Body of European Regulators for Electronic Communications

BEREC

BoR (16) 163

Case Studies on Migration from POTS/ISDN to IP on the Subscriber Access Line in Europe

6 October 2016

Table of Contents

List of Figures

List of Tables

Executive Summary

In recent years several network operators (fixed and mobile) in Europe started to migrate their networks to NGN/all-IP networks. When fixed networks are migrated to NGN/all-IP networks, also the access network needs to be migrated to IP. Network operators can either migrate the technology used on the subscriber access line (SAL) from POTS/ISDN to IP (VoIP-based SAL) or continue to use POTS/ISDN on the SAL and convert between POTS/ISDN and IP in the multi-service access node (MSAN). The focus of this report is on migration to VoIP-based SAL since this type of migration may have more impact on the subscribers and may need more regulatory intervention compared to conversion to IP in the MSAN.

In order to get a deeper insight into the migration to VoIP-based SAL and to foster the exchange of experiences between NRA this report has the following two objectives. Firstly, it aims to give an overview of the status of the migration to VoIP-based SAL in Europe on a general level based on information from 31 European countries. Secondly, it aims to give an overview of the migration to VoIP-based SAL in the network of the incumbent which have already taken place (at least to some extent) based on the experiences of ten countries (Croatia, Germany, Italy, Luxembourg, Montenegro, Netherlands, Slovakia, Slovenia, Spain and Switzerland). The analysis is descriptive and does not aim to be normative or to recommend best practice.

The high level analysis of the status of migration to VoIP-based SAL in Europe shows that in seven countries the incumbent has already finished the migration to an NGN/all-IP network, in 16 countries this migration is still ongoing and in eight countries this migration has not yet begun. From the 23 countries in which the incumbent is migrating its network to an NGN/all-IP network, or has already finished this migration, traditional copper-based SAL are migrated to VoIP copper-based SAL in 16 countries and to VoIP fibre-based SAL in 19 countries. The migration to VoIP on copper-based SAL is network driven, i.e. forced by the incumbent in 12 countries and customer driven, i.e. initiated by the customers in six countries.

The details of the migration to VoIP-based SAL in the network of the incumbent in the ten countries analysed are as follows:

- Migration strategy: The migration strategy is network driven in eight countries, customer driven in five countries and both types of migration strategy are used in three countries. The network driven migration encompasses in one country the migration of all SAL to VoIP-based SAL and in the other seven countries migration to VoIP-based SAL is only used in specific cases.
- Issues during the migration phase to VoIP-based SAL: In three countries issues occurred during the migration phase with regard to service interruptions and also with regard to information for the customers. In two of them these issues also resulted in customer complaints. During the migration phase further issues occurred in two countries, in one country with fax and in the other with the communication between incumbent operator and ANO in the migration process.
- Impact of the migration to VoIP-based SAL on the voice services for the end-users: In the eight countries with a network driven migration strategy, after the migration to VoIP-based SAL the use of the voice service was no longer possible in specific cases as e.g. for alarm systems and elevators. In order to solve this issue, customers migrated their existing system to an IP-based system (in six countries), or used a mobile service instead of the existing fixed voice service (in five countries), or installed UPS in their

premises (in two countries), or the incumbent used conversion to IP in the MSAN instead of VoIP-based SAL (in two countries). In two countries, this situation resulted to some extent in end-user complaints. In the two countries with an exclusively customer driven migration strategy, the impact on end-user services was not an issue, because an end-user might not be willing to migrate, if it can no longer use its voice service for the same purpose.

- Acceptance of modem and power outlet: In three of the eight countries with a network driven migration strategy, also standalone voice services are migrated to VoIP-based SAL. In all three countries, most of the end-users accepted that in order to migrate the voice service it was necessary to install a modem and to have a power outlet available at the customer premises. In the two countries with an exclusively customer driven migration strategy, the acceptance of modem and power outlet was not an issue, because an end-user might not be willing to migrate, if it does not accept this.
- Impact of the migration to VoIP-based SAL on WLR: In three countries, the incumbent offers WLR or has the obligation to offer WLR on VoIP-based SAL. In the other seven countries, this is not the case since in six of them alternatives are available (e.g. LLU, BSA) and in one of them WLR is also not mandated on traditional (not migrated) SAL.
- Impact of the migration to VoIP-based SAL on CS/CPS: In six countries, CS and CPS continue to be available on SAL which are migrated to VoIP-based SAL. In the four other countries this is not the case since the incumbent no longer has SMP or alternatives are available.

It can be concluded that from an overall perspective the impact of the migration to VoIP-based SAL was limited in most of the countries considered and so was the need for regulatory intervention. Consumer issues seem to be more likely to occur in cases where the migration was network driven. Wholesale services which are no longer available after migration such as WLR and CS/CPS have been replaced by other (already available) wholesale products such as bitstream access.

1 Introduction and objective

In recent years several operators (fixed and mobile) in Europe started to migrate their networks to Next Generation Networks (NGN)/all-IP networks.[1] A main driver for this is the fundamental change of the traffic from previously being dominated by voice to meanwhile being dominated by data. Therefore, previously the voice telephony networks were optimised for voice (i.e. circuit switching and the use of TDM) and to some extent also data was carried over these networks. Now the networks are optimised for data traffic (i.e. packet switching and IP) and voice is increasingly transported over these networks. When networks are migrated to NGN, this may have an impact on both boundaries of networks, the interconnection with other networks and the access to the network provided to the subscribers. BEREC has already studied the migration of the interconnection for voice services from traditional technology (circuit switching, TDM) to IP.[2] In this report BEREC will analyse the migration of the access networks due to the migration to NGN.

The migration of the traditional voice telephony network to an NGN replaces the traditional telephone exchanges (e.g. LEX) by IP-based voice platforms (e.g. IMS). The access networks also need to be migrated to IP and for this network operators have the following two options (see Figure 1):

(i) VoIP-based subscriber access line (SAL): The technology used on the SAL is migrated from POTS/ISDN to IP (VoIP). The conversion from POTS/ISDN to IP (VoIP) takes already place at the customer premises or is not necessary when IP phones (with an IP-based interface between user and network) are used.

(ii) POTS/ISDN-based SAL and conversion to IP in the MSAN: The technology used on the SAL remains unchanged and POTS/ISDN are continued to be used on the SAL. The conversion from POTS/ISDN to IP (VoIP) takes place in the multi-service access node (MSAN) at the central office (CO) or in case of NGA e.g. at the street cabinet (FTTC) or at the building of the end-users (FTTB).

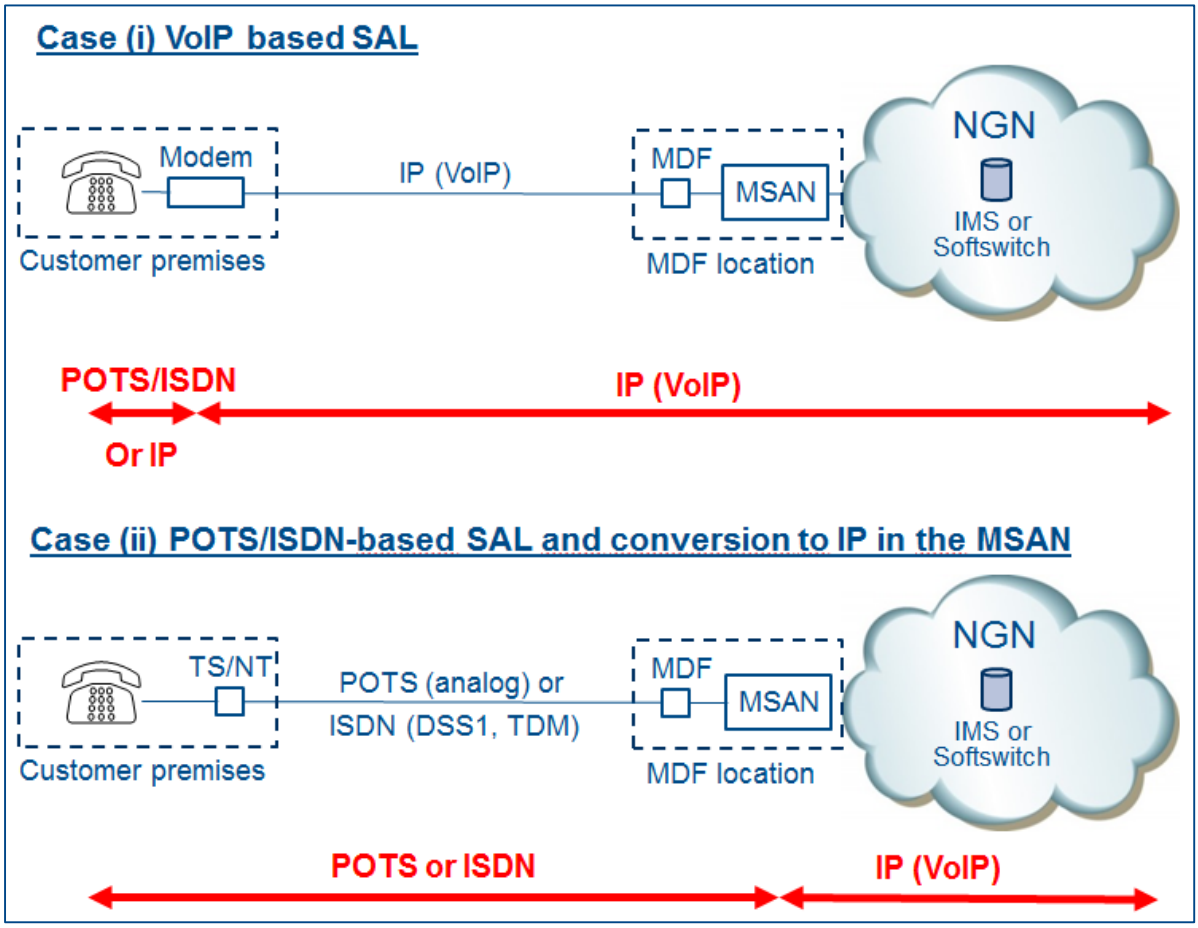
When migrating the traditional voice telephony network to a NGN, network operators can continue to use copper-based SAL or, in case this migration is linked with FTTH roll out, copper-based SAL are replaced by fibre-based SAL. In the first case, the continued use of copper-based SAL, a network operator has both options (case (i) and case (ii) mentioned above), in the second case, the migration to fibre-based SAL, only case (i) is possible, since traditional POTS/ISDN technology is available on copper but not on fibre (see Figure 2).

