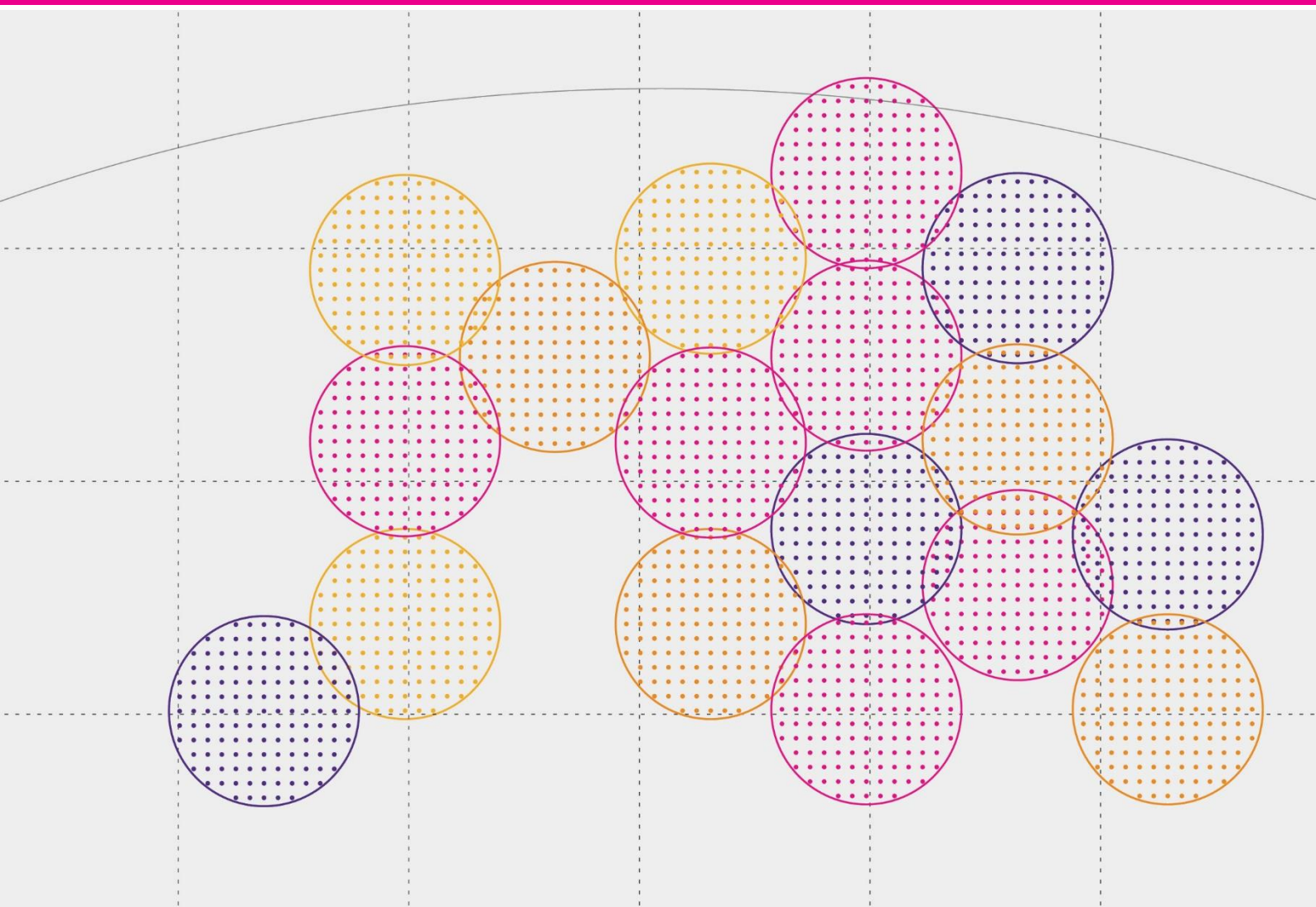# plum

Preparing the UK for an All-IP future: experiences from other countries

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About Plum

Plum offers strategy, policy and regulatory advice on telecoms, spectrum, online and audio-visual media issues. We draw on economics and engineering, our knowledge of the sector and our clients' understanding and perspective to shape and respond to convergence.

About this study

This study for the Broadband Stakeholder Group (BSG), reviews how four countries have transitioned from the PSTN to an All-IP network to reveal issues of interest for the UK as it approaches a similar transition.

Contents

Forward by the BSG

Context

The analogue/electrical based network technology that currently enables the UK's Public Switched Telephone Network (PSTN) is coming to the end of its life and will need to be replaced by the mid-2020s as it is becoming difficult and expensive to maintain. The PSTN currently provides voice services to millions of households in the UK and the underlying analogue technology also supports a range of data services both to households – such as burglar and social care alarms – and non-domestic applications such as traffic lights or payment terminals. However, it is becoming uneconomic to maintain and also does not operate over digital full fibre optical networks which the UK is aiming to deploy at scale over the next decade. Indeed, the migration of voice services to an All-IP network is an important step on the path to our full fibre future and ultimately the retirement of the copper network.

Voice services that have historically been delivered over the PSTN will be carried as a data service over IP in the future. Whilst necessary this migration does pose complications. In part these challenges can be broken down into:

➤ The continued provision of voice services in the manner that customers expect, especially resilient access to emergency services, e.g. in the event of mains power failure, for those customers who are deemed to be vulnerable. This is particularly relevant for the 1.5m landline-only customers. These challenges include ensuring that users are aware of any action needed to preserve their service, the risk of a loss of service during the migration and ongoing complications due to the UK's number portability process.

➤ Data services that utilise the PSTN. Some of these services will not be compatible with an All-IP system since they rely on the analogue/electrical capabilities of the old network and will need replacing or modifying in order to continue to provide a service.

The migration to delivering voice services over All-IP access networks in the UK is being led by individual communication providers. In order to learn from other countries' experiences and identify possible challenges, the Broadband Stakeholder Group commissioned a report from Plum Consulting, examining four international examples of a migration to All-IP and retirement of the PSTN. We identified France and Germany as being of similar size and operating under the same European regulatory umbrella, with Switzerland and New Zealand offering different regulatory frameworks. We have restricted these case studies to focus on consumers – both their access to voice services and data over PSTN services.

We hope that this work will provide value to operators as they plan their engagement with end-customers and providers of data services over the PSTN. We also expect it to help inform Ofcom's work to support industry discussions around communications and technical aspects of the migration.

International case-studies

The report identifies four categories of migration which we believe provide a useful basis for framing the discussion. These are:

➤ Voluntary; where an end-user moves to a Voice over IP (VoIP) product because they are attracted to the functionality it offers

➢ Coincidental; where an end-user moves from the PSTN to a product that is inherently VoIP. A good example is a customer upgrading from Openreach's copper network to a full fibre network.

➢ Passive; whereby the communications provider is able to move the end-user to an All-IP network without the end-user needing to do anything to preserve voice access.

➢ Forced; where the end-user is required to take action to maintain their voice service as their access to the PSTN is removed.

All four countries are at different stages of their migration. However, there are several similarities between the four, and indeed the UK, such as the fact that the primary driver is economic rather than political or regulatory. This has impacted the level of intervention from Government and regulators with only France proposing a common end date across all operators.

All of the case studies have pursued a regional approach for the migration away from the PSTN. This is an approach which the UK took in the TV Digital Switchover[1] and allows lessons to be applied as the migration moves from one area to another, as well as being more cost-effective.

The four countries examined have experienced some level of difficulty with data over PSTN services. There have, however, been relatively few issues with maintaining access to voice services during their migration. The main exception to this is Germany where initial poor communication led to higher than anticipated levels of forced migration. This led to complaints to the regulator and political pressure resulting in the migration being paused. The report outlines how the industry resolved the issues/ concerns and there is much that can be learnt from the ensuing success of the new communication process, with Germany's migration now standing at over 80%.

The case studies demonstrate the benefits of doing as much as possible to avoid a forced migration. This is evidenced both in the case studies as well as other switchovers where a forced process will tend to result in greater levels of customer complaints. However, the lessons from these countries have shown that simply highlighting to end-users the benefits of VoIP compared to their current voice service is unlikely to lead to mass voluntary migration – although efforts to bundle with other products do seem to have been more successful. Coincidental migration has been quite high in New Zealand which offers some hope to UK as we embark on scale full fibre deployment over the next decade.

UK lessons and challenges

Whilst we are at the start of our migration, a considerable amount of work has taken place at the technical level, and increasingly around industry engagement. In May 2018, Openreach consulted with its Communication Provider customers on the process and timeline for withdrawing Wholesale Line Rental (WLR) products as a result of PSTN closure. In July, BT opened a new lab[2] to help providers of data over PSTN services to test their equipment under real-world conditions, to help ensure the industry can continue to deliver services over the new networks.

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[1] Whilst there are important engagement lessons to be adopted from the TV DSO it is also important to appreciate the differences – which includes the consumer offer and the centralised nature of the switchover.

[2] https://www.btplc.com/News/#/pressreleases/bt-opens-new-lab-to-pave-the-way-for-digital-voice-services-2598345

It is clear however that the digital infrastructure sector cannot be complacent and may need to accelerate our work engaging with data service providers as well as potentially engendering greater alignment between operators' communications to consumers, and particularly vulnerable consumers On the latter there are relatively few lessons to be gleaned from the four case studies primarily because the UK has a unique approach to how it approaches vulnerable customers including a regulatory requirement for uninterrupted power supply. The role of Ofcom here in supporting effective collaboration will remain key.

Germany and New Zealand have made at least some use of PSTN emulation, a form of passive migration for voice services. Whilst imperfect, as it does not tend to maintain data services over the PSTN, some form of a "PSTN emulation" approach may be a useful bridge for some voice-only customers, particularly those who may be vulnerable. It is important to recognize this as an interim step rather than a settled end-state, albeit one which can still allow communication providers to realise some savings.

One particular area for concern is the difference between the UK's number portability process and the four countries studied. All four have a centralised database whilst the UK operates a number forwarding system. There are concerns that this is unsustainable given the volume of numbers which will need to go through this process and we are pleased that Ofcom has recognised this in its 2018/19 Annual Plan.

Summary
The complexity of the migration to All-IP should not be underestimated. However, the UK is currently well-placed and has sufficient time to conduct an orderly and successful migration as it rolls out gigabit capable networks. Industry needs to continue to engage with both those companies that provide analogue data services on the network as well as work on how best to communicate the changes to end users, particularly those who are vulnerable. The BSG is ready to support the sector on both of these points and will be looking to play an active role in shaping these engagements.

Matthew Evans
CEO
Broadband Stakeholder Group

Executive summary

The UK is now planning the closure of its PSTN and a transition to All-IP voice services and networks. This report looks at how four other countries[3], which are further advanced than the UK, have implemented their own All-IP migration. The focus of the study is on end-user impacts and how these are mitigated, rather than on impacts on access seekers or on technical issues relating to interconnect between networks.

S1   The main characteristics of the migration

The case study countries are at different points in the migration process as illustrated in Figure S1. France and New Zealand are at an early stage in the migration whilst Germany and Switzerland are close to the end of the process.

Figure S1: The state of migration in the four countries

% of fixed lines using All-IP in 2018
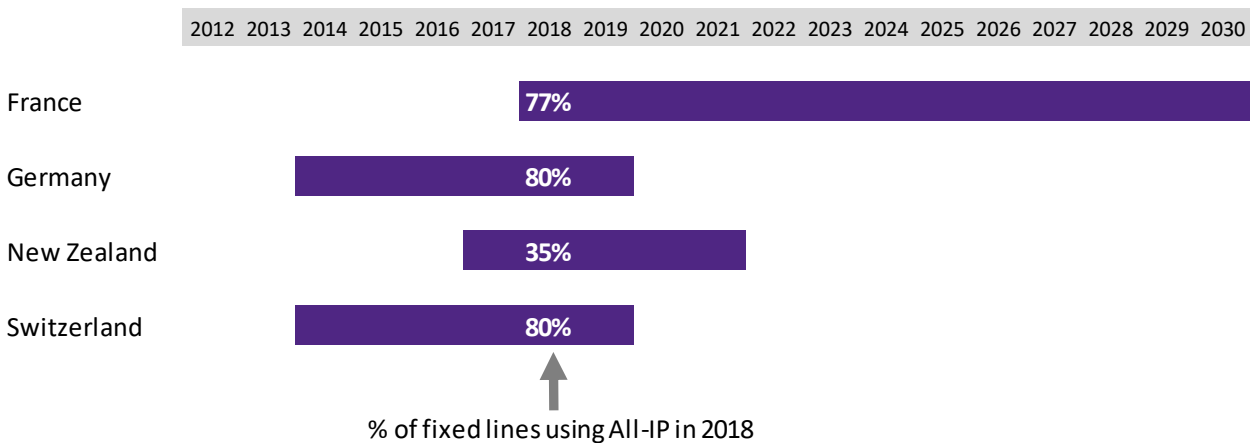
The move to close the PSTN and migrate to All-IP has been driven by the operators (and especially the incumbent operator) rather than by the regulator or the government in all the case study countries. Operators are concerned about the rising cost of maintaining legacy PSTN equipment, attracted by the network simplification which All-IP network offers and motivated by a need to remain competitive.

