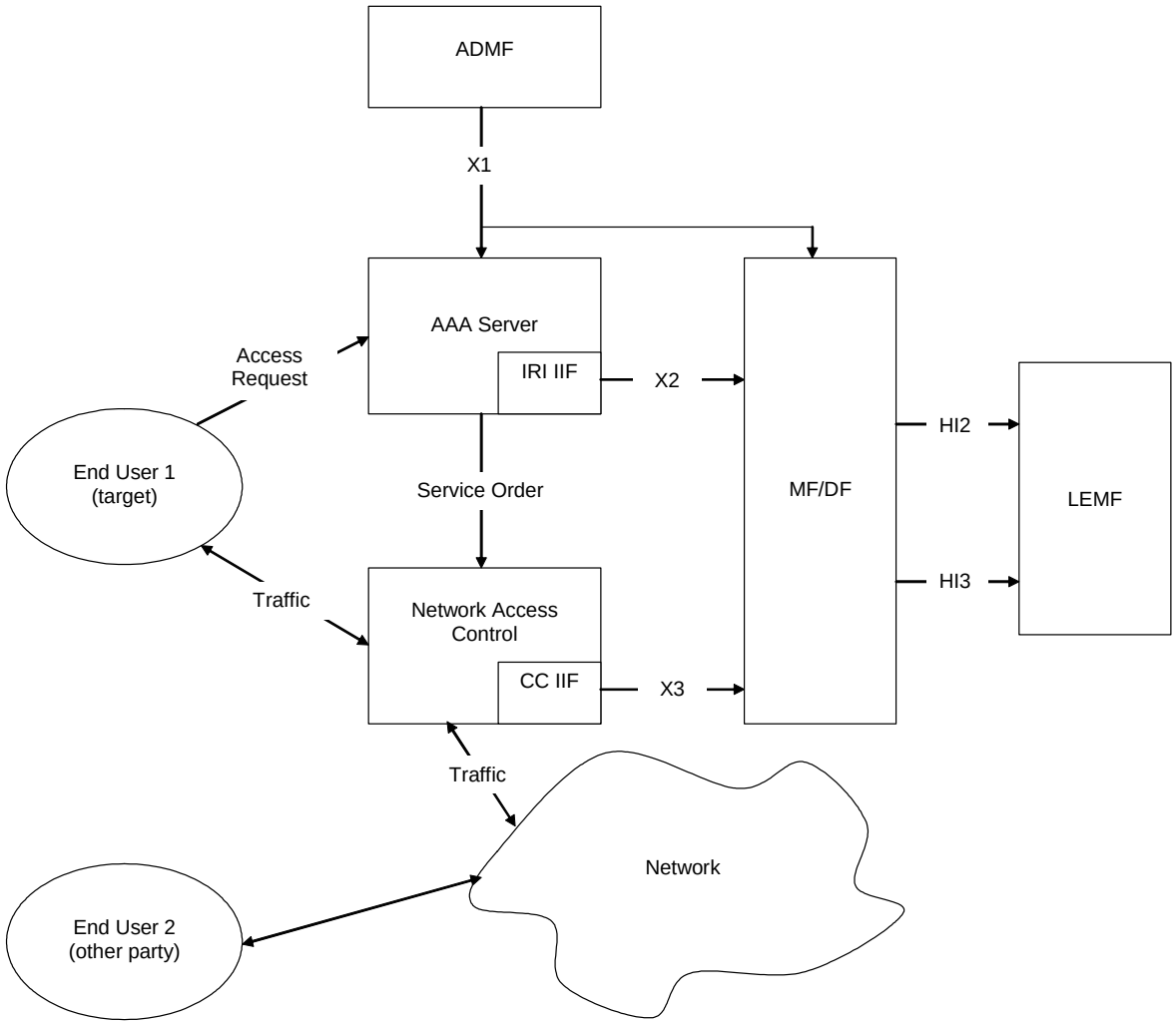

Figure 7: Functional architecture for interception of access service - user side interception

In this case it is assumed that the Network Access Control unit is accessible for installation and operation of LI functions with sufficient security. If this is not the case, another type of architecture might be applicable, as shown in figure 8.