In case of migration to an NGN based on conversion to IP in the MSAN (case (ii)) nothing needs to be changed at the customer premises and on the SAL. In the migration phase the SAL solely needs to be disconnected from the local exchange and connected to the MSAN. In contrast, if a network operator migrates to VoIP-based SAL (case (i)), then changes are necessary at the customer premises (e.g. in case of a standalone voice service, a modem needs to be installed), on the SAL (the use of IP/VoIP instead of POTS/ISDN) and at the CO (the voice service needs to be moved from the LEX to the IP-based voice platform). Furthermore, these changes need to be coordinated and take place, if possible, at the same

[1] Since the terms 'NGN' and 'all-IP network' are largely synonymous hereafter only the term 'NGN' is used in order to ease readability.

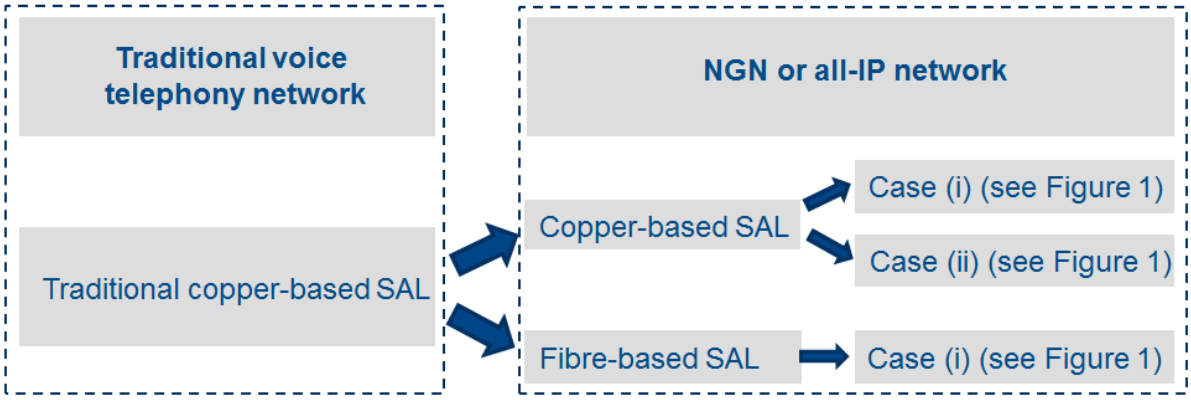
[2] See BEREC report 'Case studies on IP-based interconnection for voice services in the European Union', BoR (15) 196, http://berec.europa.eu/eng/document_register/subject_matter/berec/reports/5579-case-studies-on-ip-based-interconnection-for-voice-services-in-the-european-union

time in order to avoid service interruptions which are not tolerated by customers. Since IP is used on the SAL (and no longer POTS/ISDN) remote power supply and traditional wholesale line rental (WLR) may no longer be available. Hence, it is likely that the migration to VoIP-based SAL will have more impact on the subscribers and may need more regulatory intervention compared with conversion to IP in the MSAN. Therefore, the report focuses on the migration to VoIP-based SAL. Since the incumbent operators own most of the POTS/ISDN based SAL, the report further focuses on the migration to an NGN of incumbents.



Source: BEREC

Figure 1: Options for the migration to IP (VoIP) in the access network



Source: BEREC

Figure 2: Migration to IP (VoIP) in the access network depending on the physical media of the SAL

An incumbent can use one or both of the following two strategies to migrate its customers to VoIP-based SAL:

- Network driven migration: The incumbent forces the customer to migrate to VoIP-based SAL.
- Customer driven: The incumbent offers attractive voice services with VoIP-based SAL in order to motivate its subscribers to migrate to such a voice service on a voluntary basis.

The report also takes into account the migration strategy of the incumbent, since the impact of the migration to VoIP-based SAL on the subscribers and the need for regulatory intervention may depend on it.

In recent years incumbent operators in several countries started to migrate their networks to an NGN and the SAL from POTS/ISDN to a VoIP-based SAL. In order to get a deeper insight into the migration to VoIP-based SAL and to foster the exchange of experiences between NRA this report has the following two objectives. Firstly, it aims to give an overview of the status of the migration to VoIP-based SAL in Europe on a general level based on information from 31 European countries. Secondly, it aims to give an overview of the migration to VoIP-based SAL in the network of the incumbent already taken place at least to some extent based on the experiences of ten countries (Croatia, Germany, Italy, Luxembourg, Montenegro, Netherlands, Slovakia, Slovenia, Spain and Switzerland).[3] The analysis is descriptive and does not aim to be normative or to recommend best practice.

The document begins with an overview of the status of the migration to VoIP-based SAL in Europe on a general level (section 2). In the next step, the migration to VoIP-based SAL of the incumbent operators of the ten countries considered is analysed. This begins with an overview on the migration strategy (section 3.1) and the time frame of the migration (section 0), followed by an analysis of issues during the migration phase (section 3.3), impact on the services for the end-users (section 3.4) and impact on the wholesale services of the incumbent (section 3.5). Finally, conclusions are drawn (section 4).

[3] The report considers the migration of the technologies on the SAL from POTS or ISDN Basic Rate Access (but not ISDN Primary Rate Access) to IP (VoIP). However, in order to ease readability in the report the abbreviation ISDN and not ISDN-BRA is used.

2 Status of migration to VoIP-based SAL in Europe

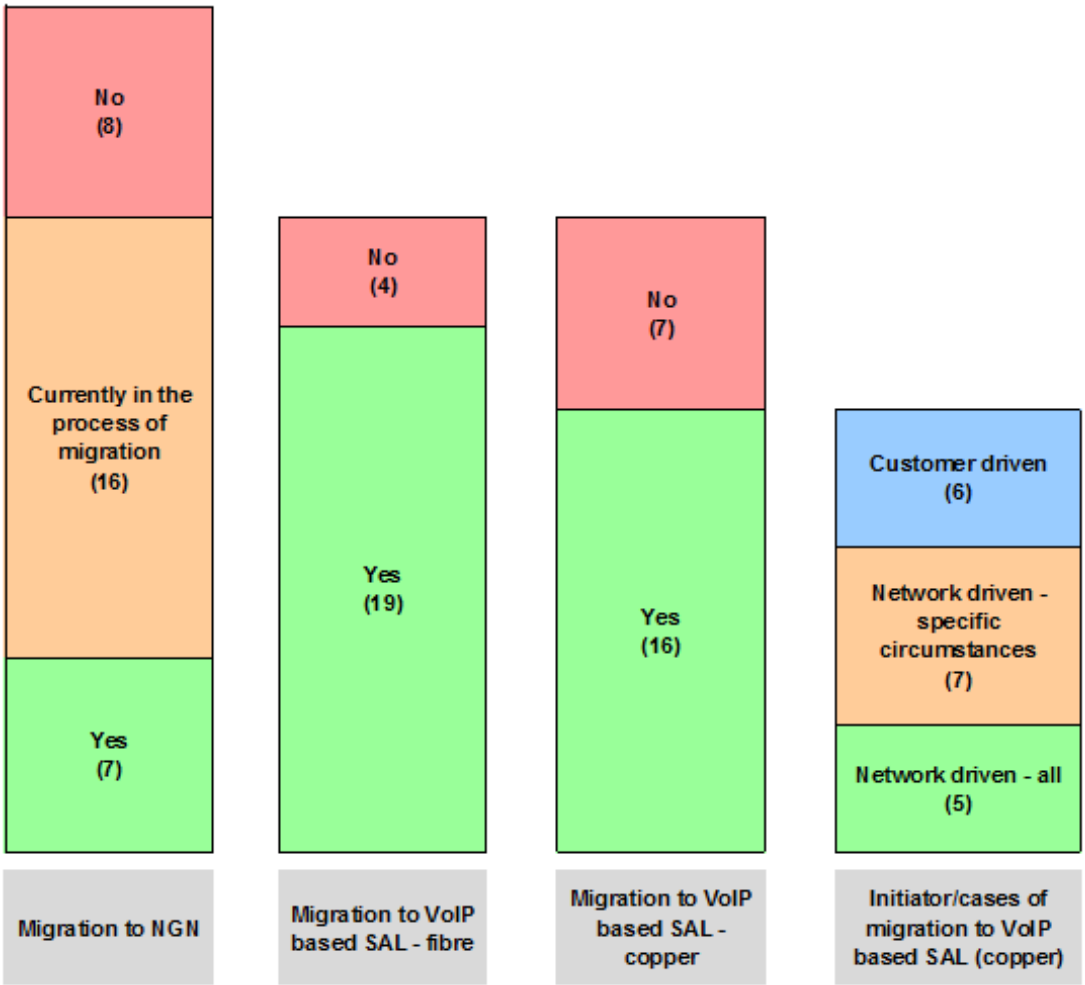
This section provides an overview on the status of the migration of European incumbent operators' networks to an NGN, as well as to VoIP-based SAL. The information provided is as of the beginning of 2016 (see Figure 3 and

Table **1**), and based on the responses of 31 NRAs (out of 37 BEREC members and BEREC observers).

In seven countries (23% of the 31 countries which responded) the incumbent has already finished its migration to an NGN, in 16 (52%) countries this migration is still ongoing and in 8 (26%) countries this migration has not yet started.

In the 23 countries in which the incumbent has already started or finished the migration to an NGN, the status of the migration to VoIP-based SAL (see case (i) in Figure 1) is as follows.