The regulator has played only a modest role in shaping the migration – intervening mainly when it has received complaints from end-users. In three of the case study countries the decision on when to complete closure of the PSTN has been left to the individual operators. Only in France is there a common closure date across all operators of 2030.

The main role for the regulator has been to preserve competition and the universal service obligations during the migration process. It has also helped ensure that the operators work closely with special service providers so that data over PSTN devices[4] are replaced or continue to work following the migration.

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[3] France, Germany, New Zealand and Switzerland
[4] Such as fire and security alarms, fax machines, EFTPOS terminals, and monitoring devices used in health and social care or by the utilities.

S2   The migration process

There are four main ways in which end users migrate to All-IP:

- voluntary migration in which the end-user migrates from the PSTN to a new VoIP-based product because he or she is attracted by the superior functionality of the VoIP product;

- forced migration in which the end-user is faced with an imminent firm date for closing the PSTN/ISDN and is required to take action in order to continue to enjoy fixed voice telephony service;

- passive migration in which the communications provider is able (through PSTN emulation) to move customers to an All-IP network without them needing to do anything to preserve their fixed voice telephony service[5]; and

- coincidental migration in which the end-user moves from a PSTN based product to another product, such as FTTP, which is inherently IP-based.

In all four countries the operators try to minimise forced migration. But they do this in different ways. In Germany and New Zealand they use PSTN emulation[6] for certain categories of lines to enable passive migration. But in France and Switzerland they implement only full VoIP to the end user premises and focus on stimulating voluntary and coincidental migration. Figure S2 illustrates.

Figure S2: The technical form of the migration in the four case study countries

Type of migration used for	France	Germany	New Zealand	Switzerland
FTTP connections	Full VoIP	Full VoIP	Full VoIP	Full VoIP
Existing copper access broadband users[7]	Full VoIP	Full VoIP[8]	PSTN emulation	Full VoIP
Existing analogue voice telephony users	Full VoIP	PSTN emulation	PSTN emulation	Full VoIP

This difference in approach has significant implications for end-users:

- PSTN emulation means that passive migration is possible. The end-user is unaffected by the migration in terms of basic voice telephony services. There is no need to change terminal equipment; power from the exchange is preserved; and existing contracts can be maintained[9].

- Full VoIP means that end-users may need to replace old routers or purchase new IP telephones.

As well as using PSTN emulation to enable passive migration operators have attempted to sell the benefits of moving from the PSTN to VoIP (voluntary migration). It is uncertain how effective these efforts have been. We get the impression that much of the unforced migration has occurred through coincidental rather than voluntary migration.

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[5] Passive migration does not deal with any problems which might arise for users of data over PSTN devices.
[6] In which the VoIP stops at the line-card at the network end of the end-user's copper loop. We define PSTN emulation as providing the core set of voice telephony services and features but not necessarily all services currently provided on the PSTN
[7] For example ADSL or VDSL based broadband.
[8] Also for ISDN users.
[9] However PSTN emulation may not deal fully with all the problems which might arise with data over PSTN devices.

In all four case study countries the migration is being carried out on an area by area basis. Such an approach allows the operator to learn for its experience in the areas where IP migration is first implemented when migrating subsequent areas. It is also more cost-effective to close and remove local exchanges on an area by area basis.

S3   Problems with forced migration

All the case study countries have encountered problems with data over PSTN devices (as discussed below). But there have been relatively few problems with maintaining fixed voice telephony services following the migration. The main exception to this is in Germany where there were significant problems at the start of the migration process – especially in terms of poor communications with end-users. This led to complaints to the NRA, poor press coverage and questions in Parliament. We understand that these problems led to a pause in the migration process. They were solved following meetings between Deutsche Telekom AG (DTAG) and the NRA, BNetzA, to develop an improved communications process.

S4   Data over PSTN devices

The experience of the case study countries is that many data over PSTN devices continue to work well following an All-IP migration. However others do not. Old EFTPOS terminals might not work; DTMF signalling may fail; and fax terminals may need to be reconfigured.

In all four countries the onus is on end-users and their special service provider to deal with these problems and to bear the cost of any modification or replacement of devices which is required. The operators have helped in a variety of ways:

- by sending letters to end-users faced with migration to alert them to the problems which might arise;

- by holding workshops with special service providers to explain the issues and the possible remedies;

- by setting up test centres at which device suppliers and special service providers can test equipment to see if it works over an IP network; and

- by developing recommendations on how to handle migration problems for each main device type. In France an industry group has taken this role; in Switzerland Swisscom has taken this responsibility.

S5   Uninterrupted power supply (UPS)

There are no regulatory requirements in any of the four case study countries for operators to provide a UPS. Nor do the European case study countries plan to introduce UPS requirements. It is up to the end user and/or their special service provider to decide if a UPS is required and, if so, to bear the cost. In New Zealand the situation is about to change. The government there is in the process of introducing measures to ensure that vulnerable users have the ability, at no cost to themselves, to call the emergency services in the event of a mains power failure. Operators will be required to put in place measures to enable this.

S6   The costs of migration for end-users

The costs to end users of the All-IP migration vary between the case study countries and depend on the extent to which PSTN emulation is used. Figure 2.6 summarises our understanding of where the end users might face additional charges.

We can see that the incumbent operator has taken a different approach in different case study countries. In France and Germany the end user pays for a new router if required to enable existing equipment to continue to work following migration. In New Zealand there is no requirement for changes to customer premises equipment for those customers who are subject to passive migration and so no charge, and in Switzerland Swisscom provides a new router free of charge.

Figure S3: Are the costs of IP migration borne by the end-user?

	France	Germany	New Zealand	Switzerland
If any new broadband router is required?	Yes[10]	Yes	No[11]	No[12]
If an analogue voice telephony line is used?	Yes	No	No	Yes
In the charge for an equivalent service following migration?	No	No	No	No
If replacement of data over PSTN device is required?	Yes	Yes	Yes	Yes
If customers decide they need a UPS?	Yes	Yes	Yes	Yes

The figure shows that in all four case study countries:

- the universal service provider is required not to charge more for an equivalent service following migration; but that

- end-users (or their special service providers) are required to bear any costs of a UPS or replacement of data over PSTN devices.

S7   Protection of vulnerable users

The concept of vulnerable end-users is not recognised in the European case study countries in the way that it is in the UK. Instead regulators rely on a general constraint which requires universal service obligations as defined in the relevant legislation and regulation to be preserved during and following the IP migration. New Zealand is different. There is an industry code under development to protect vulnerable users and a bill before Parliament which will require retail service providers to put in place measures to enable vulnerable customers to make emergency calls at no cost to themselves. This might involve the provision of a UPS or a mobile solution.

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[10] There is a charge if the customer purchases the router but no additional charge if the router is rented and part of the service fee.
[11] If broadband service is based on a copper loop plus ADSL or VDSL. In this case PSTN emulation is used and there is no requirement for the end-user to change equipment.
[12] Swisscom delivers a new router at no additional charge.

S8   Lessons for the UK

The UK is at an early stage in planning closure of the PSTN. What can it learn from the experience of the case study countries?

As in the UK, all case study countries considered it preferable to minimise the scale of forced migration. Based on the findings from the case study countries we have identified a number of ways this has been addressed. A communications provider might:

- make sure that forced migration works properly, for example through thorough trials, before implementing it at scale. This approach could be applied to both the technical process of cutting over lines to All-IP and the process of communicating with users about forced migration. If the forced migration attracts bad publicity in the early days, then this may deter end-users from voluntary migration;

- offer end-users attractive alternative products, such as the ultrafast broadband provided by FTTP, where VoIP is built in to stimulate coincidental migration;

- give end-users a long notice period before the forced migration comes into force. In France the notice period in each migration area is five years; in Germany it is only four months. During this period migration is driven by a number of factors such as users moving to FTTP (coincidental migration), users moving from fixed to mobile services for voice telephony; and demographic changes as the number of older people with fixed lines only reduces;

- use PSTN emulation rather than full VoIP to enable passive migration (and so avoid forced migration) for selected groups of customers, such as those using analogue lines for voice telephony; and

- give end-users incentives if they migrate voluntarily. This might mean offering free replacement routers or a lower service price – perhaps justified by the fact that one of the driving forces for the migration is to lower the costs of the communications providers.

It is important to get communications with end-users right when it comes to forced migration. In particular it is important:

- to define clearly who is responsible for dealing with possible end-user problems and to set up clear communication channels to the responsible parties in advance; and

- put a lot of effort into developing the right communications messages and mechanisms and testing these to make sure they work properly for the different segments of the population before starting commercial migration.

Ofcom has articulated the principle that *"customers who do not migrate on a voluntary basis should be no worse off [as a result of forced migration] than they were before migration"*. How should this principle be interpreted? The four case study countries restrict its application to requiring communications providers to offer a price for an equivalent service which does not increase following forced migration. But they require customers to pay for replacement data over PSTN devices and UPS when required. And in France and Germany the end-user is expected to bear the costs of any new router.

Ofcom has specific duties under the Communications Act to protect consumers who may be vulnerable to harm[13] and has set out guiding principles which communication providers should follow so that Ofcom can fulfil

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[13] Vulnerable users include the disabled, the elderly, those on low incomes and those living in rural areas.

these duties. The case study countries are of limited help in interpreting these principles in terms of who might be eligible for help or what support should be provided:

- None of the European case study countries explicitly recognises the concept of "vulnerable customers"[14] beyond requiring that communications providers meet universal service requirements as set out in their governments' policy on universal service.

- In New Zealand the industry is in the process of developing a vulnerable end-use code which defines a vulnerable end-use as "... *dependent on a telecommunications service for their well-being*". In parallel in New Zealand the government is in the process of introducing measures to ensure that vulnerable users have the ability, at no cost to themselves, to call the emergency services in the event of a mains power failure.

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[14] Although in New Zealand there is now a draft code from the Telecommunications Carriers Forum (TCF, a voluntary industry association to which all main communications providers belong) which sets out to define vulnerable end user and proposes procedures to ensure their telecommunication needs are met.

1   Introduction

This report examines how four countries – France, Germany, New Zealand and Switzerland – are transitioning from PSTN to All-IP services and networks.

 The BSG brief was to review three to four countries of which two or three needed to be in the EU. In choosing the case study countries, we looked for countries that:

- were of a sufficient scale to be relevant to the UK:

- had made significant progress on All-IP migration; and

- exhibited a range of market characteristics which are relevant to those in the UK.

The final decision on the four case study countries was made in conjunction with the BSG Executive.

The focus of the study is on end-user impacts and how these are mitigated, rather than on impacts on access seekers or on technical issues relating to interconnect between networks. The focus is also on All-IP migration rather than copper switch off which allows migration to full fibre access networks.

The report is structured as follows:

- Section 2 provides a summary of the case study findings - highlighting areas where there is a common approach and those where there are significant and interesting differences.

- Section 3 provides a brief summary of our understanding of the UK's current approach to All-IP migration. This forms a reference point against which to compare the case study countries.

- Section 4 then offers a list of the issues which the case studies raise for the way the UK implements its IP migration in the future.

- Finally Appendices A to D provide the case studies for each country in alphabetical order. Each case study follows the same format for ease of comparison as set out in Figure 1.1.

Figure 1.1: The format of each case study

1. The drivers for the All-IP migration
2. The progress of the migration
3. The role of the regulator
4. Coordination within the industry
5. Contractual and competition issues
6. The migration process
7. Number portability
8. Devices which deliver data over the PSTN
9. Battery backup and access to emergency services
10. Costs to the end users
11. Relevance to the UK
12. Main sources

2 The main findings from the four case studies

It is useful to distinguish four different forms of All-IP migration when analysing the findings from the case studies:

- voluntary migration in which the end-user migrates from the PSTN to a new VoIP-based product because he or she is attracted by the superior functionality of the new voice product;

- forced migration in which the end-user is faced with an imminent firm date for closing the PSTN/ISDN and is required to take action in order to continue to enjoy fixed voice telephony service;

- passive migration in which the communications provider is able (through PSTN emulation) to move customers to an All-IP network without them needing to do anything to preserve their fixed voice telephony service[15]; and

- coincidental migration in which the end-user moves from a PSTN based product to another product which is inherently VoIP based. A move from ADSL-based broadband to FTTP is a good example. Here the driver for the migration is a desire for ultra high-speed broadband rather than for the superior functionality of VoIP.

We use these terms throughout the report.

2.1 The drivers for an All-IP migration

The desire to close the PSTN and migrate to All-IP has been driven by the operators (and especially the incumbent operator) rather than by the regulator or the government in all the case study countries. The three main drivers are:

- the rising costs and challenges of maintaining the PSTN. The PSTN uses equipment which is increasingly hard to obtain and requires technical expertise which is increasingly scarce as the engineers who run TDM networks retire;

- network simplification. The move to All-IP offers a major opportunity to simplify the core network substantially and so reduce its operating costs;

- competition. A move to All-IP allows an operator to implement a next-generation network architecture in which the transport and service functions are separated. This in turn allows the operator to offer richer services more quickly and more cheaply so as to compete better in the retail marketplace.

In New Zealand respondents have also pointed out that the move to full fibre (which is especially strong in New Zealand) acts to stimulate coincidental migration to All-IP.