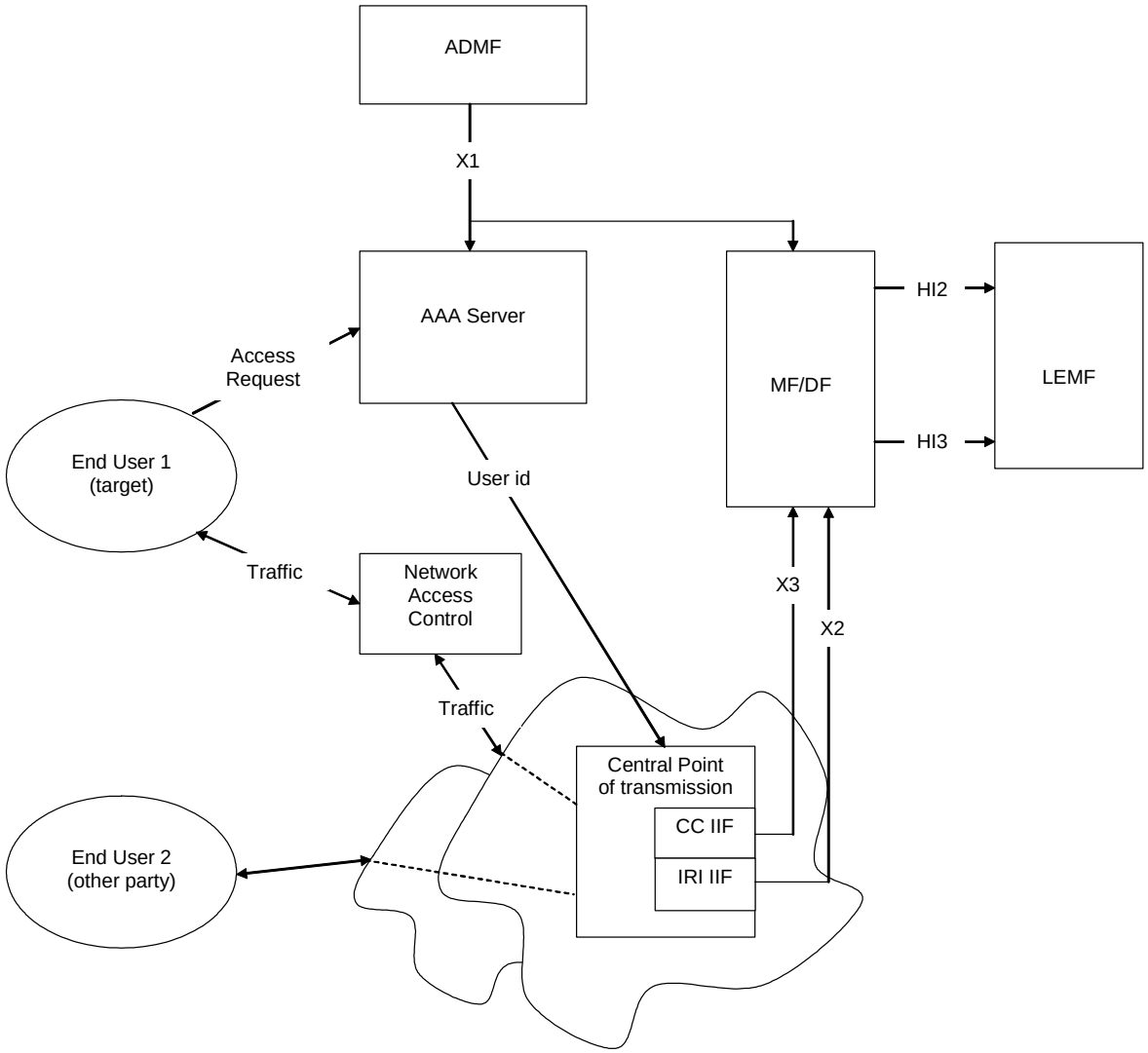

Figure 8: Functional architecture for interception of access service - network side interception

Here there is an assumption that all traffic can be forced to pass through one or more central points of transmission, where packets may be intercepted. Such interception points would typically be located in the ISP"s internal network. The LI function in such interception points needs to be in communication with all relevant AAA servers such that the user identities can be screened for interception. This would rid the AAA server of any LI functions, but would require that it can send information about user identities and allocated network identifiers (e.g. IP-address) to a central point.

5.3 Communication application services

In a modern communications network, an increasing number of different kinds of application services are offered. It may also be the case that the same kind of application service is offered through many different technologies, for instance telephony over CS or PS, e-mail over modem line or cable modem etc. If standard interfaces can be agreed on and security requirements satisfied, it is simpler for a LEA to intercept at the application level than at the access channel.

Figure 9 shows the main architectural elements for interception of application service.