Traditional POTS and ISDN technology is based on copper and not on fibre. Therefore, if an incumbent rolls out FTTH the voice service has to be provided based on a NGN and it has to use VoIP-based SAL (conversion to IP in the MSAN is not possible, see Figure 1).



Source: BEREC

Figure 3: Status of migration to NGN and to VoIP-based SAL in Europe

Table 1: Status of migration to NGN and to VoIP-based SAL in Europe

Migration to NGN	Migration to VoIP-based SAL - fibre	Migration to VoIP-based SAL - copper	Initiator/cases of migration to VoIP-based SAL (copper)
Yes (7): AT, BG, FYROM, HR, LI, ME, SK	Yes (19): AT, CH, DE, DK, ES, FYROM, HR, HU, IT, LI, LT, LU, LV, ME, MT, NL, NO, SI, SK	Yes (16): CH, DE, DK, FYROM, GR, HR, HU, IT, LI, LU, LV, ME, NL, NO, SI, SK	Network driven - all (5): DE, CH, FYROM, GR, LV
In the process of migration (16): BE, CH, DE, DK, ES, GR, HU, IT, LT, LU, LV, MT, NL, NO, RO, SI	No (4): BE (only greenfield FTTH), BG, GR, RO	No (7): AT, BE, BG, ES, LT, MT, RO	Network driven - specific circumstances (7): HR, HU, LU, ME, NO, SI, SK
No (8): CY, CZ, FI, FR[4], IE, IS, PL, PT[5]			Customer driven (6): DE, DK, IT, LI, ME, NL

Source: BEREC

In 19 countries (83% of the 23 countries), the incumbent rolls out FTTH and migrates traditional copper-based SAL (POTS, ISDN) to VoIP fibre-based SAL. The migration is usually customer driven (if customer requires services which can only be provided based on FTTH). However, in a few countries (e.g. ES, LU) also a network driven approach is used. In the other four countries (17%), there is no migration from copper to FTTH, because the incumbent does not roll-out FTTH or only for new buildings.

In 16 countries (70%), the incumbent migrates the technology of copper-based SAL from POTS/ISDN to IP (VoIP). In the other seven countries (30%), this is not the case and the incumbent uses conversion to IP in the MSAN instead.[6]

In the 16 countries in which the incumbent migrates the technology of copper-based SAL from POTS/ISDN to IP (VoIP), the following migration strategies are used. In two countries the incumbent uses both the network driven and the customer driven migration strategy, in 10 countries only the network driven migration strategy and in four countries only the customer driven migration strategy. In five of the 12 countries with a network driven migration strategy, this forced migration encompasses all subscribers with a voice service and in the other seven countries, the subscribers are forced to a VoIP-based SAL only in case of specific circumstances as e.g. subscribers with a bundle product voice and internet or subscribers which are migrated to FTTC or FTTB.

[4] In France and in Portugal, the incumbent operator currently has in place both a traditional telephony network (PSTN) and in parallel also a NGN. Since voice services of bundles (e.g. 2-play, 3-play) were from the outset based on the NGN there was never a need to migrate theses voice services to IP. Standalone voice services are currently still based on the traditional voice telephony network.

[5] In Portugal, the incumbent operator currently has in place both a traditional telephony network (PSTN) and in parallel also a NGN and is adopting progressively VoIP in its network.

[6] In Spain, the incumbent currently only migrates fibre-based SAL (not copper-based SAL) to NGN. Therefore, POTS/ISDN is used on copper-based SAL without conversion to IP in the MSAN.

3 Analysis of the migration to VoIP-based SAL

This section analyses the migration to VoIP-based SAL (see Figure 1) of the incumbent operators in ten countries (CH, DE, ES, HR, IT, LU, ME, NL, SI, SK). It begins with an overview of the migration strategy (see section 3.1) and the time frame of the migration (see section 0), followed by an analysis of issues during the migration phase (see section 3.3), impact of the migration to VoIP-based SAL on the services for the end-users (see section 3.4) and on the wholesale services of the incumbent (see section 3.5). The data collected for the analysis in this section is shown in the tables of the annex.

3.1 Migration strategy

Table 2 gives an overview of the migration strategy of the ten countries considered.[7] In three countries the incumbent uses both the network driven and the customer driven migration strategy, in five countries only the network driven approach and in two countries only the customer driven approach.

Table 2: Migration strategy of the ten countries considered

Migration strategy	Country
Only network driven	CH, HR, LU, SI, SK
Only customer driven	IT, NL
Network *and* customer driven	DE, ES, ME

Source: BEREC

In the eight countries with a network driven migration strategy the migration encompasses in one country (CH) all voice services and in the other seven countries only the following specific voice services (see Table 3):

- In three countries (LU, ME, SK), voice services of bundles including voice and internet;
- in two countries, also voice services of such bundles but in addition also some standalone voice services (HR), or voice services based on FTTC/B (SI);
- in Spain voice services based on FTTH and
- in Germany all voice services except standalone voice services.

Table 3: Migration to VoIP-based SAL in case of network driven migration strategy

Country	Voice services which are migrated to VoIP-SAL in case of network driven migration strategy
CH	All voice services
DE	All voice services except standalone voice services (POTS)
ES	Voice services based on FTTH
HR	Bundle products voice and internet access and some standalone voice services
LU	Bundle products voice and internet access
ME	Bundle products voice and internet access
SI	Bundle products voice and internet access and voice services based on FTTC/B
SK	Triple play services and some dual play services

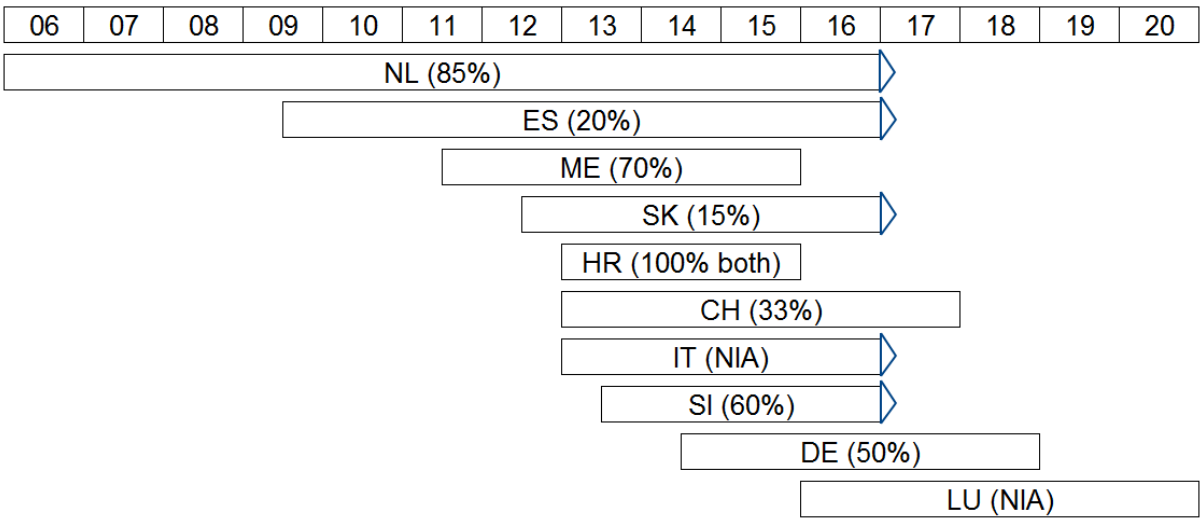
Source: BEREC

[7] The migration strategy is used for the migration from traditional copper-based SAL to VoIP copper-based SAL (see Figure 2), except in two countries (ES, IT), in which it is (also) used for the migration to VoIP fibre-based SAL since the migration is limited to FTTH (ES) or FTTH/C (IT).

The other voice services are continued to be based on the use of POTS/ISDN on the SAL and conversion to IP in the MSAN (see Figure 1).[6]

3.2 Time frame of the migration to VoIP-based SAL

Figure 4 shows the time frame of the migration to VoIP-based SAL of the ten countries considered. In the Netherlands, the migration to VoIP-based SAL is customer driven and since Q3 2005 voice services with VoIP-based SAL are offered. Since the migration is customer driven the end date of the migration is unknown. However, approximately 85% of the SAL of the incumbent are already migrated to VoIP-based SAL.



Source: BEREC

Figure 4: Time frame of the migration to VoIP-based SAL

In Spain, the migration is also customer driven, however this is restricted to FTTH. The first voice products with VoIP and fibre-based SAL were offered in 2009. Currently approximately 20% of the SAL of the Spanish incumbent are already migrated to VoIP-based SAL and FTTH. Recently the incumbent started to use forced migration to some extent. However, the incumbent has not announced information on the end of the migration so far. In Montenegro, the migration is both network and customer driven and began in 2011 and ended in November 2015. Approximately 70% of the SAL are migrated to VoIP-based SAL. On the other SAL (see Table 3) POTS and ISDN is continued to be used and the conversion to IP is done in the MSAN (see Figure 1). In Slovakia, the forced migration started in 2012 and approximately 15% of the SAL are migrated to VoIP-based SAL so far. Currently the migration to VoIP-based SAL is restricted to triple play services and some dual play services (see Table 3) and a full migration of all SAL to VoIP-based SAL is not yet planned.

In Croatia, the incumbent announced in April 2012 that it will start a forced migration to IP (VoIP) in the access network. In April 2013 it switched-off its first local exchange and at the end of 2015 this migration process was finished. Therefore, all voice services are already migrated to IP (VoIP) and all bundle products voice and internet access as well as some standalone voice services are also migrated to VoIP-based SAL (see Table 3). In Switzerland, the incumbent started a forced migration of all POTS/ISDN based SAL to VoIP-based SAL in November 2012 and plans to end this migration in 2017. Currently already approximately 33% of the SAL are migrated. In Italy, the migration is customer driven and restricted to FTTC or FTTH. The incumbent started to offer voice services with VoIP-based SAL and based on FTTC

or FTTH in December 2012. Since the migration is customer driven, the end date of the migration is unknown.