2.2 The progress of the migration

Plum estimates of where the All-IP migration[16] has reached in the four case study countries is shown in Figure 2.1. This table shows:

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[15] Passive migration does not deal with any problems which might arise for users of data over PSTN devices.
[16] Forced, passive, voluntary and coincidental migration combined.

- the current level of conversion of fixed lines from PSTN to All-IP. This is mainly based on coincidental migration; and

- the planned dates for initiatives to force the closure of the PSTN.

Figure 2.1: Migration initiatives in the four case study countries

Country	France	Germany	New Zealand	Switzerland
% Fixed lines VoIP 2018	74%	80%	35%	80%[17]
Start of migration initiative	2018[18]	2014	2017[19]	2014
Current expected PSTN closure date for incumbent	2030	2019	2022	2019
Planned migration period	12 years	4 years[20]	5 years	4 years
PSTN closure for other operators	2030	2022[21]	2022	Na
Common date for PSTN closure	Yes	No	No[22]	No

We can see that:

- Germany and Switzerland are in an advanced stage of migration while France and New Zealand are at the start of migration;

- the typical migration period is four to five years – consistent with the UK's current plans;

- France is an exception. The planned 12-year migration period means that France is relying more on voluntary and coincidental migration and less on forced migration. As Figure 2.2 shows, this migration will, on current trends, come close to eliminating the installed base of PSTN users without any forced migration by 2030; and

- only France has set a common date for PSTN closure by all the operators.

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[17] Swisscom rather than all communications providers.
[18] Trial in the Finistere department of France.
[19] Trial to close 10 rural exchanges.
[20] Originally planned for end 2018.
[21] Vodafone Kable.
[22] Vodafone and Spark have chosen the same date independently.

Figure 2.2: The changing balance between VoIP and PSTN for fixed connections in France
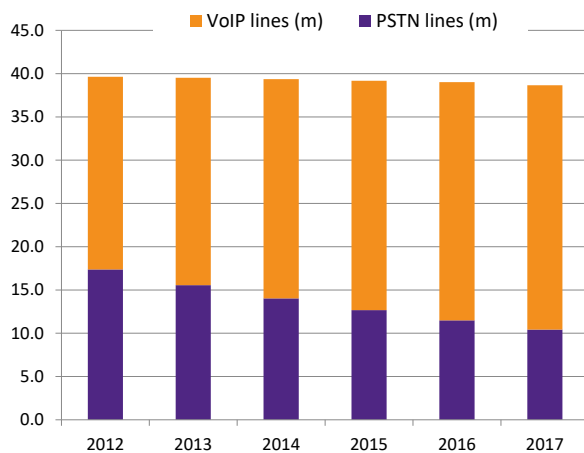
2.3   The role of the regulator

The role of the regulator in the migration initiatives has varied by case study country:

- In New Zealand the telecommunications regulator is the Commerce Commission. Its prime duty is to enable and preserve competition rather than to administer sector specific consumer protection. This latter role has fallen, to a degree, to the New Zealand Telecommunications Forum or TCF (an industry body) and to the New Zealand government.

- In France and Germany the NRAs have held regular meetings with the incumbent operator and other interested parties to ensure adequate consumer protection.

- In Switzerland the regulator's role played almost no part in shaping the migration.

The main influence of the NRAs has been:

- to ensure that the universal service requirements[23] for voice telephony, as adopted from the EU universal service directive, are maintained during and following the migration;

- to ensure that the incumbent publishes its plans for other communications providers (France);

- to ensure that the incumbent operator communicates fully with special service providers – for example through workshops – to alert them to their responsibilities during the migration and the actions they need to take (Germany);

- to set up and host regular discussion between stakeholders (France); and

- to get the incumbent operator to agree to:

  - set up test centres at which data over PSTN device suppliers can test their equipment to see if it works in an All-IP network (Germany, New Zealand)

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[23] In the EU these require the universal service provider to supply voice telephony at a fixed location on reasonable request and at an affordable price. They also give the NRA powers to require other operators to provide services to the disabled so that they have a choice of communication provider.

- supply new routers when required without charge to end users (Switzerland)

- use PSTN emulation rather than full VoIP for analogue voice telephony lines (Germany)

- set up a dedicated service centre to handle problems arising from the All-IP migration (Germany).

2.4   Coordination within the industry

There has been very little coordination across communications providers within each case study country except in France where:

- there is a common date for PSTN closure;

- regular meetings are held with the regulator which involve all the main operators; and

- the Fédération Française des Télécommunications (FFT) – an industry forum whose members include all the main communications providers – has developed recommendations on how to ensure that data over PSTN devices work on IP networks.

2.5   The migration process

The technical form of the migration

The technical form of a migration varies across the four case study countries. There are two basic choices as shown in Figure 2.3.

- PSTN emulation[24] to the end user premises; and

- full VoIP to the end user premises.

Figure 2.3: PSTN emulation[25] vs full VoIP

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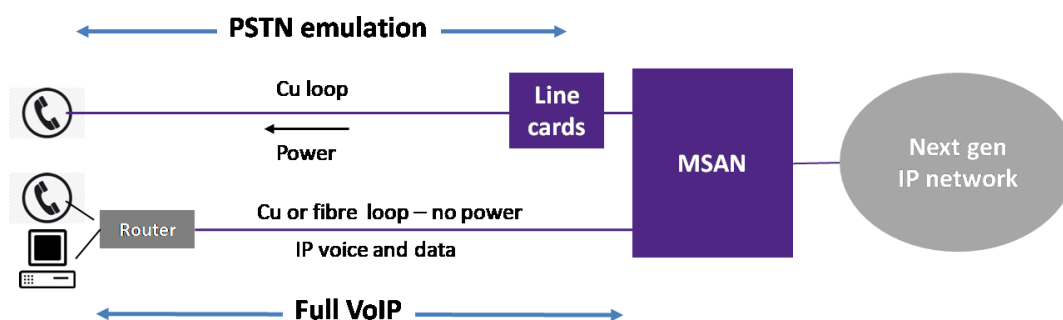
[24] We define PSTN emulation as delivering the bulk of the services and features currently available over the PSTN but not necessarily every one of them.

[25] There are slightly different technical definitions of the term. We use the term here to mean: the broad set of voice services previously available over the PSTN network are generally available, but may not be exactly the same; power is provided over the line to the premises, and no new CPE is required from the communications provider or the end user.

The four case study countries have implemented a mix these two technical arrangements as shown in Figure 2.4.

Figure 2.4: The technical form of the migration in the four case study countries

Type of migration	France	Germany	New Zealand	Switzerland
Technical form used for FTTP connections	Full VoIP	Full VoIP	Full VoIP	Full VoIP
Technical form used for existing copper access broadband users[26]	Full VoIP	Full VoIP[27]	PSTN emulation	Full VoIP
Technical form used for existing analogue voice telephony users	Full VoIP	PSTN emulation	PSTN emulation	Full VoIP

This difference in approach has implications for end-users:

- PSTN emulation means that passive migration is possible. The end-user is unaffected by the migration in terms of basic voice telephony services. There is no need to change terminal equipment; power from the exchange is preserved; and existing contracts can be maintained.

- Full VoIP means that end-users may need to initiate significant changes. They may need to replace old routers or purchase new IP telephones. In France and Germany, but not in Switzerland, these costs are borne by the end users.

However PSTN emulation does not avoid possible problems with data over PSTN devices. See Section 3.8 for details.

In all four cases the migration is being carried out on an area by area basis. In Germany and New Zealand the areas are defined by groups of local exchanges; in France and Switzerland they are defined by administrative regions – with each Canton defining a separate area in Switzerland and groups of departments defining each area in France. Such an approach allows the operator to learn for its experience in the areas where IP migration is first implemented when migrating subsequent areas. It is also more cost-effective to close down and remove local exchanges on an area by area basis.

Problems with forced migration so far

The main problems identified as a result of forced migration are listed below:

- In Germany there were significant problems at the start of the migration process in terms of poor communications with end-users. This led to complaints to the NRA, poor press coverage and questions in Parliament. We understand that these problems led to a pause in the migration process. They were solved following meetings between Deutsche Telekom AG (DTAG) and BNetzA to develop an improved communications process. Figure 2.5 summarises the process.

- In France the migration is at an early stage. There have been no reported problems in terms of migrating basic voice telephony service but a few problems with data over PSTN devices which are now being addressed by the industry body, the FFT.

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[26] For example ADSL or VDSL based broadband
[27] Also for ISDN users.

- In New Zealand Spark initially migrated 3000 customers served by 10 rural exchanges to VoIP (using PSTN emulation). Only a few problems were reported. These involved very old PBXs (over 20 years old), a few EFTPOS terminals, and customers living in very rural areas with long copper loops (where the quality of voice telephony deteriorated significantly). This last problem has also been reported in Germany.

- In Switzerland, no migration problems were reported during the migration phase.

Figure 2.5: Communicating with end-users for forced migration in Germany

The DTAG process for communicating with end-users when migrating an area to All-IP is a four-step process.

- **Step 1: A letter alerting the customer to the move to VoIP and spelling out its advantages (to stimulate voluntary migration).**

- **Step 2: A letter setting a date for termination of the PSTN service and explaining the customer's options.**

- **Step 3: A call to the customer to tell them of the impending switch off and asking them what they wish to do.**

- **Step 4: Finally a reminder letter about the termination of service.**

DTAG put a lot of effort into testing the wording of these letters to minimise confusion, misunderstandings and customer loss. The letters cover both the voice telephony service and the need to check if data over PSTN devices[28] will continue to work following the move to All-IP – for example by contacting any special service providers used. The focus here is on safety of life applications.

Sales messages to end users

To encourage voluntary migration incumbent operators have listed the following reasons for moving to All-IP:

- VoIP offers the same features as existing services plus a wide range of new features. These include (in Switzerland):

- call filtering for protection against unwanted advertising calls;

- HD voice quality;

- personalized blocking lists;

- the display of the name of all the numbers registered on www.local.ch; and

- the possibility to conduct two conversations simultaneously.

- The migration process is simple for consumers who can continue to use their existing devices.

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[28] For example pendants used to call the emergency services in case of a fall.

- IP voice means simplified wiring in the home or office.

We asked the operators in all four case study countries whether there were any particular features of the new VoIP services which encouraged users to switch on a voluntary basis. Respondents were unable to answer. We did however get the strong impression that sales messages which encouraged coincidental migration to new products such as FTTP were more effective at minimising forced migration.

In some cases the incumbent operator has also use the migration to offer more attractive products to some end-users. For example with *Swisscom line plus* customers can make unlimited calls for a monthly flat fee without needing to subscribe to Internet or TV services.

Protection of vulnerable end-users

The concept of vulnerable end-users is not recognised in the European case study countries in the way that it is in the UK. Instead they rely on a general constraint which requires universal service obligations as defined in the relevant legislation to be preserved during and following the IP migration.

New Zealand however is taking action to protect vulnerable users. There is an industry code under development and a bill before Parliament which will require retail service providers to ensure measures are in place to enable vulnerable users to make emergency calls in the face of mains power failure, at no additional charge to the customer. It is expected that in many instances this requirement will be fulfilled through the use of the user's mobile, otherwise an uninterrupted power supply may be provided free of charge.

In New Zealand and Germany use of PSTN emulation also provides some protection for users of analogue voice telephony lines. These are often older and more vulnerable people. In addition in New Zealand Spark checks on whether high-risk users are involved during the cutover process to All-IP.

2.6   Contractual and competition issues

In general end-user contracts are technology neutral. They specify that fixed voice telephony will be provided but do not specify what technology will be used. This means that communication providers are able to migrate the end user to VoIP without breaching contractual conditions. But this is not always the case:

- In Germany DTAG contracts (but not contracts for other communications providers) specify that ISDN will be used as the technology to deliver fixed voice telephony to many users. So in these cases a move to All-IP requires a change of contract and an opportunity for end-users to change supplier. We note for example[29] that DTAG's retail market share for fixed broadband connections declined by 170,000 in 2016. It is impossible to judge what proportion of this decline can be attributed to the All-IP migration.

- When the deadline for closure of the PSTN/ISDN in an area is imminent the communication provider needs to force the migration. To do this it needs to terminate the contract. This process is used extensively in Germany. It gives end users an opportunity to change communications provider.

- Even when the contract position is problem free, some communications providers have used the move to All-IP as an opportunity to try to attract customers to their network:

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[29] Based on data from the European Commission.

- In France Iliad sent out emails to certain subscribers encouraging them to migrate to its service based on full unbundled copper loops to avoid alleged "service disruption" when Orange moved to All-IP. This initiative was quickly abandoned when Orange threatened legal action.

- In Switzerland one communication provider has encouraged Swisscom users to switch supplier when faced with a forced migration.

- In Germany ISDN users who switch to Vodafone, which is continuing to run an ISDN until 2022, can delay any costs of migration for four years.

2.7   Number portability

There are now discussions underway in the UK as to whether the call forwarding method used for number portability should change during or following the All-IP migration. This issue is not relevant in the four case study countries where number portability is based on consulting a central database. This approach to implementing number portability has continued to work well during the All-IP migration and there are no plans to change it.