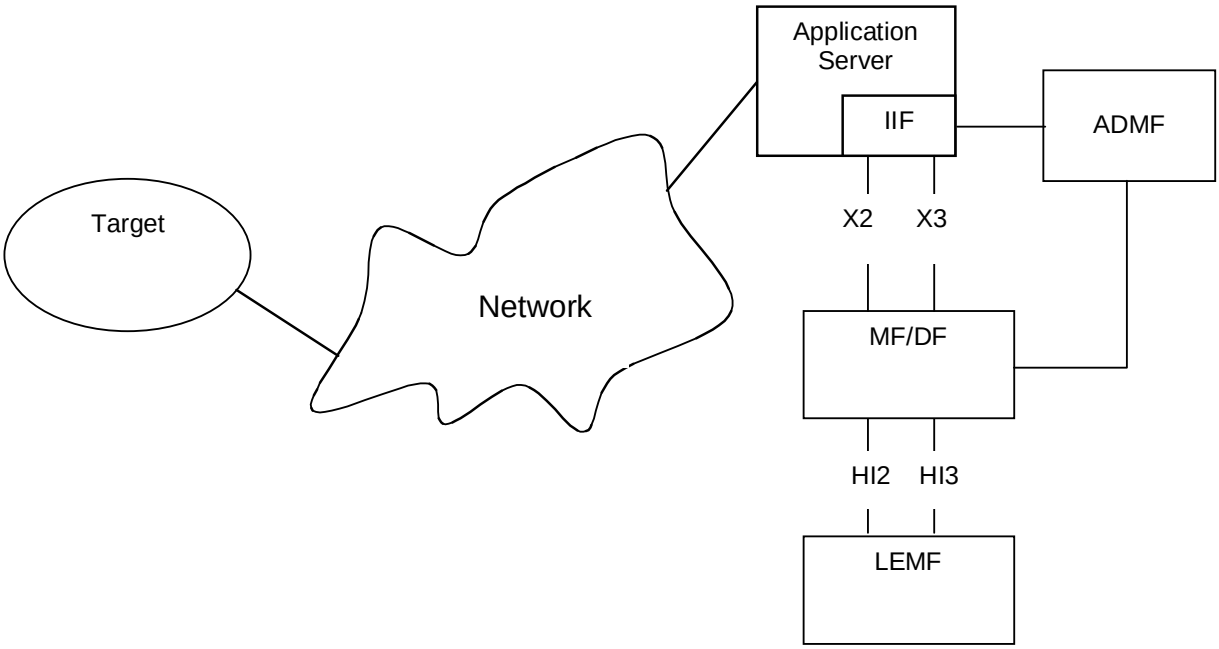

Figure 9: Interception of an application service

5.4 Intelligent network services

Intelligent network services form a somewhat special case for interception, since the application server (the IN Service Control Function - SCF) controls the access service (the IN Service Switching Function - SSF) to set up connections. Thus the SCF will be aware of user identity (eg calling card number), but not have control over contents of communication, while the SSF will know only network identities (connected phone numbers). In order to handle this case, some protocol extensions would have to be devised for the channel between SCF and SSF.