In Slovenia, the incumbent started a forced migration in April 2013. Approximately 60% of all active SAL of the incumbent (including copper and fibre) are already VoIP-based SAL. The switch off of all traditional voice exchanges is planned for 2018/2019. Since currently the migration to VoIP-based SAL is restricted to specific cases (see Table 3) the end of the migration of all POTS/ISDN SAL to VoIP-based SAL is not yet known. In Germany, the migration started in mid-2014 and is supposed to be completed by 2018. Currently already approximately 50% of all POTS/ISDN SAL are migrated to VoIP-based SAL.[8] In Luxembourg, the forced migration started in October 2015 and the end is planned for 2020.

3.3 Issues during the migration phase to VoIP-based SAL

During the migration phase from SAL based on POTS/ISDN to VoIP-based SAL (see case (i) in Figure 1), the following steps need to be done simultaneously:

- At the CO: The SAL needs to be disconnected from the local exchange and connected to the MSAN.[9]
- In the core network: The voice service of the migrated SAL needs to be activated on the IP-based voice platform (e.g. IMS, softswitch).
- At the customer premises: A modem/CPE with an interface for a voice telephony service (e.g. a/b interface for POTS) needs to be installed and the telephony needs to be disconnected from the telephone wall socket and connected to this voice interface of the modem/CPE.

Therefore, during the migration phase to VoIP-based SAL some issues may arise.

Table 4 gives an overview on the issues which actually occurred in the migration phase to VoIP-based SAL in the countries analysed. In the eight countries with a network driven migration strategy, issues during the migration phase to VoIP-based SAL occurred in three of them (DE, HR, ME), no such issues occurred in four of them (CH, ES, SI, SK) and in one of them (LU), in which this migration only started recently, it is unknown. In the two countries (IT, NL) with an exclusively customer driven migration strategy, no problems arose, as one might expect, since no large number of customers is forced to migrate at the same time.

In the three countries (DE, HR, ME) with problems during the migration phase to VoIP-based SAL, issues with service interruptions, information for customers and further issues (not in ME) occurred.

Issues during the migration phase with service interruptions

Service interruptions occurred due to different reasons. In Germany, service interruptions were caused by incompatibility of the existing terminal equipment, technical problems whilst

[8] SAL on which standalone voice services (POTS) are provided are not yet migrated to conversion to IP in the MSAN (see

Table 1, Table 3, Figure 1). This migration is planned to start at the end of 2016.

[9] VoIP-based SAL need only be connected to a MSAN with DSLAM functionality. However, if POTS/ISDN SAL with conversion to IP in the MSAN are also used at the same CO, then the MSAN need to have also VoIP-Gateway functionality in order to convert POTS/ISDN to VoIP.

expanding of the IP-based voice platform and registrations of routers. In Croatia, services were interrupted because in some cases the end-user voice service or the wholesale line rental (see section 3.5.1) were only migrated at the administrative but not at the technical level or not all wholesale services, on which the new voice service is based on, were activated at the same time. In Montenegro, service interruptions mainly occurred due to lack of coordination during the migration.

Table 4: Issues during the migration phase to VoIP-based SAL

Country	Service interruptions	Information for customers	Further issues
Network driven migration			
DE	Yes	Yes	Yes
HR	Yes	Yes	Yes
ME	Yes	Yes	No
CH	No	No	No
ES	No	No	No
SI	No	No	No
SK	No	No	No
LU	Unknown	Unknown	No
Exclusively customer driven			
IT	No	No	No
NL	No	No	No

Source: BEREC

In two countries (DE, HR), the service interruptions during the migration phase also resulted in customer complaints. In both countries, most of the complaints were made in the beginning of the migration. At this stage of the migration, in Germany, the largest of the considered countries, the NRA received a rather noticeable number of complaints, and in Croatia the number of complaints was not high compared to the number of the SAL which were migrated.

Both countries (DE, HR) also took regulatory measures to resolve the issues with service interruptions. In Germany, the NRA set in motion a structured dialogue with the incumbent and other stakeholders such as representatives of the Federal Consumer Center and of the Working Group of all Federal States. One objective of the structured dialogue is to achieve that the migration process is communicated in a consumer friendly way. Furthermore, a test center for special services[10] was introduced by the incumbent as requested by the NRA. In Croatia, the NRA defined in bylaw that users must be informed about the migration at least three months in advance. The NRA also made the following changes in the relevant reference offers based on workshops with all relevant network operators: higher penalties for service delivery date, all users must be migrated before a local exchange is allowed to be switched-off, migration reports are provided within 24 hours after migration, etc.[11]

[10] Social alarm systems which enable people with disabilities or elderly people to call their relatives or caregiver and they can be reached by them.

[11] In detail the specific regulatory terms are as follows: (i) WLR ISDN BRA users have to be migrated with special attention. (ii) Services delivery dates are same as standard, penalties are higher than standard. (iii) All users must be migrated before the switch-off of particular local exchange (iv) Information on end-users of specific ANO and its wholesale service is provided based on business to business system and refreshed daily (v) Migration reports are provided 24 hours after migration of end-users.

Issues during the migration phase with information for end-users

Problems with information for end-users occurred in Germany, because the migration to VoIP-based SAL is accompanied with the termination of the existing ISDN contracts, which led to uncertainties among the end-users. Furthermore, end-users did not have sufficient information concerning the use of terminal equipment and social alarm systems[10] connected to the IP-based voice service. In Croatia, issues with information for end-users arose, because the incumbent gave misleading information to the end-user. In Montenegro, initially end-users were not informed appropriately in case of service interruptions. Then, the incumbent informed the public and the NRA in advance in case of service interruptions.

In two countries (DE, HR), lack of information for end-users during the migration phase also resulted in customer complaints. In Germany, the structured dialog, launched by the NRA, improved the communication of the incumbent with the end-users and in Croatia, the numbers of complaints was small. Both countries took regulatory measures with regard to information for end-users (see service interruptions above).

Further issues

In two countries (DE, HR), further issues occurred. In Germany, the use of fax after the migration to the IP-based voice service was an issue and the structured dialogue was also used to mitigate this problem. The incumbent initiated various testing procedures and informed on the results in the structured dialogue. It is possible to use fax after the migration to IP-based voice services, however a proper interworking between fax device and network needs to be ensured. In Croatia, problems arose in the migration process with regard to the communication between incumbent network operator and ANO and the NRA held workshops with the incumbent network operator and ANO to resolve these problems.

3.4 Impact of the migration to VoIP-based SAL on the voice services for the end-users

The migration to VoIP-based SAL (see case (i) in Figure 1) change the technology on the SAL from POTS/ISDN to IP (VoIP) and therefore may have the following impact on the voice service provided to the end-user.

- After the migration to VoIP-based SAL the use of the voice service may no longer be possible in specific cases (section 3.4.1).
- The migration of standalone voice services to VoIP-based SAL need the installation of a modem and a power outlet for the modem at the customer premises, which may not be accepted by end-users (section 3.4.2).
- The migration to VoIP-based SAL may have further impacts on the voice service for the end-users (section 3.4.3).

3.4.1 Voice service can no longer be used after the migration to VoIP-based SAL

In all eight countries with a network driven migration strategy, after the migration to VoIP-based SAL the use of the voice service was no longer possible in specific cases as e.g. for alarm systems and elevators (see Table 5). In order to solve this issue, the following solutions were used. In six countries (CH, DE, ES, LU, SI, SK), customers migrate the system (e.g. alarm system) they used so far to an IP-based systems. In five countries (CH, DE, ES, LU, SI), customers migrate to a mobile service and did not use the voice service provided on VoIP-

based SAL. In two countries (ES, SI), customer installed uninterruptible power supply (UPS) equipment in their premises and also in two countries (HR, ME), the incumbent migrates the SAL to conversion to IP in the MSAN (see case (ii) in Figure 1) and not to a VoIP-based SAL. In two countries (DE, HR), this situation resulted to some extent in end-user complaints.

In three countries (DE, ES, HR), the NRA responded to this situation with regulatory measures. In Germany, the NRA set in motion a structured dialog between incumbent and stakeholder as e.g. consumer representatives (see section 3.3), which discussed the functionality of concerned end-user systems (e.g. social alarm systems). Furthermore, a test centre was made available for testing the reliability of the concerned end-user systems. In Spain, the regulatory obligation with regard to the continuity of voice services in case of power failure was modified before the migration to IP fibre-based voice services started. In case of access technologies which are incompatible with remote power supply from the network operator (e.g. FTTH), the power supply must be provided by the end-user. In Croatia, the NRA foresaw the use of migration to IP in the MSAN in cases, in which voice services provided on VoIP-based SAL would not be possible for end-users.

Table 5: Voice service can no longer be used after the migration to VoIP-based SAL

Country	Voice service not possible in specific cases	Solution used	End-user complaints	Regulatory measures
Network driven migration				
DE	Yes	IP-based end-user systems, mobile services	Yes, to some extent	Yes, structured dialog, test center for end-users systems
CH	Yes	IP-based end-user systems, mobile services	No	No
SI	Yes	IP-based end-user systems, mobile services, UPS	NIA	No
ES	Yes	IP-based end-user solutions, mobile services, UPS	NIA	Yes, with regard to power supply
SK	Yes	IP-based end-user systems	No	No
HR	Yes	Conversion to IP in the MSAN	Yes, small number	Yes (conversion to IP in MSAN)
ME	Yes	Conversion to IP in the MSAN	No	No
LU	Yes	SIM based solutions, IP-based end-user solutions.	No	No
Exclusively customer driven				
IT	NA			
NL	NA			

Source: BEREC

In the two countries (IT, NL) with an exclusively customer driven migration strategy, the customer decides whether it migrates its voice service to a voice service provided on VoIP-based SAL. If a customer would not be able to use the voice service after migration to VoIP-based SAL for the same purpose (e.g. alarm system) as before, then it might not be willing to migrate to such a service. Therefore, the issues discussed above are not applicable in these countries.