2.8   Data over PSTN services

There are two categories of devices which send data over the PSTN and which might not work satisfactorily over an IP network:

- devices which are provided by a special service provider such as one offering security or fire alarm monitoring, or one providing remote health or social care; and

- devices which end users have purchased on their own initiative e.g. fax machines and devices to monitor elderly relatives living independently which are not provided by a special service provider.

Across all four case study countries:

- Many of these devices continue to work on IP networks satisfactorily.

- Where there are problems such devices may often be made to work satisfactorily by changing device settings – for example on fax machines.

- In other cases new equipment might be needed – either an adapter or a new device.

In all four case study countries the costs of replacing or modifying devices are borne by a mix of the end-user and the special service provider, if relevant.

In Germany and New Zealand the incumbent operator provides a test centre for device suppliers and special service providers to determine whether their equipment works on an IP network.

In terms of recommendations on what device suppliers and special service providers should do to deal with problems created by the All-IP migration the approach varies:

- in France, the industry group (the FFT) has developed recommendations for what to do with each main device type when migration occurs;

- in Germany DTAG has held two workshops with special service providers to raise awareness of the need for them to take action; and

- in Switzerland Swisscom has developed recommendations for each main device type.

At a more detailed level:

- Swisscom has emphasised the need to move devices used for safety of life applications, such as medical alarms, to dual communications which can deliver data using both the mobile network and the fixed line VoIP network.;

- Spark in New Zealand has highlighted that there are problems for some medical and house alarms, for old satellite TV decoders, for old EFTPOS terminals and for old PBXs; and

- Spark's process for cutting over to All-IP includes a step to check whether it involves high risk customers e.g. those using medical devices.

2.9   Uninterrupted power supply (UPS) and access to the emergency services

Requirements for UPS, for example through battery backup, and continuing access to the emergency services are both issues which are of particular relevance in protecting vulnerable customers.

UPS

UPS backup may be required for both voice telephony calls and for data over PSTN devices in the event of a failure in the mains electricity supply. Clearly it is important during a power failure that end users should be able to contact the emergency services. But it is also recognised that a UPS may be required to enable certain data over PSTN devices to continue to work during an interruption to mains power. But there are no regulatory requirements in any of the four case study countries for operators to provide an uninterrupted power supply (UPS). With the ubiquity of mobile phones and the reliability of the mains electricity supply, the German regulator does not consider such a requirement a proportionate response. This is not the case in the UK.

Nor are there any plans in the European case study countries to introduce UPS requirements following the All-IP migration. Use of PSTN emulation (which means that devices can continue to receive power from the network) helps in New Zealand and, to some extent, in Germany to preserve calling to the emergency services. But even in France and Switzerland, where there is full VoIP implementation, it is up to the end users and/or their special service provider to decide if a UPS is required and, if so, to pay for it. In France, the FFT raised this issue in its work on data over PSTN devices but did not make any recommendation.

The position in New Zealand is somewhat different, however. Here the government plans to introduce measures to ensure that vulnerable users have the ability, at no cost to themselves, to call the emergency services in the event of a mains power failure – this might include the provision of a UPS.

Continuing access to the emergency services

There are two main issues here:

- Are such calls possible from a fixed location when there is a failure in the mains power supply? This issue is dealt with under the battery backup section above.

- Will caller location information be delivered to the emergency services call centre from a fixed line following the migration? This is not seen as a problem in any of the case study countries – where the regulatory focus is on better caller location information for calls made from mobile phones. Nomadic VoIP services remain a problem. But this problem predates IP migration. In New Zealand there is an obligation on communications providers, under an industry code, to require service providers to make the emergency services aware when a call is made from a nomadic VoIP service and to indicate that the caller location information delivered may not be reliable.

2.10   The costs to the end users

The costs of the All-IP migration to end users vary between the case study countries and depend on the extent to which PSTN emulation is used. Figure 2.6 summarises our understanding of where the end users might face additional charges.

We can see that the incumbent operator has taken a different approach in different case study countries. In France and Germany the end user pays for a new router if one is required to enable existing equipment to continue to work following migration. In New Zealand there is no requirement for changes to customer premises equipment for those customers who are subject to passive migration and so no charge, and in Switzerland Swisscom provides a new router free of charge.

Figure 2.6: Are the costs of IP migration borne by the end-user?

	France	Germany	New Zealand	Switzerland
If any new broadband router is required?	Yes[30]	Yes	No[31]	No[32]
If an analogue voice telephony line is used?	Yes	No	No	Yes
In the charge for an equivalent service following migration[33]?	No	No	No	No
If replacement of data over PSTN device is required?	Yes	Yes	Yes	Yes
If customers decide they need a UPS?	Yes	Yes	Yes	Yes

2.11   All-IP migration by the AltNets

In three of the four case study countries AltNets which operate their own access networks are free to determine when they close their PSTN and what technical solutions they use. Only in France has a common date been set for the closure of the PSTN. In many cases these AltNets build their networks using voice over broadband technologies from the start or have already migrated their customers to All-IP. For those which have chosen to complete their All-IP migration at a later date than the incumbent, there is an opportunity to attract customers

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[30] There is a charge if the customer purchases the router but no additional charge if the router is rented and part of the service fee.
[31] If broadband service is based on a copper loop plus ADSL or VDSL. In this case PSTN emulation is used and there is no requirement for the end-user to change equipment.
[32] Swisscom delivers a new router at no additional charge.
[33] This constraint applies to the universal service provided through regulation

who wanted to delay IP migration. This is, for example, the situation in Germany where DTAG completes the migration of its ISDN customers by 2019 while the Vodafone completion date is set for 2022.

In contrast AltNets which use PSTN-based wholesale products (similar to WLR in the UK) are locked into the migration timetable of the incumbent operator. To preserve competition the regulator needs to ensure that there is an appropriate wholesale migration product available. In France Orange made its "Access Essentiel" available to access seekers in 2018. This offers a low-speed bitstream service to enable access seekers with analogue voice telephony only customers to migrate their customers to VoIP. In New Zealand Chorus, the wholesale only provide of access networks, offers a similar product.

3 The current position in the UK

As in the case study countries, the decision to close the PSTN and migrate to All-IP has been driven by the operators rather than by the regulator or the government. In its Connected Nations 2017 report, Ofcom sets out some of the issues involved in the All-IP migration, and sets out its approach to managing the transition.[34] Ofcom notes that:

- the PSTN network is becoming increasingly difficult to maintain;

- the fixed access network is moving away from copper to fibre technology;

- PSTN switch off may present challenges during migration for the 1.5m landline-only customers in the UK; and that

- switch off may also cause compatibility issues for some applications and services that run over the PSTN, such as personal alarms and point to point connections for industrial purposes such as process monitoring.

Ofcom's response to the challenge of an All-IP transition is to have communications providers (CPs) lead and manage the migration process. In Ofcom's view, this is the more efficient approach because:

- switching off the PSTN is a commercial decision;

- the providers can set timescales suitable for their own business; and

- providers can communicate directly with users and over-the-top service providers.[35]

Ofcom also considers that:

"Migration will work best where people migrate voluntarily, and where providers' migration strategies rely on developing new services which make it attractive to move".[36]

Communications providers (CPs) in the UK are currently at different stages of managing their migration:

- Virgin Media is starting to deploy All-IP voice solutions to new customers. Initially this was to enable voice services to premises using Virgin Media's FTTP-based Project Lightning network expansion. But now services can be offered more widely.

- Openreach published a consultation in May 2018[37] on its plans to transition to IP voice services in which it proposed a number of key dates for closure of its exchange based PSTN access product WLR:

  – The introduction of transition products, starting in March 2019.

  – The stopping of new sales of wholesale line rental (WLR).

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[34] Ofcom (2017) *Connected Nations 2017*, Para. 8.48 https://www.ofcom.org.uk/__data/.../connected-nations-security-resilience-2017.pdf [Connected Nations (2017)]

[35] Presentation by Huw Saunders of Ofcom, https://www.riscauthority.co.uk/utilities/download.html?fid=5C07D544-E2EB-4DF5-B5E4277D002085FA

[36] Connected Nations (2017)

[37] Openreach, 15 May 2018, *Upgrading the Access Network: the withdrawal of WLR products and the smooth transition to IP voice services*, (Openreach 2018) http://www.fcs.org.uk/image_upload/files/upgradingtheaccessnetworkconsultation.pdf

- The withdrawal of WLR from the market in December 2025.

- Openreach's plans create incentives for access seekers currently using WLR to migrate their customers to a VoIP-based service and to move their own network to All-IP.

- Other communications providers which use their own access infrastructure or fully unbundled copper loops are free to follow any timetable that they wish.

While Ofcom's current approach provides a significant degree of latitude for CPs to determine when and how they migrate to All-IP, Ofcom has stated that it will apply a set of consumer protection principles during the migration. The principles listed below cover both providing help to those who need it most and ensuring resilient solutions. The aim is to ensure that customers are no worse off as a result of the migration. As Ofcom notes not everyone who needs a resilient solution will need help with migration, and vice versa. For example, someone with no mobile signal at their home may need a resilient solution but not help with migration, whereas someone who has fixed voice and mobile, but not broadband, may need help with migration but not a resilient solution.

Figure 3.1: Ofcom's consumer protection principles for the transition to All-IP[38]

Emergency services access should be provided in accordance with the General Conditions (GCs).

Technical solutions for ensuring reliable operation of new voice services, for example during localised or widespread power outages, should provide levels of protections equivalent to that provided by traditional means.

New voice services will maintain existing protections for vulnerable consumers in a manner which is appropriate for the technology they employ and their usage.

Equivalents to the current social phone tariffs will be applied to future voice services where appropriate.

Before and during any planned withdrawal, providers of existing voice services will work with third party service providers which rely on them, in order to minimise end customer disruption.

Providers of traditional voice networks must give reasonable notice to their wholesale customers of any intention to withdraw relevant voice services, or to replace them with alternatives based on different network technology.

Customers who do not migrate on a voluntary basis should be no worse off than they were before migration.

Vulnerable consumers[39] must receive any assistance they require for the migration process and continue to receive a service they recognise as a telephony service.

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[38] For the full text see Paragraph 8.59 of Ofcom's *Connected Nations 2017*
[39] Which reflects the duties given to Ofcom in the 2003 Communications Act. Vulnerable users includes the disabled, the elderly, those on low incomes and those living in rural areas.

Also of relevance is Ofcom's recent consultation[40] and guidance[41] on General Condition A3, which requires CPs to take measures to ensure uninterrupted access to emergency organisations for their customers. While the underlying requirement has not changed, Ofcom's guidance provides clarification on the measures it expects CPs to take to protect consumers as landline services migrate to VoIP services. The guidance takes the form of four principles CPs must adhere to for customers who are dependent on the fixed lines:

- Providers should have at least one solution available that enables access to emergency organisations for a minimum of one hour in the event of a power outage at the premises.

- The solution should be suitable for customers' needs and should be offered free of charge to those who are at risk due to their dependence on their landlines.

- Providers should (i) take steps to identify at risk customers and (ii) engage in effective communications to ensure all customers understand the risk and eligibility criteria and can request the protection solution.

- Providers should have a process to ensure that customers who move to a new house or whose circumstances change in some other way are aware of the risk and protection solution available.

In developing its guidance for the provision of battery back-up, Ofcom conducted research in November 2017 across the UK into the use of landlines.[42] Based on the research, Ofcom noted that:

- 68% of customers that have a landline in their home have a cordless phone only;[43]

- approximately 2m adults[44] live in a home with a landline and no mobile phone; and

- 50% of customers that live in a home with only a landline phone use a cordless phone rather than a traditional corded phone.

The above figures provisionally suggest that there are around 750,000 to 1m consumers in the UK who may require a battery back-up solution and/or additional assistance during the All-IP transition.

The UK is now in the early stages of planning the All-IP migration. So far:

- Ofcom has established two All-IP working groups – one to deal with technical issues and another consumer communications.

- Ofcom has held a series of workshops with communications providers, special service providers and consumer groups to identify the problems which might arise in dealing with vulnerable consumers and in ensuring that critical services – such as telecare, alarms and payment terminals – that currently use data over PSTN devices continue to work following migration.

- BT has established test facilities for data over PSTN devices at Adastral Park.

- Openreach has consulted with, and is now working with, the industry on the closure of its PSTN based WLR products.

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[40] https://www.ofcom.org.uk/__data/assets/pdf_file/0018/114219/consultation-access-emergency-power-cut.pdf

[41] https://www.ofcom.org.uk/consultations-and-statements/category-2/access-emergency-organisations-power-cut

[42] https://www.ofcom.org.uk/__data/assets/pdf_file/0016/114217/phone-use-home-survey.pdf

[43] Most modern cordless phones are based on the DECT (Digital Enhanced Cordless Telecommunications) standard, and have a base station or dock requiring mains power. When power to the premises is lost, DECT phones will cease to work, regardless of whether the powered broadband CPE is supported by battery back-up.

[44] Note that this is different to the 1.5m figure in Ofcom's (2017) Connected Nations report.

- The Office of the Telecommunications Adjudicator is developing a code of practice for restoring special services in the case of migration problems.

- The NICC, which agrees interoperability standards for the UK's telecommunications sector, is developing new standards and updating existing standards to support the new All-IP voice network. It has also set up a cross-industry All-IP forum to raise potential issues.