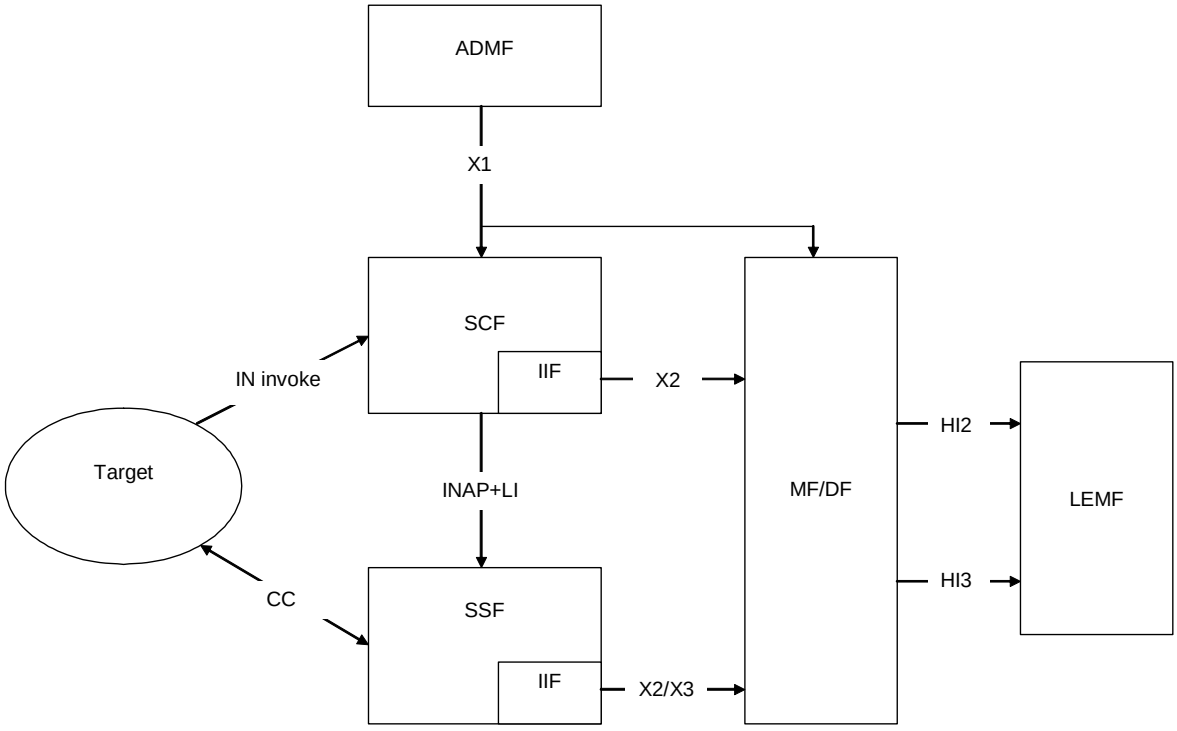

Figure 10: LI on intelligent network with extended INAP

The user (target) will invoke an IN service in the SCF (via the INAP link). The SCF needs to be equipped with some sort of IIF, which either contains a list of targets, or checks a target list in a special node. The SCF may also include the IN user identity into the extended INAP setup communication with the SSF, which holds the list of targets. Security issues need to be considered before deciding to include any LI-specific information in the SCF design.

Further details on lawful interception for intelligent networks can be found in EG 201 781 [10].

6 Interfaces

6.1 General

As discussed above, there are two basic types of interfaces:

- Internal interfaces (X), which are assumed to be vendor proprietary, or according to ad-hoc industry standards.
- Handover interfaces (HI), which are specified in international standards with more or less of a "national flavour".

6.2 Internal interfaces

Internal interfaces are adapted to the vendor"s proprietary technology and optimized together with the communication functions of the respective node. It is important to avoid increase in cost and decrease in performance when introducing the internal interception function in nodes that are produced and marketed in large volumes. Therefore it may be necessary to pack the information in the interfaces into pure binary form and use simple protocol stacks, such as UDP instead of TCP for the transport layer.

There are some recent initiatives for development of industry standards for internal interfaces, such as the Tap-MIB [9]. This interface technology is based on Simple Network Management Protocol (SNMP), which of course may impose a certain extra load on node design, unless SNMP is already being used for other purposes in the node in question.

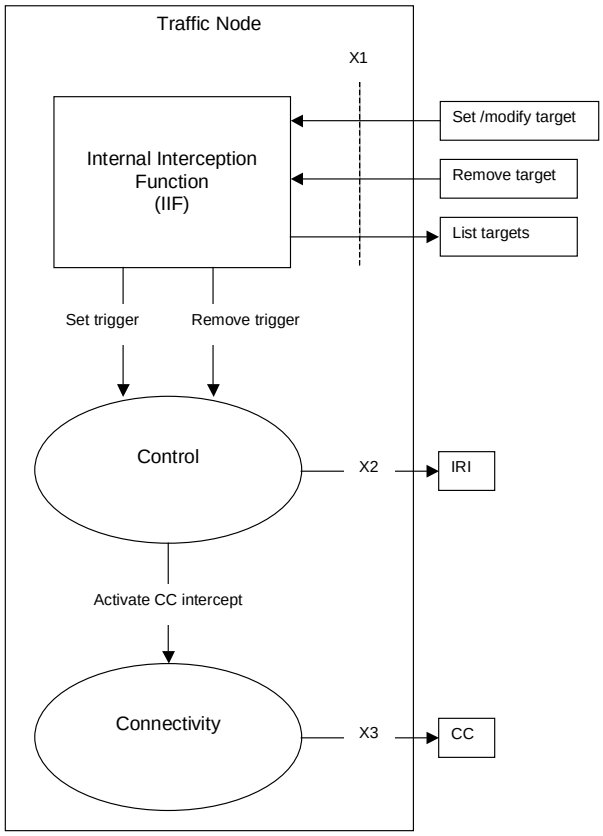

Figure 11: Node structure with internal interfaces

The interface for setting/modifying target and setting trigger, respectively, may contain information about internal or external delivery address for IRI and CC. There will also be information about whether the interception is IRI only or IRI + CC.

6.3 Handover interfaces

The mediation function will receive IRI and possibly also CC for transformation from internal interface format to the handover format. The delivery function will then handle dispatching of these LI products to the designated LEA(s). The syntactic elements of the HI2 and HI3 interfaces are described in several (partially overlapping) international and national standards. Currently ASN.1/BER is used for the presentation, but XML has been proposed as an alternative format.

At the application level in the protocol stack, FTP and ROSE are alternatives for IRI transmission. When using FTP, throughput requirements (IRI/hour) should be considered and the transmission mode, ie whether a transmitted file contains one IRI record or several records (see TS 101 671 [5], clause C.2) selected accordingly.