3.4.2 Acceptance of modem and power outlet

In three (CH, DE, HR) of the eight countries with a network driven migration strategy, also standalone voice services are migrated to VoIP-based SAL (see Table 6).[12] In Switzerland, all standalone voice services (POTS and ISDN) are migrated to VoIP-based SAL, in Germany all ISDN (not POTS) standalone voice services and in Croatia some POTS and ISDN standalone voice services. For the other standalone voice services, conversion to IP in the MSAN is used and therefore it is not necessary to install a modem and to have a power outlet available at the customer premises (see case (ii) in Figure 1).

Table 6: Acceptance of modem and power outlet

Country	Acceptance	Regulatory measures	Standalone voice service
CH	Mostly yes	No	All (POTS and ISDN)
DE	Mostly yes	No	All ISDN (not POTS)
HR	Mostly yes	Yes, information three month in advance	Some POTS and ISDN

Source: BEREC

In all three countries (CH, DE, HR), most of the end-users accepted, that it was necessary to install a modem and to have a power outlet available at the customer premises. Only in one country (HR), regulatory measures were taken with regard to this. The NRA specified in bylaw that end-users must be informed at least three months in advance of the migration to VoIP-based SAL.

In the two countries (IT, NL) with an exclusively customer driven migration strategy, a customer will not migrate to a voice service provided on VoIP-based SAL, if it does not accept the installation of a modem and the availability of a power outlet at the customer premises.

3.4.3 Further impact on the voice services for the end-users

In one (DE) of the considered ten countries, the migration to VoIP-based SAL had further impact on the end-user service noticeable for the NRA. In Germany, after migration to VoIP-based SAL subscribers of POTS will no longer receive charging impulses in real-time on the SAL. The structured dialogue (see section 3.3 and 3.4.1) is also used to discuss and communicate this information in a consumer friendly way.

In none of the ten countries analysed, the migration to VoIP-based SAL had an impact on the universal service. In one country (HR), in the universal service ordinance the methods used to measure the QoS of the universal service were adapted.

3.5 Impact of the migration to VoIP-based SAL on the wholesale services of the incumbent

The migration to VoIP-based SAL (see case (i) in Figure 1) changes the technology on the SAL from POTS/ISDN to IP (VoIP) and therefore may have an impact on the following wholesale services provided by the incumbent to ANO.

- Wholesale line rental (WLR) (section 3.5.1);
- Carrier selection (CS)/carrier pre-selection (CPS) (section 3.5.2);

[12] In the other five countries with a network driven migration strategy, only voice services of bundle products (e.g. with internet access) are migrated to VoIP-based SAL (see Table 3).

- Further wholesale services (section 3.5.3).

3.5.1 Wholesale line rental

In three of the ten countries considered (LU, ME, SK), the incumbent offers WLR or has the obligation to offer WLR on VoIP-based SAL. In Luxembourg, the incumbent has the obligation to offer WLR or an equivalent solution on VoIP-based SAL (but this may change in the future), in Montenegro, the incumbent offers WLR in the sense of resale which continues to be available on VoIP-based SAL and in Slovakia the incumbent continues to offer WLR[13] based on migration scenarios in the customer relationship management (CRM) system, although the market regarding WLR is no longer regulated (see Table 7).
In six countries (CH, ES, HR, IT, NL, SI), the incumbent has the obligation to offer WLR on traditional SAL but not on VoIP-based SAL. The reasons why WLR is not mandated for VoIP-based SAL in these six countries are as follows. In two countries (CH, SI), the incumbent does not have the obligation to offer CPS on VoIP-based SAL (see section 3.5.2) and without CPS WLR does not make sense. Furthermore, in these two countries ANO have the possibility to use alternative wholesale products (bitstream access - BSA, local loop unbundling - LLU). In the four other countries (ES, HR, IT, NL), it was not considered to be proportionate (ES, HR, NL) or deemed necessary (IT) to impose on the incumbent a new IP-based WLR which is necessary on VoIP-based SAL since ANO have the possibility to use

Table 7: Impact of the migration to VoIP-based SAL on WLR

Country	WLR available on VoIP-based SAL?	Why is WLR not available?	Alternatives available?	Regulatory measures
LU	Yes, WLR or equivalent solution (may be cancelled in the future)	NA	Yes, BSA, LLU	No
ME	Yes, WLR in the sense of resale	NA	NA	No
SK	Yes, WLR based on migration scenarios in the CRM system[13]	NA	NA	No
ES	No	Not proportionate	Yes, BSA with specific QoS for voice	No
HR	No	Not proportionate	Yes, naked BSA with specific QoS for voice, LLU	Yes, changes in reference offers
NL	No	Not proportionate	Yes, BSA, LLU	No
IT	No	Not deemed necessary	Yes, BSA, LLU	No
CH	No	CPS no longer mandated	Yes, LLU	No
SI	No	CPS no longer mandated	Yes, BSA, LLU	No
DE	No, but also not on traditional SAL	NA	NA	NA

Source: BEREC

[13] WLR is offered on SAL based on POTS, GPON and VoBB.

other wholesale services as an alternative to WLR. In Italy and the Netherlands BSA and LLU are available, in Croatia naked BSA with specific QoS for voice services and also LLU and in Spain BSA with specific QoS for voice services.[14]

In the remaining country (DE), the incumbent neither offers WLR on VoIP-based SAL nor on traditional SAL.

In one (HR) of the ten countries considered, the NRA took regulatory measures with regard to the availability of WLR or alternatives to WLR and made changes in the relevant reference offers based on workshops with all relevant network operators which defined the possible migration scenarios.

3.5.2 Carrier selection/carrier pre-selection

In six (DE, LU, ME, NL, IT, SK) of the ten countries analysed, CS and CPS continue to be available on SAL which are migrated to VoIP-based SAL (see

Table 1, Table 8). In the four other countries (CH, ES, HR, SI) this is not the case and the reason why CS/CPS are no longer mandated are as follows. In Slovenia the incumbent no longer has SMP, in Switzerland CPS was not implemented in the IMS, because it was too expensive to find a solution and in two countries (ES, HR) alternative wholesale access products are considered to be sufficient.

Table 8: Impact of the migration to VoIP-based SAL on CS/CPS

Country	CS/CPS available on VoIP-based SAL?	Why is CS/CPS not available?	Alternatives available?	Regulatory measures
DE	Yes	NA	NA	NA
LU	Yes	NA	NA	NA
ME	Yes	NA	NA	NA
NL	Yes	NA	NA	NA
IT	Yes	NA	NA	NA
SK	Yes[15]	NA	NA	No[15]
SI	No	Incumbent does no longer have SMP	NA	NA
CH	No	Implementation in IMS is too expensive	Little adapter box (converter)[16]	No
HR	No[17]	Alternatives are available	Naked BSA with specific QoS for voice, LLU	No
ES	No	Alternative is available	BSA with specific QoS for voice	No

Source: BEREC

[14] The alternative wholesale services differ from WLR which is reflected in their prices.
[15] In Slovakia, the incumbent continues to offer CS/CPS, although the market regarding CS/CPS is no longer regulated.
[16] Temporary during migration phase
[17] CS/CPS are still available on SAL with conversion to IP in the MSAN.

In none of the ten countries considered, the NRA took regulatory measures with regard to the impact of the migration to VoIP-based SAL on CS/CPS.

3.5.3 Further wholesale services

In one (DE) of the ten countries considered, the migration to VoIP-based SAL has impact on further wholesale services. In Germany, the NRA plans to withdraw the obligation to offer line sharing on VoIP-based SAL, since on VoIP-based SAL the frequency spectrum is no longer divided into the frequency range of traditional POTS/ISDN on the one hand and the frequency range of DSL on the other hand, which is the basis for line sharing.[18]

4 Conclusions

In conclusion, the status of migration to VoIP-based SAL in 31 European countries can be summarised as follows. In seven countries the incumbent has already finished the migration to an NGN, in 16 countries this migration is still ongoing and in eight countries this migration has not yet begun. From the 23 countries, in which the incumbent is migrating its network to an NGN or has already finished this migration, traditional copper-based SAL are migrated to VoIP copper-based SAL in 16 countries and to VoIP fibre-based SAL in 19 countries. The migration to VoIP on copper-based SAL is network driven, i.e. forced by the incumbent in 12 countries and customer driven, i.e. initiated by the customers in six countries. In five of the 12 countries with a network driven migration strategy, all SAL are migrated to VoIP-based SAL and in the other seven countries VoIP-based SAL are only used in specific cases.

The overview of the migration to VoIP-based SAL in the network of the incumbent in ten countries can be summarised are as follows:

- Migration strategy: The migration strategy is network driven in eight countries, customer driven in five countries and both types of migration strategy are used in three countries. The network driven migration encompasses in one country the migration of all SAL to VoIP-based SAL and in the other seven countries migration to VoIP-based SAL is only used in specific cases.
- Issues during the migration phase to VoIP-based SAL: In three countries issues occurred during the migration phase with regard to service interruptions and also with regard to information for the customers. In two of them these issues also resulted in customer complaints. During the migration phase further issues occurred in two countries, in one country with fax and in the other with the communication between incumbent operator and ANO in the migration process.
- Impact of the migration to VoIP-based SAL on the voice services for the end-users: In the eight countries with a network driven migration strategy, after the migration to VoIP-based SAL the use of the voice service was no longer possible in specific cases as e.g. for alarm systems and elevators. In order to solve this issue, customers migrated their existing system to an IP-based system (in six countries), or used a mobile service instead of the existing fixed voice service (in five countries), or installed UPS in their premises (in two countries), or the incumbent used conversion to IP in the MSAN

[18] Line sharing enables ANO to unbundle the local loop and to use the frequency range of DSL, but not the frequency range of traditional POTS/ISDN, on the unbundled SAL. On the same SAL the incumbent operator provides a voice service based on the frequency spectrum of traditional POTS/ISDN to the subscriber.

instead of VoIP-based SAL (in two countries). In two countries, this situation resulted to some extent in end-user complaints. In the two countries with an exclusively customer driven migration strategy, the impact on end-user services was not an issue, because an end-user might not be willing to migrate, if it can no longer use its voice service for the same purpose.