- CPs are engaging with the trade associations representing OTT services, for example through conferences and events

4 Key issues for Broadband Stakeholder Group members

4.1 Introduction

The findings from the case study countries – which show how an All-IP migration is being tackled from an end-user perspective – highlight a number of issues which BSG members might wish to consider. In some cases Ofcom and the industry may have already made tentative decisions which the case studies either conflict or confirm; in others they might help to clarify the debate in the UK.

4.2 Should the UK adopt a common date for closing the PSTN?

Setting a common date for closing TDM switched networks in the UK provides a focal point around which to communicate to special service providers, device suppliers and end-users. It makes for a simple public message – that the old telephone network will cease by (say) 2025. This should make raising public awareness easier.

This is the approach being adopted in France but not in the three other case study countries. In the latter, as in the UK, the closure date is left to individual communications providers to decide. Such an approach:

- is less likely to distort competition. A common date will suit some communications providers better than others – who are then at a competitive disadvantage in working to a common deadline; and

- fits better with an area by area approach to closure. This approach has been adopted in all four case study countries since it allows communications providers to focus resources on specific areas sequentially to make the transition more cost-effective than a nation-wide transition. Under an area by area approach, many end-users will face a forced migration date well in advance of the final closure date and the simple message of a single closure date is not valid for them.

4.3 How can the UK minimise the scale of forced migration?

There are clear benefits in minimising forced migration and maximising voluntary and/or coincidental migration as the way in which end users move away from the PSTN. As Ofcom puts it:

"Migration will work best where people migrate voluntarily, and where providers' migration strategies rely on developing new services which make it attractive to move".[45]

There are a number of ways to do this. A communications provider might:

- offer end-users attractive alternative products where VoIP is built in. In New Zealand for example the move to full fibre is driving migration away from the PSTN;

- give end-users a long notice period before the forced migration comes into force. In France the notice period in each migration area is five years; in Germany it is only four months. Over a five-year period voluntary and coincidental migration in France will, on current trends, reduce the proportion of fixed

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[45] Connected Nations (2017)

connections facing forced migration from 25% to 10% of lines[46]. This migration is driven by a number of factors such as:

– users moving to FTTP;

– users moving from fixed to mobile services for voice telephony; and

– demographic changes as the number of older people with fixed lines only reduces.

There is a trade-off here, however. A long notice period means a late closure of the PSTN which, given the problems of finding equipment and staff to run this legacy network, may mean deteriorating quality of service and higher costs;

• use PSTN emulation rather than full VoIP to enable passive migration (and so avoid forced migration) for selected groups of customers, such as those using analogue lines for voice telephony. This is the approach used in Germany and New Zealand. With demographic change the number of such customers may reduce quickly so that the scale of forced migration in (say) 10 years' time is an order of magnitude smaller than it is now. Of course such an initiative raises operating costs when compared with a pure VoIP solution. But it does allow the closure of TDM services in the core network – a move which should generate substantial cost savings;

• make sure that forced migration works properly – for example through thorough trials – before implementing it at scale. This approach could be applied to both:

– the technical process of cutting over lines to All-IP to make sure it does not lead to a significant period of loss of service; and

– the process of communicating with users about forced migration. Here the case study experience in Germany suggests that this is important for customers to understand what they need to do in terms of both preserving voice telephony service and ensuring that data over PSTN devices continue to work.

If the forced migration attracts bad publicity in the early days, then this may deter end-users from voluntary migration; and

• give end-users incentives if they migrate voluntarily. This might mean offering free replacement routers or a lower service price – given that one of the driving forces for the migration is to lower the costs of the communications providers.

4.4   How best to communicate with consumers?

It's clear from the experience of DTAG in Germany that it is important to get communications with end-users right when it comes to forced migration. In particular it is important to:

• define clearly who is responsible for dealing with possible end-user problems and set up clear communication channels to the responsible parties in advance;

• put a lot of effort into developing the right communications messages and mechanisms;

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[46] In areas where early migration is planned.

- test these to make sure they work properly for the different segments of the population before starting migration on an industrial scale;

- alert end-users to potential migration problems with both voice telephony services and data over PSTN devices;

- specifically list what is meant by data over PSTN devices - particularly those where there may be safety of life issues;

- communicate multiple times with each household or business using a mix of communication channels. In Germany there are four main steps for communicating with consumers – three involve letters and one a phone call; and

- consider how best to identify and communicate with those end users with disabilities (for example visually impaired consumers).

4.5   How best to protect UK consumers during the migration?

As one of its guiding principles for the transition to All-IP, Ofcom has asked that:

"customers who do not migrate on a voluntary basis should be no worse off [as a result of forced migration] than they were before migration"

How should this principle be interpreted? The four case study countries have, as shown in Figure 2.6, confined implementation of this principle to requiring communications providers to offer a price for an equivalent service which does not increase following forced migration. But in terms of other aspects of the All-IP migration:

- They allow communications providers to charge for new routers if required in France and Germany. However Swisscom provides new routers free of charge if needed and, in New Zealand, PSTN emulation is used for all copper loop services[47] so a new router is not required.

- All require consumers to pay for any new data over the PSTN device

- With the exception of vulnerable customers in New Zealand (in the future), all require consumers to pay for any uninterrupted power supply which is required.

There is also the general argument that, if an overgenerous interpretation of this principle is applied, then end users would opt for forced migration and incentives for end-users to migrate voluntarily would be reduced.

4.6   How best to protect vulnerable customers in the UK?

Ofcom has specific duties under the Communications Act to protect consumers who may be vulnerable to harm[48]. With this duty in mind Ofcom has, in its guiding principles for the All-IP migration, stipulated as follows:

- Vulnerable consumers must receive any assistance they require for the migration process and continue to receive a service they recognise as a telephony service.

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[47] Analogue voice telephony, ADSL broadband and VDSL broadband.
[48] Vulnerable users include the disabled, the elderly, those on low incomes and those living in rural areas.

- New voice services will maintain existing protections for vulnerable consumers in a manner which is appropriate for the technology they employ and their usage.

- [Communications] providers should (i) take steps to identify at risk customers and (ii) engage in effective communications to ensure all customers understand the risk and eligibility criteria and can request the protection solution. Additionally, the guidance on General Condition A3 sets out an expectation that protection solutions are provided free of charge to those customers that are dependent on their landline.

The case studies are of limited help in interpreting this principle in terms of who might be eligible for help or what support should be provided. None of the European case study countries explicitly recognises the concept of "vulnerable customers"[49] beyond requiring that communications providers meet universal service requirements as set out in their governments' policy on universal service. But in New Zealand the industry is in the process of developing a vulnerable end-use code which defines a vulnerable end-use as "... dependent on a telecommunications service for their well-being"

In terms of ensuring uninterrupted power supply (UPS) for vulnerable users free of charge, the case studies are also of limited use. In none of these countries is there a general policy of requiring universal access to a UPS. Nor are there plans to introduce such a policy on either a universal or selective basis following the All-IP migration in the European case study countries. There are however two mitigating factors here:

- In New Zealand and Germany, power from the network is maintained for analogue voice telephony lines through use of PSTN emulation while the copper access network is maintained to the premises[50]

- in New Zealand the government plans to introduce measures to ensure that vulnerable users have the ability, at no cost to themselves, to call the emergency services in the event of a mains power failure.

In terms of ensuring continuity of fixed voice telephony services, Germany and New Zealand use passive migration for analogue voice telephony lines. The users of such lines are more likely to be vulnerable customers than other users of fixed connections.

In terms of satisfactory use of existing data-over-PSTN devices following the migration, the case studies offer a number of ideas. These are of relevance to all categories of users but are especially important for vulnerable customers:

- In Germany, following initial complaints, DTAG put a lot of effort into ensuring that the communications with those end-users facing forced migration was made effective. For example the initial letter for termination of service listed the main categories of data devices which needed to be checked, with a focus on those used for safety-of-life applications.

- In Switzerland and France written recommendations have been produced for end-users and special service providers to advise them on what to do to deal with migration problems for each of the main categories of data devices.

In New Zealand and Germany the incumbent operators provide test facilities which device suppliers can use to check whether their existing equipment will continue to work over an IP network. But it is not clear whether these test facilities simulate the use of devices across networks – given that some problems are introduced at the interconnecting gateways between (say) an IP and a TDM network.

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[49] Although in New Zealand there is now a draft code from the TCF which sets out to define vulnerable end user and proposes procedures to ensure their telecommunication needs are met.

[50] Where the access network moves to fibre, FTTP, the end user has the choice of using a native VoIP service or moving to mobile calling.

Appendix A   The French case study

See Section A11 for a comparison of the market structures in France and the UK.

A.1   Drivers for the All-IP migration

In 2014, Orange, the French telecommunication incumbent, officially announced to ARCEP and other operators the progressive shut down of its historical network for fixed telephony – the PSTN – over a period of 10 years.

Orange explained that its decision derived from the fact that the long-term sustainability of its legacy telephone network was threatened in the coming years. It argued that the equipment and components designed specifically for this network were becoming obsolete, and the network itself was becoming increasingly difficult to maintain as equipment suppliers were abandoning the technology. As a result, continuing to operate the network for too long into the future would result in significant malfunctions and even service outages.

Orange established the time frame of this progressive shut down. In late 2018, Orange will stop selling new PSTN subscriptions. Then the migration of lines will be organized by regions, for a total shut down planned for 2030. This agenda is outlined in Section A.2 below. In the longer term, the Orange Group plans to ensure transition from PSTN to All-IP in the countries in which it operates as the incumbent (Poland, Kenya, Jordan, Senegal, Côte d'Ivoire and Mauritius).

ARCEP, the French telecommunications regulator, announced that it would not oppose Orange's decision to shut the PSTN. But it has required Orange to comply with some rules which are detailed in Section A.3.

A.2   The progress in the migration

PSTN shut down timeframe

PSTN shutdown has been planned across two activity streams:

- a stream for production shutdown: It will not be possible for consumers to subscribe to an analogue PSTN line from 15 November 2018, or to a digital PSTN line as of 15 November 2019.

- a stream for technical shutdown: The technical migration from PSTN to VoIP will be progressive and done by "plaques" (by groups of French departments[51]). In November 2018, Orange has announced the first lot (9 geographical areas) to be migrated by 2023[52], complying with its regulatory requirement to make announcements five years before the shut down in each plaque. The planned date for final shut-down is 2030. It is a common date for all operators.

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[51] There are 101 French departments, including 5 overseas departments.
[52] These geographical areas have been coloured in orange on the map: https://reseaux.orange.fr/projet/modernisation-telephonie-fixe

Evolution of subscriptions

As shown in Figure A.1, the number of PSTN connections is declining steadily through voluntary and coincidental migration, as end-users switch to fixed broadband with voice over broadband or become mobile only households. On current trends, use of the PSTN will have disappeared by 2030 without forced migration.

Figure A.1: Evolution of PSTN and VoIP subscriptions in France
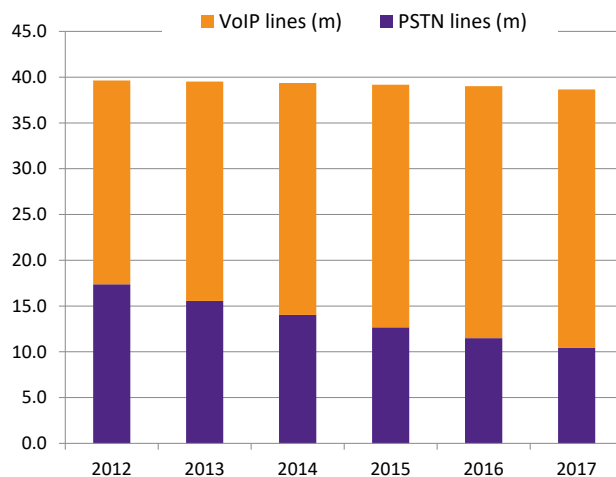
Source: Telegeography

The Finistère trial

In early 2017, an experiment of PSTN replacement by IP was run in 14 municipalities of Finistère, a French geographic department located in Brittany. This area was chosen as representative of Orange's subscription base for both the consumer and business segments.

This experiment was primarily about production shut down, not about the technical shut-down. It included migrations from PSTN to VoIP and the installation of boxes[53]. It also included testing the migration of special services (payment systems, lift alarms, fax, etc.). These tests were generally successful, and the lessons learnt have been incorporated by the Fédération Française des Télécommunications (FFT) – an industry forum whose members include all the main communications providers - in their White Paper[54] on migration from the PSTN.

An experiment on the technical shut-down will be completed by the end of 2021 in six municipalities of Finistère and one municipality in Ile de France[55].

A.3   The role of the regulator (ARCEP)

As it was mentioned in Section A.1, ARCEP did not oppose Orange's decision to shut the PSTN. Nevertheless, it required Orange to comply with a series of advanced notices consisting in communicating five years in advance of the PSTN shut-down to each territory concerned[56]. This ARCEP decision requires that Orange regularly

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[53] Customer premises equipment to enable use of VoIP.
[54] In French only: https://www.fftelecoms.org/app/uploads/2017/08/livre_blanc_fin_rtc_-2.pdf
[55] These municipalities are the yellow areas on the map: https://reseaux.orange.fr/projet/modernisation-telephonie-fixe
[56] ARCEP decision No°2014-1102.

communicates its timetable on PSTN shutdown, "*whatever the deadline that has been decided, in order to anticipate evolutions, enable upstream work on special services currently provided on PSTN (alarms, etc.) and allow sufficient time for the industry for visibility on their investment plans*".