Even if ROSE has existed for many years as an established standard, it does not seem to have penetrated widely into the common marketplace. Before deciding to use ROSE in a national LI system, consideration should be given to availability of and support for the necessary software. Performance of the intended product choice should also be assessed.

CC for circuit switched traffic is delivered over standard PCM links. The correlation information is to be sent as UUS1 messages in the signal phase, ASN.1/BER-encoded. If the network does not support UUS, correlation data may be sent in ISDN subaddress fields. This will impose some limitations on extent and format of the data in the correlation information.

6.4 Interface protocols

CC for packet data (GPRS) can be delivered either as a stream of IP packets with a special correlation header, or as files over FTP. In the case of FTP delivery, TLV is used for encoding the correlation information, while a fixed layout for the correlation header part is applied when IP delivery is used (see TS 101 671 [5], clause F.3). Since the data load on CC transmission may be quite heavy, performance issues related to packaging that into files should be considered before deciding to use FTP. When straight IP delivery is used, there is an ambiguity as to what session/application protocol to use. TPKT has been specified for the USA, see TS 133 108 [6], clause G.3. In theory it is possible to have a "virtual session" going - the LEA will order CC delivery to a certain IP address and port number and then make sure that the designated port is open in the LEMF. This means that the communication does not extend beyond the transport layer at each side - the DF and the LEMF applications will not communicate with each other. In case there is a problem in transmission, leading for instance to buffer overflow on the sending side or if the received data turn out to be corrupt, there is no protocol mechanism to handle the case. When intercepting CC for packet data, the LI products received at the LEMF will be plain copies of all the data exchange between the parties. There will of course not be any way for the LEMF to ask any of the parties for a retransmission. If some portion of the traffic between the parties is re-transmitted, this will also be copied to the LEMF.

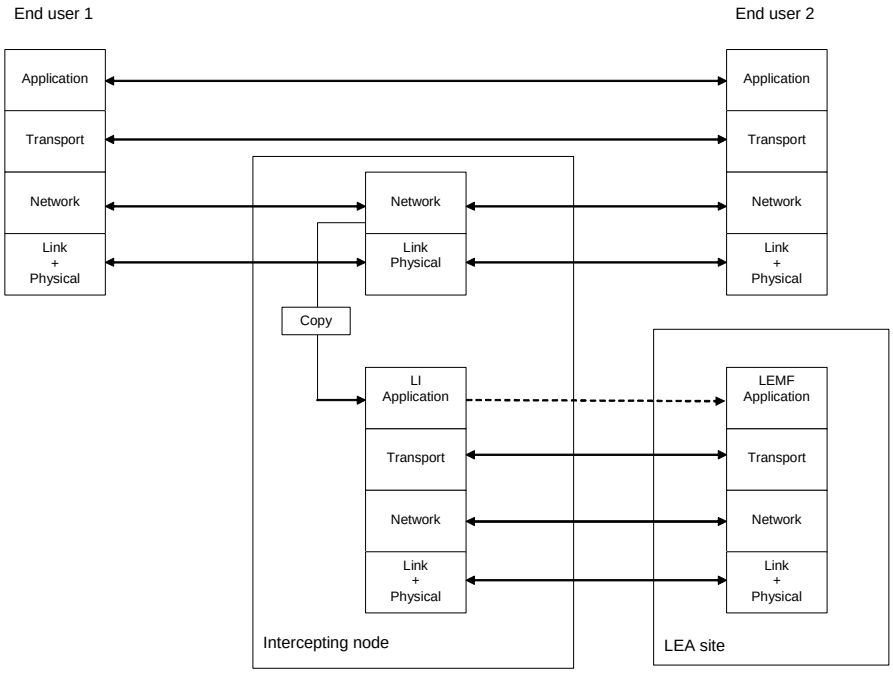

Figure 12: Protocol stacks with CC interception of packet data

Figure 12 shows how the intercepting node triggers on the network address of the intercepted user and sends copies of the thus intercepted packets to the LI application. After having identified the target user, the LI application will add a correlation header and then use the underlying protocol stack, from transport layer and downwards, to forward the intercepted packets to the LEMF. The LI Application and the LEMF Application will however not be aware of each other, except that the LEMF application may perform certain checks. For instance sequence numbers in LI headers may be used to synchronize between disjunct TCP sessions. This is indicated with a dotted line in figure 12.

6.5 Mapping IRI from PS Contents

When analysing results of interception of packet switched communication, it may be necessary to map IRI that is embedded in the protocols, which are used to emulate certain services. This information is found in the payload and requires special functionality in the analysis function, which also may depend on information in SIP or other types of control messages received over the HI2 channel.