- Acceptance of modem and power outlet: In three of the eight countries with a network driven migration strategy, also standalone voice services are migrated to VoIP-based SAL. In all three countries, most of the end-users accepted that in order to migrate the voice service it was necessary to install a modem and to have a power outlet available at the customer premises. In the two countries with an exclusively customer driven migration strategy, the acceptance of modem and power outlet was not an issue, because an end-user might not be willing to migrate, if it does not accept this.
- Impact of the migration to VoIP-based SAL on WLR: In three countries, the incumbent offers WLR or has the obligation to offer WLR on VoIP-based SAL. In the other seven countries this is not the case since in six of them alternatives are available (e.g. LLU, BSA) and in one of them WLR is also not mandated on traditional (not migrated) SAL.
- Impact of the migration to VoIP-based SAL on CS/CPS: In six countries, CS and CPS continue to be available on SAL which are migrated to VoIP-based SAL. In the four other countries this is not the case since the incumbent no longer has SMP or alternatives are available.

It can be concluded that from an overall perspective the impact of the migration to VoIP-based SAL was limited in most of the countries considered and so was the need for regulatory intervention. Consumer issues seem to be more likely to occur in cases where the migration was network driven. Wholesale services which are no longer available after migration such as WLR and CS/CPS have been replaced by other (already available) wholesale products such as bitstream access.

5 Abbreviations for countries

Abbreviation	Country
AT	Austria
BE	Belgium
BG	Bulgaria
CH	Switzerland
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France

Abbreviation	Country
FYROM	Former Yugoslavian Republic of Macedonia
GR	Greece
HR	Croatia
IE	Ireland
IT	Italy
LI	Liechtenstein
LT	Lithuania
LU	Luxembourg
ME	Montenegro
MT	Malta
NL	Netherlands

Abbreviation	Country
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
RS	Serbia
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey
UK	United Kingdom

6 Further abbreviations

ANO	Alternative Network Operator
BEREC	Body of European Regulators for Electronic Communications
BRA	Basic Rate Access
BSA	Bitstream Access
CO	Central Office
CPS	Carrier Pre-Selection
CRM	Customer Relationship Management
CS	Carrier Selection
DSS1	Digital Signalling System No. 1
EU	European Union
FTTB	Fibre To The Building
FTTC	Fibre To The Curb
FTTH	Fibre To The Home
GPON	Gigabit-capable Passive Optical Network
IMS	IP Multimedia Subsystem
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISDN-BRA	ISDN Basic Rate Access
LEX	Local Exchange
LLU	Local Loop Unbundling
MDF	Main Distribution Frame
MSAN	Multi-Service Access Node
NA	NA
NGA	Next Generation Access
NGN	Next Generation Network
NIA	No Information Available
NRA	National Regulatory Authority
NT	Network Termination

POTS	Plain Old Telephone Service
SAL	Subscriber Access Line
TDM	Time Division Multiplexing
TS	Telephone Socket
UPS	Uninterruptible Power Supply
VoBB	Voice over Broadband
VoIP	Voice over IP
WLR	Wholesale Line Rental

7 Annex

Table 9: Strategy of the migration to VoIP-based SAL (HR, DE, IT, LU)

Country	Croatia	Germany	Italy	Luxembourg
Name of the incumbent operator	Hrvatski Telekom (HT)	Telekom Deutschland GmbH	Telecom Italia	EPT
Strategy of the incumbent of the migration to VoIP-based SAL	Forced migration by the incumbent (network driven)	Both migration forced by the incumbent (network driven) and on customer's choice (customer driven)[19]	Migration is a customer's choice (customer driven). Telecom Italia is not planning a massive migration from POTS/ISDN to IP.	Forced migration by the incumbent (network driven)
Which of the following technologies on the SAL are migrated to IP (VoIP): POTS, ISDN or both?	Both	Both	Both	Both
Is it planned to migrate all POTS based SAL to VoIP-based SAL or only in case of specific circumstances?	• All subscribers with a bundle voice (POTS) + internet access • Some subscribers with standalone voice (POTS)[20]	• All except subscribers with a standalone voice (POTS) service[21] (network driven) • On choice of subscriber (customer driven)	Only on choice of subscriber in case of FTTC or FTTH (customer driven)[22]	So far, all subscribers with a bundle voice (POTS) + internet access
Is it planned to migrate all ISDN based SAL to VoIP-based SAL or only in case of specific circumstances?	• All subscribers with a bundle voice (ISDN) + internet access • Some subscribers with standalone voice (ISDN)[23]	• All (network driven) • On choice of subscriber (customer driven)	Only on choice of subscriber in case of FTTC or FTTH (customer driven)[22]	So far, all subscribers with a bundle voice (ISDN) + internet access

Source: BEREC

[19] DTAG tries to convince their customers (e.g. with appropriate marketing) to migrate on a voluntary basis to a voice service based on IP (VoIP). DTAG also terminates end-user contracts (based on a 4 stage approach) in case they do not migrate to a voice service based on IP (VoIP).
[20] Other subscribers with a standalone voice (POTS) are migrated to conversion to IP in the MSAN (see case (ii) in Figure 1).
[21] Subscribers with a standalone voice service (POTS) which will not migrate to a voice service based on IP (VoIP) will be migrated by DTAG (forced migration) to conversion to IP in the MSAN and the use of POTS on the SAL.
[22] The incumbent has not planned yet the forced migration of its POTS/ISDN copper access lines to IP.
[23] Other subscribers with a standalone voice (ISDN) are migrated to conversion to IP in the MSAN and the use of POTS on the SAL (with only one phone number).

Table 10: Strategy of the migration to VoIP-based SAL (ME, NL, SK)

Country	Montenegro	Netherlands	Slovakia
Name of the incumbent operator	Crnogorski Telekom	KPN	Slovak Telekom
Strategy of the incumbent of the migration to VoIP-based SAL	Both migration forced by the incumbent (network driven) and on customer's choice (customer driven)	Migration is a customer's choice (customer driven)	Forced migration by the incumbent (network driven)
Which of the following technologies on the SAL are migrated to IP (VoIP): POTS, ISDN or both?	Both	Both	Both
Is it planned to migrate all POTS based SAL to VoIP-based SAL or only in case of specific circumstances?	• All subscribers with a bundle voice + internet access (network driven) • On choice of subscriber (customer driven)	Only on choice of subscriber (customer driven)	• All subscribers with triple-play service • Some subscribers with dual-play service
Is it planned to migrate all ISDN based SAL to VoIP-based SAL or only in case of specific circumstances?	• All subscribers with a bundle voice + internet access (network driven) • On choice of subscriber (customer driven)	Only on choice of subscriber (customer driven)	• All subscribers with triple-play service • Some subscribers with dual-play service

Source: BEREC

Table 11: Strategy of the migration to VoIP-based SAL (SI, ES, CH)

Country	Slovenia	Spain	Switzerland
Name of the incumbent operator	Telekom Slovenije, d.d.	Telefónica	Swisscom AG
Strategy of the incumbent of the migration to VoIP-based SAL	Forced migration by the incumbent (network driven)	• Migration is a customer's choice (customer driven)[24] • Recently to some extend also forced by the incumbent (network driven)	Forced migration by the incumbent (network driven)
Which of the following technologies on the SAL are migrated to IP (VoIP): POTS, ISDN or both?	Both	Both	Both
Is it planned to migrate all POTS based SAL to VoIP-based SAL or only in case of specific circumstances?	In case of FTTC/B roll-out and bundles of voice with internet access[25]	Only in case of FTTH • On choice of subscriber (customer driven) • Recently in some areas also forced by Telefónica (network driven)	All
Is it planned to migrate all ISDN based SAL to VoIP-based SAL or only in case of specific circumstances?	In case of FTTC/B roll-out and bundles of voice with internet access[25]	Only in case of FTTH • On choice of subscriber (customer driven) • Recently in some areas also forced by Telefónica (network driven)	All

Source: BEREC

[24] Telefónica is commercially incentivizing customer migration to FTTH lines (i.e. applying the same price for internet access products based on copper and fiber at equal binary rate or by introducing very high speed products based on fiber or TV advanced services).
[25] In other cases POTS and ISDN are continued to be used on the SAL and converted to IP in the MSAN.

Table 12: Time frame of the migration to VoIP-based SAL (HR, DE, IT, LU)

Country	Croatia	Germany	Italy	Luxembourg
When did the migration from POTS/ISDN to IP start?	April 2012 – HT announced migration process April 2013 – first LE was switched-off	The IP-migration started in mid-2014.	VoIP commercial offers are available for end-users since December 2012.	October 2015
When is the (planned) end of the migration from POTS/ISDN to IP?	End of 2015 (realised)	The IP-migration of the incumbent is supposed to be achieved by 2018.[26]	End date not yet set (customer driven migration)	End 2020
Share of SAL already migrated from POTS/ISDN to IP (VoIP)	100% including SAL with conversion to IP in the MSAN	Approximately 50%	No information available	More than all FTTH premises

Source: BEREC

Table 13: Time frame of the migration to VoIP-based SAL (ME, NL, SK)

Country	Montenegro	Netherlands	Slovakia
When did the migration from POTS/ISDN to IP start?	2011	Q3/2005	2012
When is the (planned) end of the migration from POTS/ISDN to IP?	November 2015 (realised)	End date not yet set (customer driven migration)	Full migration to VoIP-based SAL not planned yet
Share of subscriber access lines already migrated from POTS/ISDN to IP (VoIP)	Approximately 70%	Approximately 85%	Approximately 15%

Source: BEREC

[26] According to the incumbent it was planned to migrate 70,000 customers per week. Since 2016 an even larger number of subscribers will be migrated per week.