ARCEP closely follows up the migration from PSTN to All-IP in order to ensure that there is no discrimination from Orange (both as an infrastructure operator and as a service provider) towards other operators. Requirements for non-discrimination include:

- obligations for Orange to communicate its work plan to other interested stakeholders;

- obligations to publish wholesale offers which third operators can use; and

- obligations in terms of prices for both end-users and access seekers.

As from 2016, ARCEP has hosted regular meetings – every 2 months – with Orange and other operators, to discuss issues and updates related to the All-IP migration. This is to ensure fair and effective competition between stakeholders as well as a proper support to end-users.

End-users will remain protected by the Universal Service Obligation that already existed in France. The Universal Service Obligation requires Orange, the universal service provider in France, to provide voice telephony to all end-users at an affordable price. The concept of "vulnerable user" does not exist in French regulation as it does in other countries. But the topic is strongly related to the USO, especially in terms of requirements for poor and disabled users.

A.4   Coordination within the industry

The date for general shut down of the PSTN is common across operators and has been set up around 2030.

As mentioned in Section A.3, multi-stakeholder meetings on this topic have been set up regularly by ARCEP. These offer an opportunity for operators to collaborate on the subject.

In order to comply with non-discrimination regulations, Orange has developed a wholesale offer called "Accès Essentiel" (access and collection on copper) which has been commercialised since the beginning in 2018. It is a substitute for the VGA ("Vente en Gros de l'Abonnement", "RTC wholesale offer") that enables third operators – particularly in low-density areas – to propose a VoIP offer (not bundled with internet access) that will replace the PSTN offer and will be based on a box or modem solution. "Accès Essentiel" is a bitstream offer at low speed, which runs over the local loop between the box on the end-user side and the telephony server on the network side.

Regarding special services using the PSTN, the FFT has played a major role. Section A.8 gives more details.

A.5   Contractual and competition issues

When faced with a "forced" migration, the end-user has the opportunity to terminate its contract with Orange and move to another operator (but not to get another PSTN offer).

The USO in France requires Orange to offer an affordable fixed telephony service to everyone throughout France But the USO relates to fixed telephony only and not to broadband. The maintenance of this universal fixed telephony service is independent of the technology used.

The State has now included within the USO the issue of the gradual shutdown of the PSTN, the switch to IP and the arrival of fibre: Within this framework Orange now proposes a universal service offer on the access networks (copper or fibre) and IP technology with the same pricing conditions as the historical offer of universal service over the PSTN.

From a more commercial point of view, migration from the PSTN to VoIP has not been used by public authorities to stimulate churn and competition. Nevertheless, some operators have attempted to use the migration as a lever for acquisition of new subscribers. In September 2018, Free (Iliad) sent an email to its shared-LLU subscribers[57], encouraging them to migrate to a full-LLU offer, because of a risk of "service interruption" when Orange migrates its PSTN lines to All-IP. Orange considered that Free's email was misleading. With the threat of legal action, Orange required Free to send an amending email and explain to its subscribers that the PSTN shut-down would not have any consequences on Free or Orange's services for the end-user. Free complied with this request.

A.6   The migration process

The technical migration

Migration to All-IP in France uses full-IP rather than PSTN emulation. When the copper line to the end-user is too long (which is not an issue for PSTN but may be an issue for VoIP), end-users are protected by the USO. Solutions like fibre, cable and satellite are then used to provide the end-user with voice telephony.

Communication programmes

Orange communicates on its institutional website about the All-IP project and the PSTN shut down[58]. It stresses the following advantages for both individuals and enterprises:

- All-IP offers a dynamic communication management depending on the device used;

- All-IP enables an enriched service offer (video-conference, documents and photo sharing, written transcription of speech, live translation, diaries and address books to be shared in real time...); and

- IP is a universal protocol used in the whole world.

Regarding specific communication programmes from operators for the general public, Orange has plans to communicate at each milestone of the project – for example in November 2018 when PSTN subscriptions cease to be sold and when the PSTN shut down date in each geographic department is decided.

A.7   Numbering and number portability

Number portability when changing contracts is an EU obligation (2002/22/CE Directive). In France, a central database is used for number portability. It is monitored by the "Association de la Portabilité des Numéros Fixes" (Association for Portability of Fixed Numbers). There are no plans to change the number portability system because of the All-IP migration.

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[57] These subscribers have a broadband subscription with Free and have kept their fixed PSTN line with Orange.

[58] https://www.orange.com/fr/actualites/2017/fevrier/Orange-modernise-son-reseau-de-telephonie-fixe-vers-le-tout-IP

A.8   Devices which deliver data over the PSTN

Devices associated with special services providers

The PSTN is used by many devices in France (fax, alarms, tele-surveillance, elevator security systems…) to send data. Ensuring that the special services and devices which use the PSTN continue to work, following the move to All-IP, is not a responsibility that has been formally defined. Nevertheless, the FFT has led on this specific issue. The FTT contacted its counterparts (Federation of Energy[59], Federation of Elevators[60], etc.) to work with them on substitution solutions. Special services working on PSTN have been reviewed one by one, and the working group has proposed solutions for each of them.

Some devices do not have to be changed (e.g. payment terminals stay the same). Most of the time only a box needs to be installed. In some cases, a special box or a special configuration of the box is necessary – for example special coding of fast DTMF used for alarms.

The FFT has published a White Paper[61] on potential malfunctions when migrating devices from PSTN to VoIP, including modem and DTMF type communications. This paper is a first set of recommendations based on the main issues identified.

In terms of additional costs, whether for special services or basic VoIP offers, migration from the PSTN may necessitate the installation of a box for VoIP (in cases where the user does not already have broadband). The cost of the box is borne by the customer. But the subscription fee for the underlying service remains the same, whatever the technology (PSTN, VoIP), based on the USO.

Devices purchased independently by end users

The end user is responsible for ensuring that such data devices work with IP networks and bears the cost of a replacement if it is required. For example, most fax machines are analogue devices and the end-user may need to reconfigure then, or purchase an adapter to connect the fax to IP lines.

A.9   Battery backup and access to emergency services

Battery backup

In France, 80% of fixed telephony devices need electric power. So, in case of power breakdown, PSTN devices do not work anyway. There is no regulatory requirement for an uninterrupted power supply to deal with this problem.

This issue was identified in the FFT in its White Paper, for the case of special services. Their recommendation is to use battery backup or inverters. But no allocation of responsibility for implementing battery backup (between the operators, the special service providers, and the end-users) has been defined.

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[59] http://www.fedene.fr/
[60] http://www.ascenseurs.fr/
[61] https://www.fftelecoms.org/app/uploads/2017/05/Livre-blanc-FFTelecoms-Fin-du-RTC-1.pdf

Access to the emergency services

When a call is made to the emergency services delivery of caller location information is not an issue. The VoIP number is attached to a code for a municipality to indicate the location of the caller.

A.10   The cost to the end-user

Service prices do not increase with the migration to All-IP. But All-IP voice may require a new box at the customer's home or office. The purchase price of a new box is borne by the customer. If the customer rents the new box instead, the monthly subscription fee may increase to cover this additional cost.

PSTN and VoIP basic monthly subscriptions have the same price of €.17.96. Calling costs are not included in this subscription fee.

In many cases, the monthly cost to the user of a PSTN package is quite high compared to another Orange All-IP broadband solution. For example the PSTN monthly subscription is €17.96 plus call costs of €0.21 per minute[62]. In contrast a basic ADSL triple play monthly subscription is €36.99. This includes the box monthly rental, ADSL broadband, Orange TV and unlimited voice calls to fixed phones.

A.11   Relevance to the UK

Figure A.2 provides a comparison between France and the UK on key market statistics which are relevant to an All-IP migration. The two are similar on these measures.

Figure A.2: France and UK market statistics

Measure	France	UK
Population	67,2m	66m
Fixed line connections	38,7m	34m
% ISDN	Low	Low
% households fixed voice but not mobile voice	7%	7%
Fixed broadband connections	28m	25m
Percentage fixed broadband[63]: incumbent retail access seekers infrastructure-based competitor	40% 49%? 11%?	37% 42% 21%
Fixed number portability technology	Central database	Call forwarding

Main sources: ARCEP, ITU, Eurobarometer, European Commission's Digital Agenda scorecard

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[62] Including calls to fixed phones in Europe, North America and overseas departments.

[63] *Incumbent retail* refers to the retail business of the incumbent operator; *access seekers* to those who buy wholesale products from the incumbent so as to provide fixed voice telephony; and *infrastructure-based competitors* means communications providers which use their own access networks to provide fixed voice telephony services – for example a cable operator.

A.12 Sources

The main sources used in compiling this case study are as follows:

- Discussion with Orange

- ARCEP file on PSTN migration[64]

- Orange update report on migration to All-IP[65]

- FFT White paper[66]

- FFT Infography[67]

- Miscellaneous reports in the French press

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[64] https://archives.arcep.fr/index.php?id=13707
[65] https://www.orange.com/fr/content/download/34336/1102578
[66] https://www.fftelecoms.org/app/uploads/2017/05/Livre-blanc-FFTelecoms-Fin-du-RTC-1.pdf
[67] https://www.fftelecoms.org/app/uploads/2017/08/fftelecoms-arret-rtc-170531-c-2.pdf

Appendix B   The German case study

See Section B11 for a comparison of the market structures in Germany and the UK.

B.1   The drivers for the All-IP migration

Deutsche Telekom AG (DTAG) is driving the All-IP migration. The stance of BNetzA is neutral[68]. The Telekommunikationsgesetz (Telecommunications Act) is predicated on technology neutrality. Therefore, there is no obligation on communications providers to offer one technology or another for their customers to access the public telecoms network, and operators can freely decide how they design their product offerings.

DTAG is making the migration to All-IP for three main reasons:

- It enables the creation of a single standardised network with substantially lower operating costs. DTAG estimates that the cost reduction is about €10 per line per year[69].

- It enables the separation of services from transmission. This enables the speedier creation of richer services for customers.

- The cost of maintaining existing TDM equipment is rising whilst the number of staff and suppliers able and willing to maintain TDM networks is declining rapidly.

B.2   The progress of the migration

DTAG

DTAG's migration started in 2014. This followed on from migrations in some Eastern Europe countries where DTAG has operations. Figure B.1 shows the progress DTAG had made outside Germany with All-IP migration as at August 2015. We are told that DTAG learnt a lot technically from its All-IP migrations in Croatia and Slovakia. Specifically these experiences:

- demonstrated that a relatively speedy All-IP migration was possible (albeit in much smaller countries than Germany);

- proved that there were significant cost reductions to be made; and

- helped overcome technical issues for the German implementation.

In contrast the end-user migration processes are specific to Germany and have involved BNetzA.

The proportion of DTAG fixed lines connections (retail plus wholesale) which use IP voice has now risen from 25% in 2014 to 47% in mid-2016 and to 77% by mid-2018. DTAG expects its migration to be completed before the end of 2019. This represents a small slippage in the deadline for completing the migration from the original

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[68] https://www.bundesnetzagentur.de/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Technik/ATRT/IPMigration/IPMigration-node.html
[69] https://www.telekom.com/resource/blob/419986/fe0573637cc1a2492ad75ab696e9c4d7/dl-All-IP-data.pdf

date of the end of 2018. This slippage reflects network and systems problems[70] rather than problems with end-user migration processes.

Figure B.1: DTAG's IP migration outside Germany – August 2015

ALL-IP TRANSFORMATION BY COUNTRY (NUMBERS IN THOUSANDS)				
	Total Voice customers August 2015	IP access lines August 2015	Areas shut down August 2015	expected completion dates
Macedonia	230	230 (100%)	22 of 22 ✓	Jan 15th, 2014
Slovakia	598	598 (100%)	50 of 50 ✓	Dec 15th, 2015
Croatia	1.110	1.076 (97%)	46 of 72	EoY 2015
Montenegro	144	130 (90%)	0 of 4	EoY 2015
Hungary	1.406	954 (68%)	25 of 67	EoY 2016
Romania	2.000	227 (11%)	0 of 96	EoY 2018
Greece	2.601	29 (1%)	0 of 190	EoY 2018
Europe	8.089	3.244 (40%)	143 of 501	EoY 2018

Other operators

There is no common date across German operators for closing the PSTN. For example Vodafone Kable, which runs the main cable network in Germany, has set a date of 2022 for completing its All-IP migration. Vodafone Kable's network is mostly VoIP already. But it also offers ISDN services and is trying to get business customers which use ISDN to switch to it so as to postpone the business's cost of migrating to All-IP.

Other fixed operators started their migration much earlier than DTAG. For example QSC (which provides services at the retail level to 40,000 customers and to many more at the wholesale level) started to migrate to VoIP in 2005/6 as it moved its core network to an NGN architecture. For the customers who rented equipment from QSC there were no additional costs. QSC kept the service price the same and paid for any equipment replacement which was necessary. It reports that customers were keen to migrate to a superior service on a voluntary basis. The migration took two years to complete and, in almost all cases, it was voluntary rather than a forced migration.