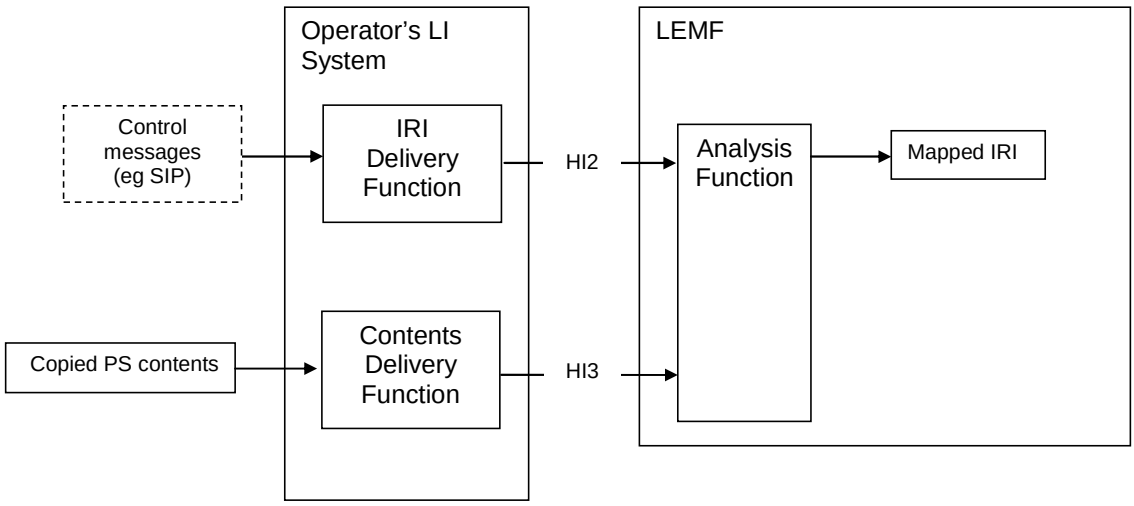

Figure 13: Mapping of IRI equivalents for service extracted in LEMF Analysis Function

It has been proposed to place the mapping function on the operator side, thus obliging the TSP to perform certain analysis work. As has been discussed above, such an arrangement could lead to that essential information is missed and that data may be misinterpreted. TSP staff might even be called into court to testify about the correctness of the mapping function.

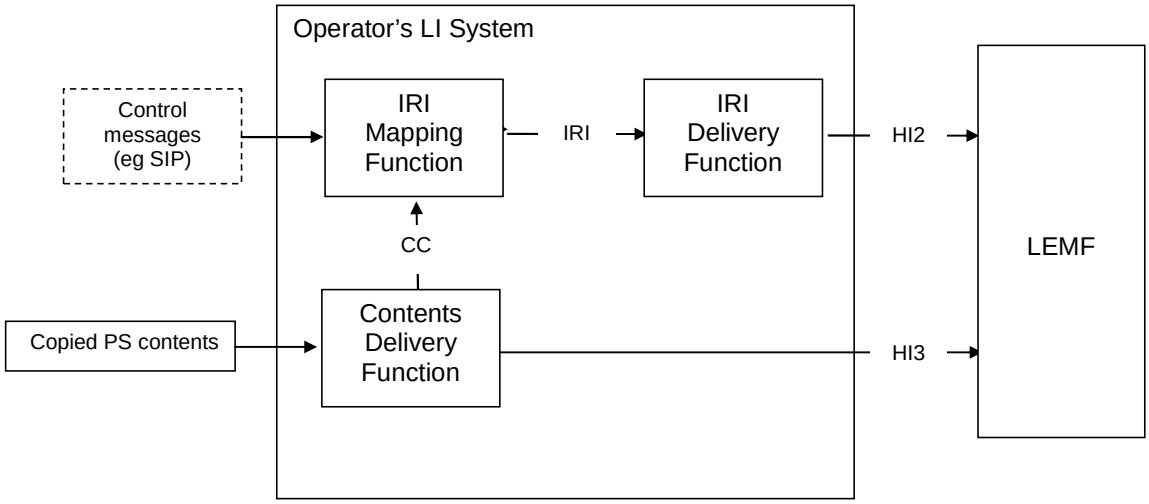

Figure 14: PS CC and control message IRI used to map IRI for service on operator's side

7 Security

7.1 General

The security of LI systems will be partially embedded in general network security provisions. It is no less necessary to protect the critical parts of the telecommunication system from intrusion than it is required to do so for the LI system. There are however some special aspects of the LI system that are related to the necessity to keep its operation secret. The most sensitive information in the LI system is data about who is intercepted. Results of interception are also sensitive information, which have to be protected against intrusion and tampering. Criminal organizations are potentially interested in blocking the function of LI systems and even taking control of them to use them for their own purposes. Such threats must be considered and provisions made to avert them. Experience shows that the most damaging actions tend to come from within, ie from corrupt or intimidated staff. Therefore screening and monitoring of personnel is one of the most important actions to enhance security.