Table 14: Time frame of the migration to VoIP-based SAL (SI, ES, CH)

Country	Slovenia	Spain	Switzerland
When did the migration from POTS/ISDN to IP start?	April 2013	Telefónica only offers VoIP commercially with FTTH access. FTTH based VoIP offers were launched in 2009	November 2012
When is the (planned) end of the migration from POTS/ISDN to IP?	End of the migration from POTS/ISDN to IP is not yet planned[27]	End of the migration from POTS/ISDN to IP not announced so far. It will probably depend on fibre-based offers adoption pace by end-users.	December 2017
Share of subscriber access lines already migrated from POTS/ISDN to IP (VoIP)	Approximately 60% of all active SAL of the incumbent (including copper and fibre) are already VoIP-based SAL.	Approximately 20%	Approximately 33%

Source: BEREC

[27] The switch off of all incumbent TDM exchanges is planned for 2018/2019.

Table 15: Issues during the migration phase to VoIP-based SAL – part 1 (HR, DE, IT, LU)

Country	Croatia	Germany	Italy	Luxembourg
Are there any issues during the migration phase with service interruptions?	Yes, there were problems with the implementation of the substitute service. In some cases the substitute service were implemented only at the administrative but not at the technical level or all needed wholesale services were not activated synchronously.	Yes, the NRA has noticed some problems with service interruptions. Some service interruptions are related to the incompatibility of the existing terminal equipment, some of the problems are related to technical problems whilst expanding the IP-based voice platform or the registrations of routers.	Not at the moment	Unknown
Have this caused any end-user complaints?	Yes, but if we take into account number of migrated access lines the number of complaints was not big and most of them was at the beginning of migration process.	Yes, the NRA received number of end-users complaints. After a rather noticeable number of complaints in 2014/2015, the NRA launched a structured dialogue with the incumbent and other stakeholders (such as representatives of the consumer centres and of the Länderarbeitskreis (working group of all federal countries)). Currently the number of complaints is steadily decreasing.	NA	No complaints known
Regulatory measures taken with regard to this	Yes, due to migration process HAKOM made some changes in the relevant reference offers. The changes have been made based on workshops with all relevant operators.[11] HAKOM also defined in bylaw that users must be informed about migration to IP (VoIP) at least 3 months in advance.	The NRA set in motion a structured dialogue with the incumbent and other stakeholders (see above).[28] One key-element of the dialogue is a consumer friendly communication of the migration process. Moreover a test centre for special services[10] was introduced by the incumbent as requested by the NRA. Complaints of consumer facing a service disruption were forwarded to the incumbent in order to solve the problem.	NA	No

Source: BEREC

[28] Since a great number of the consequences of the IP-migration are of contractual nature, the NRA has few possibilities to intervene. Regulatory measures can only be taken as far as the universal service or if sector-specific consumer regulations (i.e. contractual transparency) are affected.

Table 16: Issues during the migration phase to VoIP-based SAL – part 1 (ME, NL, SK)

Country	Montenegro	Netherlands	Slovakia
Are there any issues during the migration phase with service interruptions?	Yes. Service interruptions for some subscribers because of poor coordination during migration.	No	No significant issues.
Have this caused any end-user complaints?	No. No end-user complaints to NRA (Agency for Electronic Communication and Postal Services).	No	No significant complaints.
Regulatory measures taken with regard to this	No	No	No

Source: BEREC

Table 17: Issues during the migration phase to VoIP-based SAL – part 1 (SI, ES, CH)

Country	Slovenia	Spain	Switzerland
Are there any issues during the migration phase with service interruptions?	No	No	No
Have this caused any end-user complaints?	NA	Not aware	No
Regulatory measures taken with regard to this	No	No	No

Source: BEREC

Table 18: Issues during the migration phase to VoIP-based SAL – part 2 (HR, DE, IT, LU)

Country	Croatia	Germany	Italy	Luxembourg
Are there any issues during the migration phase with information for customers on the migration process?	Yes, HT's retail gave misleading information to the end-users.	Yes, a problem during the migration process was the communication with the end-users. The IP-migration is accompanied by the termination of the old ISDN-contracts and led to uncertainties among the end-users. Furthermore, there was lack of information concerning the use of terminal equipment and special services[10] in an IP-based network.	Not at the moment	Unknown
Have this caused any end-user complaints?	Yes, but the number of complaints of this kind was really small.	Some end-users felt misinformed during the migration process and addressed these issues towards the NRA. As mentioned above the communication with the end-users has been improved by the incumbent since the structured dialogue has been launched.	NA	No
Regulatory measures taken with regard to this	See above.	See above	NA	No
Any further issues during the migration phase?	Yes, there were problems in the migration process with regard to the communication between incumbent network operator and ANO .	The possibility of using a fax after IP-migration has been discussed as an issue as well.	Not at the moment	No
If yes: Regulatory measures taken	Yes. The NRA held workshops with the incumbent network operator and ANO to resolve these problems.	See above.	NA	NA

Source: BEREC

Table 19: Issues during the migration phase to VoIP-based SAL – part 2 (ME, NL, SK)

Country	Montenegro	Netherlands	Slovakia
Are there any issues during the migration phase with information for customers on the migration process?	Yes. In accordance with the law, Crnogorski Telekom informed the NRA (Agency for Electronic Communication and Postal Services) and the public in advance regarding service interruptions in some locations during the migration process. Initially Crnogorski Telekom contacted customers by phone call.	No	No significant issues.
Have this caused any end-user complaints?	No	No.	No known complaints.
Regulatory measures taken with regard to this	No	No	No
Any further issues during the migration phase?	No	No	No
If yes: Regulatory measures taken	NA	No	No

Source: BEREC

Table 20: Issues during the migration phase to VoIP-based SAL – part 2 (SI, ES, CH)

Country	Slovenia	Spain	Switzerland
Are there any issues during the migration phase with information for customers on the migration process?	No	No	No
Have this caused any end-user complaints?	NA	Not aware	No
Regulatory measures taken with regard to this	No	No	No
Any further issues during the migration phase?	No	No	No
If yes: Regulatory measures taken	No	No	No

Source: BEREC

Table 21: Impact of the migration to VoIP-based SAL on the voice services for the end-users – part 1 (HR, DE, IT, LU)

Country	Croatia	Germany	Italy	Luxembourg
In which cases can the voice service no longer be used after migration (e.g. elevators, alarm systems)	In order to avoid this, in such cases conversion to IP in the MSAN with POTS on the SAL is used.	Alarm systems, remote emergency call systems (such as those installed in elevators), home emergency systems (social alarm systems) and EC-cash-terminals are so called special services which are sometimes connected via POTS/ISDN to the phone network. Some of these services can be modified to become IP-compatible or can be used via mobile connection.[29]	NA (the migration is user-initiated and not forced by the incumbent)	In such cases end-users migrate to SIM based solutions or IP based solutions.
Has this caused any end-user complaints?	Yes, small number	These issues have to some extent caused end-user complaints.	NA	No
Regulatory measures taken with regard to this	Yes, for such kind of services we foresaw to use conversion to IP in the MSAN with POTS on the SAL.	Yes, the functionality of these services were discussed in the structured dialogue with the incumbent with an emphasis on the functionality of home emergency systems. Furthermore a test centre for special services (i.e. care phones) was introduced in order to test the reliability of these services.	NA	No

Source: BEREC

[29] Some of these services can be used in case a subscriber is migrated to conversion to IP in the MSAN (compare footnote 21).

Table 22: Impact of the migration to VoIP-based SAL on the voice services for the end-users – part 1 (ME, NL, SK)

Country	Montenegro	Netherlands	Slovakia
In which cases can the voice service no longer be used after migration (e.g. elevators, alarm systems)	For such cases (e.g. alarm systems) conversion to IP in the MSAN is used.	NA (the migration is user-initiated and not forced by the incumbent) We know that a certain number of applications of POTS services (alarm, elevators, etc.) needs POTS and does not work with VoIP.	Special security solutions have to be migrated to new IP-based solution. Old solutions were not compatible with IP technology.
Has this caused any end-user complaints?	No	NA	No
Regulatory measures taken with regard to this	No	NA	No

Source: BEREC

Table 23: Impact of the migration to VoIP-based SAL on the voice services for the end-users – part 1 (SI, ES, CH)

Country	Slovenia	Spain	Switzerland
In which cases can the voice service no longer be used after migration (e.g. elevators, alarm systems)	Elevators – need UPS for voice service or use mobile service. Some old alarm and fax devices did not work properly. Incumbent provides IP solutions.[30]	When power fails, the voice service is not available, unless a power supply (UPS) is connected to the ONT.This affects voice service and obviously elevators/alarm systems. In case of problems end-users migrate to IP-based end-user systems or mobile services. Alarms and faxes must support DTMF.	In order to avoid this, the following solutions are used: • replacement by mobile solution and then by IP by end of 2017 • alarm systems are updated for IP solution • Fax can be connected to analogue output of routers
Has this caused any end-user complaints?	No	Not aware.	No
Regulatory measures taken with regard to this	No	The regulatory obligation for voice operators to guarantee the continuity of voice service in case of power failure during 4 hours was modified in 2011, allowing that when access technologies are incompatible with power supply from operator side then the power supply must be provided by the user.	No

Source: BEREC

[30] Incumbent provides complete IP-based alarm solution (devices and access to portal) and for fax a solution based on email (message in PDF format and confirmation of successful delivery).