The mobile operators in Germany all offer voice over IP on their 4G networks. O2 and Vodafone launched in 2015 and DTAG in early 2016.

The nature of the DTAG IP migration

DTAG is using a hybrid approach to its migration.

For existing broadband users with voice telephony and for ISDN users, DTAG will deploy VoIP right to the premises. This means that a broadband or ISDN customer faces:

- costs for a new router (if the existing router is old and does not have an ATA);

- costs for any data over PSTN device which will not work on VoIP; and

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[70] For example network development delays, problems of missing data in the customer database, arrangements for wholesale customers.

- the need to consider whether an end-user uninterrupted power supply is required.

For existing analogue voice telephony customers DTAG uses PSTN emulation from the local exchange to the end-user. This means that the customer does not need to change terminal equipment and continues to enjoy line power from the exchange.

The forced migration for broadband and ISDN customers is done on an area by area basis. There are just under 8000 areas in Germany which correspond with the location of local exchanges.

B.3   The role of the regulator (BNetzA)

BNetzA has taken a technology neutral approach to the migration – the choice of access technology is a decision for the service provider, who is free to choose the most appropriate technology. Initially BNetzA was not involved when DTAG started the migration in 2014. But there were complaints to BNetzA (200 per month at the peak). These related mainly to poor communication by DTAG. In particular customers were not aware of the options when DTAG cancelled contracts, or the need to check whether special services or fax machines might not work following migration, or even what devices might be affected in this way. The complaints led to negative newspaper stories and even questions in Parliament.

As a result BNetzA initiated a series of quarterly meetings with DTAG and other interested stakeholders such as user groups and special service providers (but not other communications providers). There were also high-level meetings between the CEO of DTAG and the head of BNetzA. A number of actions were taken as a result of these meetings:

- DTAG and BNetzA agreed on a process for communicating with customers which started with a letter four months in advance of terminating the service. This letter was carefully worded to avoid the communications problems listed above.

- DTAG held two workshops with special service providers which were very effective.

- DTAG agreed to offer PSTN emulation to customers (mostly over 70 years old) who used analogue voice telephony lines only[71].

- DTAG setup a test centre where special service providers and device manufacturers could test their equipment to see if it worked over the IP network.

- DTAG investigated the best protocols and parameter settings for fax machines to work over the IP network. This process is still on-going.

- DTAG agreed to set up a centre to which BNetzA could refer complaints received about the migration.

These steps lead to a largely trouble-free migration. There have however been problems for:

- the data over PSTN devices used by pharmacists to order drugs; and

- rural customers who are on long copper loops of poor quality and who use old customer premise equipment. Voice calls to customers in similar circumstances are of a particularly poor quality.

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[71] There are a few areas in Germany where this was not technically possible.

B.4   Coordination within the industry

There has been no coordination within the industry. For example whilst DTAG has set a completion date of the end of 2018, one of its main rivals, Vodafone Kable, has set a date of 2022.

B.5   Contractual and competition issues

There is a requirement for DTAG to terminate its contracts with its ISDN customers when it forces migration because these contracts specify that the service is be provided using ISDN and moving to All-IP therefore breaks the contract. This gives customers an opportunity to choose their fixed line supplier afresh and has led to a small loss of customers for DTAG. We note for example[72] that DTAG's retail market share for fixed broadband connections declined by 170,000 in 2016. It is impossible to judge what proportion of this decline can be attributed to the All-IP migration.

The contracts of other communications providers (e.g. Vodafone) just say that the communications provider will supply voice telephony without specifying the technology. So there is no requirement on them to terminate the contract.

BNetzA stresses that it continues to ensure that consumer protection in relation to the provision of telecommunications service as per the Telecommunications Act is not violated in the transition process and that USO on voice service, and its affordability requirements, continue to be met.

B.6   The migration process

The DTAG process for communicating with end-users when migrating an area to All-IP is a four-step process.

- Step 1: A letter alerting the customer to the move to VoIP and spelling out its advantages (to stimulate voluntary migration).

- Step 2: A letter setting a date for termination of the service and explaining the customer's options.

- Step 3: A call to the customer to tell them of the impending switch off and asking them what they wish to do.

- Step 4: Finally a reminder letter about the termination of service.

BNetzA was involved in specifying this process and the wording of the communications. DTAG has put a lot of effort into testing the wording of these letters to minimise confusion, misunderstandings and customer loss (see Section B.3 above). The letters cover both the voice telephony service and the need to check if data over PSTN devices[73] will continue to work following the move to All-IP – for example by contacting any special service providers used. The focus here is on safety of life applications.

The forced migration steps (Steps 2 to 4) are implemented as each customer reaches the end of his or her contract with DTAG and there is then a one-month notice period.

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[72] Based on data from the European Commission.
[73] For example pendants used to call the emergency services in case of a fall.

The main sales messages DTAG emphasises in encouraging voluntary migration to All-IP (for example on its website and in its initial communication with end-users) are as follows:

- IP voice offers the same features as current ISDN services.

- In addition IP voice offers a range of new features including high definition voice [74].

- IP voice means simplified wiring in the home or office.

There appear to have been some initial problems with migration in Germany. In a report of October 2016[75] BEREC reported that:

- there were early problems with the IP migration process in Germany in terms of service interruptions, inadequate information supplied to customers, and use of fax machines; and

- these problems were resolved after BNetzA entered into a structured dialogue with DTAG and other stakeholders. This resulted in DTAG setting up a test centre for equipment using the IP network and customer communications which were expressed in a more customer friendly way.

B.7   Number portability

Germany uses a centralised database approach to number portability which has continued to work well during the migration. There are no plans to change.

B.8   Devices which deliver data over the PSTN

There are two categories of devices which send data over the PSTN and which might not work satisfactorily over an IP network:

- devices which are provided by a special service provider such as one offering security or fire alarm monitoring, or one providing remote health and social care; and

- devices which end users have purchased on their own initiative e.g. fax machines.

Neither DTAG nor BNetzA has any idea of the extent to neither which such devices are used nor how many have encountered problems as a result of the All-IP migration.

Devices associated with special service providers

As part of the process of making stakeholders aware of the All-IP migration, DTAG held two workshops with special service providers:

- The first spelt out the special service provider's responsibility to ensure that devices continue to work.

- The second went into more detail about what special service providers should do.

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[74] Available only if both parties to the call use high-definition capable devices.
[75] *Case Studies on Migration from POTS/ISDN to IP on the Subscriber Access Line in Europe*, BEREC, October 2016.

DTAG (but not other communications providers) offers a test centre for data over PSTN devices where service providers can talk to technical DTAG staff.

The responsibility for (and costs of) ensuring that data devices continue to work lies with a combination of the special service provider and the end user. Which bears the cost of any change of equipment will depend upon the contract between them. If the service charge includes a rental fee for the device, then the cost will probably fall on the special service provider. But otherwise the customer will be responsible.

Devices purchased independently by end users

Here it is the end user who is responsible for ensuring that data devices work with IP networks and who bear the cost of a replacement if it is required. Both BNetzA and DTAG, in their communications with end-users, make this point. In terms of fax machines BNetzA gives the following advice:

"*Most of the existing fax machines can continue to be used when switching to an IP-based telephone service. However, fax machines may need to be reconfigured to accommodate the technical conditions of IP technology, thereby increasing the robustness of the transmission. When fax machines and more complex fax solutions are used for business purposes, timely, expert preparation before switching to an IP- based telephone service can help prevent disruptions to business fax communications*".[76]

B.9   Battery backup and access to emergency services

Battery backup

There is no legal obligation on the operators to offer uninterrupted power supply to any group of customers. It is up to customers to decide if they need UPS and then buy a solution in the marketplace. DTAG thinks this is a minor problem in Germany – especially given that PSTN analogue lines, which are used by some of the most vulnerable sections of the community, will remain powered from the local exchange.

BNetzA shares his view. Given the reliability of the mains electricity supply in Germany, the prevalence of mobile phones, and the high level of use of ISDN connections (where power from the exchange is not available) BNetzA does not consider it proportionate to impose obligations on operators to provide uninterrupted power supply to any end users.

There is no concept of vulnerable users in Germany. But the letters sent out by DTAG (after agreement with BNetzA) do focus on safety of life applications when they stress the need for users to check that data devices will continue to work following migration.

Access to the emergency services

There are two separate issues here:

- The ability to make emergency calls during a failure of the mains electricity supply – covered under the section on battery backup above.

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[76] https://www.bundesnetzagentur.de/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Technik/ATRT/IPMigration/IPMigration-node.html

- The provision of caller-location information to the emergency services. This has not been affected by the All-IP migration. The delivery of location information with emergency calls, in which a database is accessed so as to links the callers home location information to the E164 number used, remains unchanged during the migration.

B.10   The costs to end users

The cost of migration for a DTAG customer will vary by category of end-users as shown in Figure B.2.

Figure B.2: What costs fall on end users as a result of the migration?

Costs fall on end-user for	Broadband or ISDN line	Analogue PSTN line
New router if required?	Yes	No[77]
Battery backup if required?	Yes	No[78]
New data devices?	In some cases	In some cases
Change in line rental?	Yes if better broadband package chosen	No

Note that new data devices may be required. If this is the case, then the cost will be borne by the end-user if the device is not associated with a special service provider. If the device is provided by a special service provider, then the cost is borne by some mix of the end-user and the special service provider. In the latter case it will depend on the terms of the special services contract as to who bears the costs.

B.11   Relevance to the UK

Figure B.3 provides a comparison between Germany and the UK on key market statistics which are relevant to an All-IP migration.

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[77] PSTN emulation used
[78] Line power from exchange continues

Figure B.3: Germany vs the UK

Measure	Germany	UK
Population	83m	66m
Fixed line connections	44m	34m
% ISDN	High	Low
% households fixed voice but not mobile voice	12%	7%
Fixed broadband connections	34m	25m
Percentage fixed broadband: incumbent retail access seekers infrastructure-based competitor	40% 36% 24%	37% 42% 21%
Fixed number portability technology	Central database	Call forwarding

Main sources: ITU, Eurobarometer, European Commission's Digital Agenda scorecard

Germany is 25% bigger than the UK. But in most other respects its market characteristics are similar to those of the UK. Note that ISDN take-up and the proportion of households which use mobile only are significantly higher in Germany.

Appendix C   The New Zealand case study

See Section C11 for a comparison of the market structures in New Zealand and the UK.

C.1   Drivers for All-IP migration

In interpreting this case study it is important to recognise that:

- The regulatory structures in New Zealand are different to those in the other case study countries.

- New Zealand is the only case study country where the fixed incumbent, Telecom New Zealand, has been separated into a fixed access network business (Chorus) and a retail service provider and core network operator (Spark).

The All-IP migration in New Zealand has been driven by an industry transition away from copper line access to full fibre and wireless access networks and end users migrating to these networks.

Spark, largely because maintenance of the PSTN network is becoming harder, has also started to migrate customers off legacy PSTN exchanges. As Mark Beder, Spark's Chief Operating Officer, explains: "*components are no longer manufactured, we've bought every second-hand part we can source from around the world, and people with the skills to maintain the technology are harder to find*.[79]"

Other reasons cited by operators are more user-oriented. Compared with PSTN services, All-IP will:

- improve customer experience (voice, video and collaboration features over all services: landline, mobile, video, data-based); and

- enable the development and deployment of new services in the future. M. Williams, Vodafone consumer director, says the early switch over is: "*so our customers can take advantage of the benefits of this technology as it evolves versus languishing on an outdated network*."[80]

Until relatively recently operators were not actively migrating end users to VoIP. Telecom New Zealand[81] (TNZ) was required, under modifications of the Telecommunications Act in 2006, to move 15% of its customers to VoIP by 2012. TNZ carried out a small technical trial in 2011 and the (disappointing) results were used as part of a successful effort to persuade the government to drop this obligation.

More recently there has been a significant acceleration in the migration to VoIP as demand for government funded FTTP and wireless networks has taken off. Operators have also been more active – driven largely by lifecycle issues for legacy PSTN infrastructure." In April 2017, Spark announced that it would migrate users from the PSTN to All-IP by 2022. Vodafone followed suit with a similar announcement in the same year.

C.2   Progress in the migration

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[79] https://www.sparknz.co.nz/news/pstn-upgrade
[80] https://www.stuff.co.nz/business/industries/98590931/vodafone-to-start-migrating-customers-off-pstn-next-month
[81] Structurally separated into Spark and Chorus in 2011

The overall position

The All-IP migration is one of three major migrations in the New Zealand telecommunications sector. The three are:

- The move from copper to FTTP as part of the Government's ultrafast broadband initiative.

- The move from fixed to mobile broadband. In particular rural (supported by the government funded Rural Broadband Initiative, a mobile centric plan) and low-volume data households are moving to LTE based connections, both fixed and mobile, and fixed IP migration is not relevant to these households.

- The All-IP migration and closure of the PSTN.