7.2 Threat model

In ETR 332 [4] on security, there is a systematic approach to analysis of threats and security. The following types of threats are listed there:

1) impersonation;
2) masquerade of communicating parties and entities;
3) identity interception;
4) password interception;
5) data interception of signalling and user data;
6) replay of signalling and user data unauthorized copying;
7) modification and violation of data;
8) access right manipulation;

9) misuse of access rights;

10) denial of service;

11) denial of sending respectively authorship (repudiation);

12) denial of receipt access control;

13) installation of intentional malfunction;

14) sabotage.

In this discussion about security of LI systems, the following types of threats are considered:

1) identity interception;

2) password interception;

3) data interception of signalling and user data;

4) modification and violation of data;

5) access right manipulation;

6) misuse of access rights;

7) denial of service;

8) installation of intentional malfunction;

9) sabotage.

The discussion is based on suggested arrangements to counteract these threats. A more thorough analysis, where severity of threats is considered, should be done on a national and network characteristics basis.

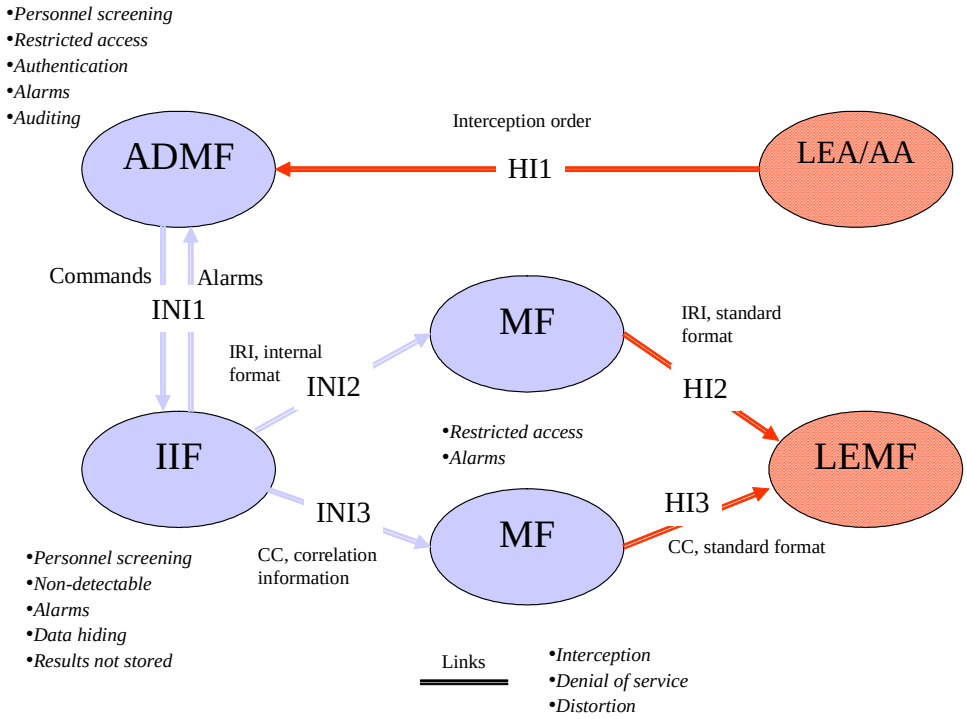

Figure 15: Diagram showing application of threat model to LI system

7.3 System security

7.3.1 Encryption of stored data

Data about intercepted subscribers, which is stored in the LI system, might be encrypted to enhance security. This is however likely to have adverse effects on performance. There is also some risk that the added complexity of encryption key management may cause problems. It should in most cases be sufficient to protect access paths to the stored data. Special care should however be taken to prevent that LI data leaks out from backups and transaction logs. The general rule is to exclude LI data from being backed up and logged outside the LI system itself, where it can be assumed to be adequately protected.

7.3.2 Logical access control

Access to LI systems should be restricted with strong authentication and authorization control. It is also to be recommended that operational information about the LI systems, such as how they are implemented, where they reside and how they are operated and maintained, should be kept within a small group of authorized persons.

7.3.3 Physical access control

Telecommunication systems are regularly protected against unauthorized access and the location of critical components is not comonnly known. Buildings, floors and rooms that house telecom systems are usually protected through access control. LI systems may be embedded in such security regimes and should be further protected through anonymity (no "red boxes" or such).