Table 24: Impact of the migration to VoIP-based SAL on the voice services for the end-users – part 2 (HR, DE, IT, LU)

Country	Croatia	Germany	Italy	Luxembourg
Have the customers accepted the installation of a modem and the need of a power outlet for the modem at their premises?	Mostly yes.	Yes, the great majority did accept this.	NA (the migration is user-initiated and not forced by the incumbent)	Yes
Regulatory measures taken with regard to this	HAKOM specified in bylaw that users must be informed about migration to IP (VoIP) at least 3 months in advance.	No measures planned.	No	No
Any further impact on end-user services?	No	After migration POTS subscribers will not receive any charging impulses in real-time any more.	No	No
If yes: Regulatory measures taken	NA	Structured dialogue as mentioned above	NA	NA

Source: BEREC

Table 25: Impact of the migration from POTS/ISDN to IP on the voice services for the end-users – part 2 (ME, NL, SK)

Country	Montenegro	Netherlands	Slovakia
Have the customers accepted the installation of a modem and the need of a power outlet for the modem at their premises?	Yes	NA (the migration is user-initiated and not forced by the incumbent)	Mostly yes
Regulatory measures taken with regard to this	No	No	No
Any further impact on end-user services?	No	No	No
If yes: Regulatory measures taken	NA	NA	NA

Source: BEREC

Table 26: Impact of the migration to VoIP-based SAL on the voice services for the end-users – part 2 (SI, ES, CH)

Country	Slovenia	Spain	Switzerland
Have the customers accepted the installation of a modem and the need of a power outlet for the modem at their premises?	Yes	No complaints. As VoIP service is currently offered bundled with broadband service in FTTH access, the customer accepts the connection to the ONT.	Yes, but some customers (mostly elderly) complain for form's sake.
Regulatory measures taken with regard to this	No	No	No
Any further impact on end-user services?	No	Not aware of further impacts	No
If yes: Regulatory measures taken	NA	NA	NA

Source: BEREC

Table 27: Impact of the migration to VoIP-based SAL on the wholesale services of the incumbent – part 1 (HR, DE, IT, LU)

Country	Croatia	Germany	Italy	Luxembourg
Is Wholesale Line Rental (WLR) on VoIP-based SAL available?	No	WLR in the strict sense was never available in Germany. Competitors can rent a SAL at the same price as consumers (PSTN). This option is not available for migrated SAL.	No	Currently incumbent has the obligation to offer WLR or an equivalent solution. In the future this may change
Why is WLR no longer available?	Alternatives to WLR are available and it was not considered to be proportionate to impose on the incumbent a new IP-based WLR which is necessary on VoIP-based SAL	NA	No new WLR service adapted to work on IP is available so far because there are other wholesale services available for ANO.	NA
Are alternatives to WLR available?	Yes. Alternatives for WLR were naked BSA or LLU.[31]	No. Not a direct alternative.	No	In the opinion of the NRA (ILR) a move to VoIP does not need a WLR anymore. The incumbent offers BSA and LLU as alternatives to WLR**.**
Regulatory measures taken with regard to this	Yes, due to migration process HAKOM made some changes in the relevant reference offers. The changes have been made based on workshops with all relevant operators. In these changes HAKOM defined all migration scenarios.	NA	No	No

Source: BEREC

[31] In special cases for ISDN BRA users which require high quality and high availability there was extra option, the option to realize one number with conversion to IP in the MSAN while other numbers have been realized on virtual channel for VoIP (WLR + BSA with virtual channel for VoIP).

Table 28: Impact of the migration to VoIP-based SAL on the wholesale services of the incumbent – part 1 (ME, NL, SK)

Country	Montenegro	Netherlands	Slovakia
Is Wholesale Line Rental (WLR) on VoIP-based SAL available?	WLR in the sense of resale is still available.[32]	No	Incumbent continues to offer WLR on POTS, GPON and VoBB with migrations scenarios in the CRM system, although the market regarding WLR is no longer regulated
Why is WLR no longer available?	NA	Replicability is possible based on LLU or BSA. To impose WLR on VoIP-based SAL therefore was considered not to be proportionate	NA
Are alternatives to WLR available?	NA	Yes, alternatives for WLR are LLU and BSA	NA
Regulatory measures taken with regard to this	NA	No	NA

Source: BEREC

[32] WLR enables service providers to issue one single bill to customers for Carrier Pre-selection (CPS) of "all calls" and line rental charges. The service provider may offer its own branded telephony service to its customers based on WLR and CPS. Incumbent operator provides wholesale billing details to service providers, which then bill customers at their own retail rates for calls. Therefore, this service is not dependent on the technology used on the SAL and continues to be available to the market.

Table 29: Impact of the migration to VoIP-based SAL on the wholesale services of the incumbent – part 1 (SI, ES, CH)

Country	Slovenia	Spain	Switzerland
Is Wholesale Line Rental (WLR) on VoIP-based SAL available?	No	No. Incumbent (Telefónica) offers voice services on VoIP-based SAL only in FTTH areas (see Table 11). WLR is not available for FTTH access.	No
Why is WLR no longer available?	No need to impose WLR since, due to the migration to all-IP, the NRA no longer mandates CPS (see Table 32).	WLR is not available for FTTH lines, because operators can offer VoIP with other wholesale access products as bitstream although it is only economically viable if customer is also signing up for a broadband service.	No need to impose WLR since, due to the migration to all-IP, the NRA will no longer mandate CPS (or an alternative to CPS) (see Table 32).
Are alternatives to WLR available?	Yes, LLU and bitstream access	When the customer has a broadband access, then ANO can offer VoIP by themselves. A specific QoS is included in the bitstream wholesale service enabling the provision of voice services besides of internet access services.	No
Regulatory measures taken with regard to this	No	No	No

Source: BEREC

Table 30: Impact of the migration to VoIP-based SAL on the wholesale services of the incumbent – part 2 (HR, DE, IT, LU)

Country	Croatia	Germany	Italy	Luxembourg
Are Carrier selection (CS) and carrier pre-selection (CPS) on VoIP-based SAL available?	No	Yes	Yes.	Yes
Why is CS/CPS no longer available?	Alternatives are available.	NA	NA	NA
Are alternatives to CS/CPS available?	Naked BSA with specific QoS for voice, LLU	NA	NA	NA
Regulatory measures taken with regard to this	No	NA	The regulatory measures concerning the provision of CS/CPS services hold irrespective of access network typology.	NA

Source: BEREC

Table 31: Impact of the migration to VoIP-based SAL on the wholesale services of the incumbent – part 2 (ME, NL, SK)

Country	Montenegro	Netherlands	Slovakia
Are Carrier selection (CS) and carrier pre-selection (CPS) on VoIP-based SAL available?	Yes	Yes	Incumbent continues to offer CS/CPS, although the market regarding CS/CPS is no longer regulated
Why is CS/CPS no longer available?	NA	NA	NA
Are alternatives to CS/CPS available?	NA	NA	NA
Regulatory measures taken with regard to this	NA	NA	NA

Source: BEREC

Table 32: Impact of the migration to VoIP-based SAL on the wholesale services of the incumbent – part 2 (SI, ES, CH)

Country	Slovenia	Spain	Switzerland
Are Carrier selection (CS) and carrier pre-selection (CPS) on VoIP-based SAL available?	No. Incumbent does not have the obligation to offer CS/CPS.	No for FTTH (VoIP)	No
Why is CS/CPS no longer available?	CS/CPS is no longer imposed on the incumbent - market deregulated[33]	Same answer as for WLR (see Table 29).	The NRA (BAKOM) will no longer impose CS/CPS on the incumbent. CPS is not implemented in the IMS of the incumbent, because it is, too expensive to find a solution.
Are alternatives to CS/CPS available?	NA	Same answer as for WLR (see Table 29).	Yes. The alternative is a little adapter box, common to the incumbent and ANO, working as a converter.[34]
Regulatory measures taken with regard to this	NA	No	No

Source: BEREC

[33] CS/CPS is technically also not possible in the current IP-based network of the incumbent without special and likely costly solutions.

[34] This little box, called CPS Dialer, is installed at the customer premises between the router/modem and the telephone. It can divert call traffic away from the line provider direct to a customers desired alternative call provider. It can also bar call types or specific numbers going through. The unit recognizes the first few digits dialed and handles it accordingly It can even redirect / translate a number to another number. It is to notice that this solution is not really advertised by operators and should remain temporary during the transition phase and maybe for a few year later, until end-users let go of carrier preselection.

Table 33: Impact of the migration to VoIP-based SAL on the wholesale services of the incumbent – part 3 (HR, DE, IT, LU)

Country	Croatia	Germany	Italy	Luxembourg
Impact on other wholesale services?	No	With the demise of the splitter, there is no basis for Carrier Line Sharing (CLS) any more. A switch from Annex B to Annex J in ADSL-Applications becomes necessary.	No[35]	No
If yes: Regulatory measures taken	NA	The obligation to offer CLS is planned to be withdrawn in the next decision on market 3a. The decision is not yet finalized.	NA	NA
Are there any issues with regard to the migration to alternative wholesale products?	No	No	No	No
Regulatory measures taken with regard to this	NA	NA	NA	NA

Source: BEREC

[35] However, if Telecom Italia decides to dismiss the local exchanges of its own copper network due to the transition towards the NGA network, then the incumbent (Telecom Italia) has to inform ANO in advance and the NRA (Agcom). The NRA has recently launched an ad hoc proceeding in order to define the detailed economical and technical aspects of the general procedure for the switch-off of the local exchanges.

Table 34: Impact of the migration to VoIP-based SAL on the wholesale services of the incumbent – part 3 (ME, NL, SK)

Country	Montenegro	Netherlands	Slovakia
Impact on other wholesale services? (Yes(which?)/No)	No	No	No
If yes: Regulatory measures taken	NA	NA	NA
Are there any issues with regard to the migration to alternative wholesale products?	No	No	No
Regulatory measures taken with regard to this	NA	NA	NA

Source: BEREC

Table 35: Impact of the migration to VoIP-based SAL on the wholesale services of the incumbent – part 3 (SI, ES, CH)

Country	Slovenia	Spain	Switzerland
Impact on other wholesale services? (Yes(which?)/No)	No	No[36]	NA
If yes: Regulatory measures taken	NA	NA	NA
Are there any issues with regard to the migration to alternative wholesale products?	No	No	No
Regulatory measures taken with regard to this	NA	NA	NA

Source: BEREC

[36] Considering that in Spain migration from POTS/ISDN to VoIP is bound to fiber access adoption, the migration from copper to FTTH obviously has an impact to other wholesale services. Migration from copper local loops to FTTH and closure of central offices has a big impact on ULL and bitstream wholesale services but not directly related to migration form POTS/ISDN to IP.