7.4 Interface and link security

7.4.1 Protection of transmitted data

If there is a risk that LI data may be intercepted or tampered with while in transmission, encryption may be used as protection. Standard procedures and products, such as IPSEC, should be preferred for this task. Proprietary encryption systems run the risk of becoming obsolete and unsafe, unless they are maintained to match development in communication technology and code cracking.

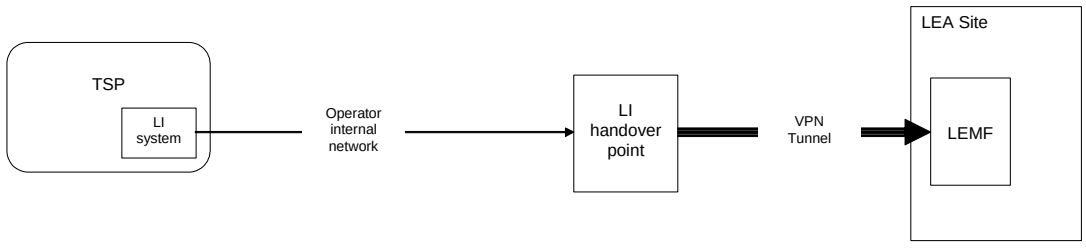

Figure 16: Secured IP delivery over VPN tunnel

For circuit switched CC, which is transmitted over phone lines, the standards allow for use of closed user groups and special screening of phone numbers for the sending LI system side and the receiving LEMF.

7.4.2 Management of keys

Keys for encryption of transmitted data can be managed through IKE (Internet Key Exchange), which is standard routine for IPSEC.

7.4.3 Use of leased lines

By using leased lines it is possible to protect interfaces and links such that encryption would not be necessary. By such an arrangement, LI data will never pass through public networks, so the network addresses for delivery of LI products can be defined in a private address space (e.g. 192.168.X.X) and E164 numbers defined outside of national routing tables. It is assumed that the private link is protected against physical tampering, for instance by using optical fiber in anonymous routing or protected ducts or both.

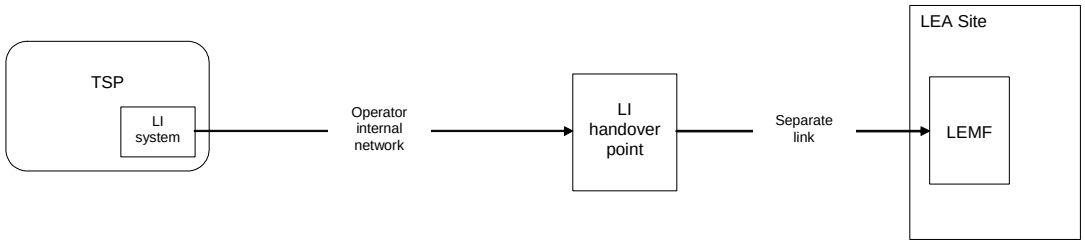

Figure 17: Handover point with separate links

Annex A (informative): Bibliography

- ETSI TS 101 909-20: "Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 20: Lawful Interception".
- ETSI TS 102 053: "Telecommunications security; Lawful Interception (LI); Notes on ISDN lawfull interception functionality".
- ETSI TS 102 233: "Lawful Interception (LI); Service specific details for E-mail services".
- ETSI EN 301 040: "Terrestrial Trunked Radio (TETRA); Security; Lawful Interception (LI) interface".
- ETSI TR 101 514: "Digital cellular telecommunications system (Phase 2+); Lawful interception requirements for GSM (GSM 01.33)".
- ETSI TS 101 507: "Digital cellular telecommunications system (Phase 2+); Lawful interception - Stage 1 (GSM 02.33)".
- ETSI TS 101 509: "Digital cellular telecommunications system (Phase 2+) (GSM); Lawful interception; Stage 2 (3GPP TS 03.33)".
- ETSI ETR 331: "Security Techniques Advisory Group (STAG); Definition of user requirements for lawful interception of telecommunications; Requirements of the law enforcement agencies".

Annex B (informative): Change Request History

Status of Technical Report TR 101 943 Concepts of Interception in a Generic Network Architecture		
Date	**Version**	**Remarks**
July 2001	1.1.1	First publication of the TR after approval by ETSI/ SEC WGLI #28; (15–17 May 2001, Hamburg) Version 1.1.1 prepared by Stefan Björnson (Ericsson) (rapporteur edtion 1)
September 2004	2.1.1	Included Change Request: TR101943CR001 (cat F) Publication of a new edition, version 2.1.1 This CR and updated TR was approved by TC LI#07 (28-30 September 2004, Bremen) Version 2.1.1 prepared by Stefan Björnson (Cecratech) (rapporteur edtion 2)

History

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V1.1.1	July 2001	Publication
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