The operator lead migration to All-IP started in 2017. There are currently just over 1.7 million fixed line connections and this number is declining slowly as households move to mobile only. Just over 550,000 of these lines used FTTP by Q2 2018. Adding in other technologies brings the total to over 600,000 VoIP-based fixed connections. This number is growing rapidly as illustrated in Figure C.1. There is an expectation that over 1 million of New Zealand's fixed line connections will use FTTP by 2022. All of these lines will use VoIP.

**Figure C.1: Fixed broadband connections by technology**
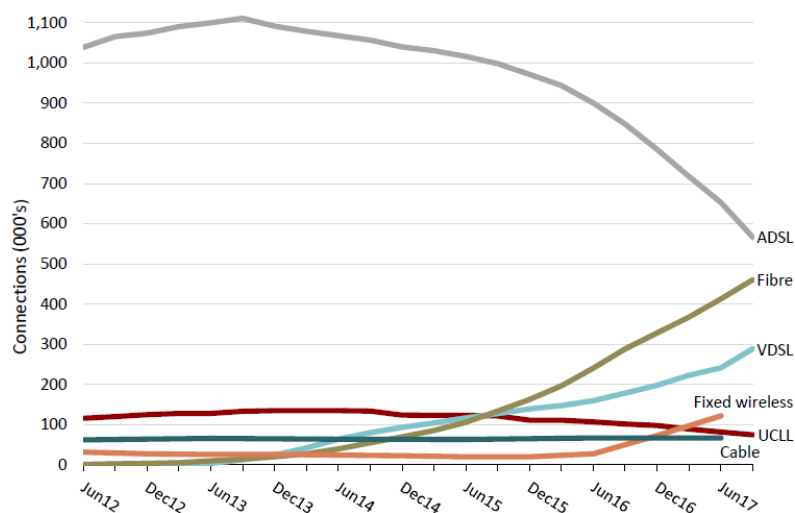
Source: Chorus, MBIE, annual telecommunications questionnaire

Source: Annual telecommunications monitoring report 2017 Key facts, Commerce Commission

The approach to migration by the main operators

Spark, Vodafone and Vocus are the three main retail communications providers (or retail service providers as they are known in New Zealand). Their market shares (measured for fixed broadband) are shown in Figure C.2.

Figure C.2: Market shares in the fixed broadband market
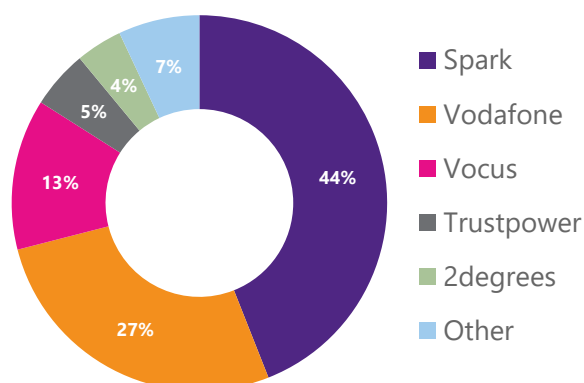
In addition Chorus provides fixed access network services on a wholesale basis to these retail service providers. It has an obligation to provide a network input service across New Zealand under universal service arrangements[82]. Spark uses this service to meet its universal service obligations. In addition Chorus supplies FTTP on a monopoly wholesale basis to most areas of New Zealand and local fibre companies supply FTTP to the remaining areas.

Spark started to migrate PSTN customers to its IP-based voice network, dubbed the 'Converged Communications Network' (CCN), in 2017 when it decommissioned 10 small rural exchanges serving 3000 customers (out of the 482 PSTN exchanges). Spark's COO stated that disruption to customers had been minimal and that "*the migration {had} entailed a small outage of a few minutes, scheduled during off-peak times for residential customers*." Spark also reported no material impediments to migrating customers. According to a presentation made to investors in 2017 there were only four problems – all involving a dial-up EFTPOS terminal[83]. A Commerce Commission contact confirmed that no particular problem had arisen from the first 10 exchanges decommissioned by Spark, the operator having used a fairly mature technology there.

By June 2018 Spark had decommissioned 72 local exchanges representing 10% of lines and by the end of the 2019 financial year it plans to decommission a further 100 exchanges. The migration is scheduled for completion by 2022 using a phased migration with key platform and capability decisions expected by 2020.

Migration plans for ISDN services are slightly different. Most ISDN use in New Zealand is for primary rate access from PBXs. Here there will be no new sales from 2019 and the plan is to move all ISDN PRA connections to SIP by 2020.

In addition market lead migration is rapidly reducing the scale of the problem of PSTN closure. In 2016 16% of Spark's broadband customers used FTTP or LTE-based network access rather than the PSTN for voice telephony services. By mid-2018 this proportion had risen to just over 50%.

Vodafone is in a similar position to Spark and plans closure of its PSTN using the same approach as Spark by 2022. In contrast Vocus has built its network using VoIP from the start and so does not need to migrate its customers.

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[82] Universal service obligations in New Zealand require Chorus to provide an access network (wireless, copper or fibre) to enable users to access to a voice telecommunications service. Spark then has an obligation to provide a standard residential voice telephony service at the retail level. But these obligations are limited only to residential premises which were connected as at 2001. The obligation is not an obligation to connect per se.
[83] *Introducing the converged communications network - Presentation to Investors and Stakeholders*, Spark, 19 April 2017

C.3   The role of the regulator and the government

The telecommunications regulator in New Zealand, the Commerce Commission, has so far played little role in shaping the All-IP migration. There are two main reasons:

- New Zealand telecommunications legislation works on the basis of technology neutrality. So, if an operator wants to move its customers from TDM switching to All-IP, the regulator forebears from intervening.

- The Commerce Commission has a primary duty to preserve competition through the administration of the Competition Act and the Telecommunications Act. It also administers the Fair Trading Act, a piece of general consumer protection legislation. There is little in the way of telecommunications specific consumer protection regulation, as the presumption is that outside of generalised trading laws, competition will deliver consumer benefits. However, where the Commission or the telecoms industry determine that specific processes or rules are needed to ensure appropriate engagement with consumers, such as the move from copper to fibre, the telecommunications operators may develop an industry code through the auspices of the NZ Telecommunications Forum (TCF).[84]

The Government is amending the regulatory framework for telecommunications in New Zealand[85] This will give the Commerce Commission powers to:

- Monitor industry retail service quality and set compulsory industry codes.

- Approve a copper withdrawal code setting out minimum consumer protection requirements for end-users where Chorus proposed to withdraw copper services.

- Make a mandatory emergency service code to ensure that vulnerable consumers have a reasonable means to contact emergency services, at no cost to themselves, in the event of a power failure. The Commission will define the details of the code and who constitutes a vulnerable consumer.

It is as yet unclear what implications this consumer regulation will have on VoIP services.

C.4   Coordination within the industry

Most of the retail service providers (including Vocus and Vodafone) currently buy PSTN-based voice telephony from Spark on a resale basis. But they are now moving to purchase a baseband IP service from Chorus or use their own technologies to provide voice telephony when customers move to VoIP. On the face of it, the industry is working to a common date for completion of the All-IP migration. But the decision on this date has been taken independently by each operator.

C.5   Contractual and competition issues

Migration from PSTN to All-IP does not require the termination of contracts (as it does for many DTAG customers in Germany). Nor are we aware of any competition issues.

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[84] An industry body, of which all the main operators are members, www.tcf.org.nz
[85] See Telecommunications (New Regulatory Framework) Amendment Bill, https://www.parliament.nz/en/pb/bills-and-laws/bills-proposed-laws/document/BILL_74818/tab/digest. It is expected that this bill will become during 2018

C.6   The migration process

During its initial phase, the closure of the PSTN is based on a passive migration whereby there is PSTN emulation from the end-user to the line card, which is typically located in the cabinet, and IP from then on in an NGN core. This passive migration is used for both analogue voice telephony lines and copper lines which combine voice telephony and ADSL or VDSL-based broadband. Passive migration means that:

- there is no need for the end-user to change equipment; and

- the end-user continues to enjoy power from the network (for voice telephony).

The PSTN emulation is provided by Chorus's Baseband IP copper service which is sold on a non-discriminatory basis to all retail service providers including Spark.

Spark recognises the need to minimize end-user impact during and following the migration of PSTN exchanges[86]. It says that:

- There might be a small outage of a few minutes during the day at off-peak times for residential callers (between 9.00am and 2.00pm).

- There is a check for active 111 calls (calls to the emergency services) before cutting over.

- There is a scan for high-risk customers (e.g. medical alarms).

- Services are immediately restored once connection to IP has been established.

For the 3% of landlines that are not covered by broadband customers there have the following options:

- to use a retail service provider which uses a Chorus baseband service;

- to use a fixed wireless service supplied by wireless providers or under the Rural Broadband Initiative; or

- to use a fixed or mobile voice service provided by one of the mobile networks.

Communication with end-users on the subject of migration to All-IP is part of the responsibilities of each operator. Each retail service provider (e.g. Spark, Vodafone, and Vocus) is required to spell out the consequences of going to All-IP through its retail sales channels[87]. This includes making end users aware of UPS issues where appropriate. In practice operator communication to date relates primarily to voice services over broadband or fibre, since PSTN emulation is used for analogue PSTN lines and this minimises end-user impacts and the need for communication.

C.7   Number portability

Number portability is implemented in New Zealand through a synchronized and centralised database run by a consortium of the operators (established by the Number Administration Deed, NAD[88]). This system is expected to work well during the migration and there are no plans for change.

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[86] As set out in Spark's presentation introducing the Converged Communications Network of April 2017
[87] See for example http://help.vodafone.co.nz/app/answers/detail/a_id/28629/~/about-upgrading-to-voice-calling-over-broadband-%28voip%29
[88] NAD https://www.nad.org.nz/

C.8   Data over PSTN devices

Spark is working closely with providers of data over PSTN devices[89] (including special service providers or SSPs) to help ensure that these devices continue to work on All-IP. In particular device suppliers can use the Spark laboratory to test their equipment. Chorus also runs a laboratory in Auckland to test data devices using VoIP networks. It is worth noting that:

- There is a growing alignment of interests here between the communications providers and the SSPs as the latter move their service platforms from analogue to IP technology.

- Spark does not fund any replacement of data over PSTN devices. This is up to the SSP and/or the end-user. Typically, the conversion involves inserting a card which costs around NZ$100.

Retail service providers work closely with SSPs to ensure customer devices are compatible with the All-IP network. There are some potential problems here. For example Spark indicates that there might be problems with medical and house alarms, legacy decoders, old EFTPOS terminals, and old PABX systems[90].

C.9   Battery backup and access to emergency services

Battery backup

There is no requirement on operators to provide battery backup. Operators are required by TCF industry codes to explain the implications of taking services which rely on power at the home and customer options, i.e. Emergency Services Calling Code and Product Disclosure Code. The general principle is that, if there is a mains power outage, customers can use their mobile phones or, if they judge it necessary, purchase battery backup for themselves.

The TCF is further in the process of developing the *Vulnerable End User Code*[91], a voluntary industry code which it expects to be finalised in December 2018. The code defines a vulnerable user as a person *"...dependent on a telecommunications service for their wellbeing"* and proposes that there be an obligation on RSPs to inform vulnerable end users of the impact of a power outage on broadband based voice calling. Additionally, there is a bill being developed in Parliament which is likely to require some form of uninterrupted power supply to be provided for vulnerable users when contacting the emergency services. See also the section above on the role of the regulator government.

Location information for the emergency services

The All-IP migration is not creating any obvious problems in terms of sending location information to emergency services with either PSTN emulation or a move to FTTP. There is a code for emergency voice calling services[92] which was developed by the TCF[93]. This requires:

- fixed service providers to deliver call location information to the emergency services;

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[89] Such as alarms and EFTPOS terminals.

[90] *Introducing the converged communications network - Presentation to Investors and Stakeholders*, Spark, 19 April 2017

[91] https://www.tcf.org.nz/industry/workstreams/current-projects/vulnerable-end-users/tcf-vulnerable-end-user-code-for-public-consultation-aug-2018.pdf

[92] Code for Emergency Voice Calling Services ("Emergency Calling Code"), TCF, May 2015.

[93] Of which all the main retail service providers in New Zealand are members.

- nomadic fixed service providers to indicate that the location information might be unreliable; and

- mobile operators to provide customer information.

Mobile network operators and emergency services have recently deployed mobile caller location capability which provides more accurate caller location information using GPS and tower location.

C.10   The cost to the end-user

Generally, existing PSTN customers will not incur costs when migrating voice services to All-IP where the migration is based on PSTN emulation. There may however be cost for customers who need to upgrade legacy data over PSTN devices. See for example the website[94] for what Spark tells customers who are contemplating an upgrade to FTTP.

C.11   Relevance to the UK

Figure C.3 provides a comparison between New Zealand and the UK on key market statistics which are relevant to an All-IP migration. The split of fixed broadband between different categories of suppliers is a Plum estimate.

Figure C.3: New Zealand vs the UK

Measure	New Zealand	UK
Population	4.7m	66m
Fixed line connections	1.7m	34m
% ISDN	Low	Low
% households fixed voice but not mobile voice	Na	7%
Fixed broadband connections	1.6m	25m
Percentage fixed broadband: incumbent retail access seekers infrastructure-based competitor	44% 40%? 16%?	37% 42% 21%
Fixed number portability technology	Central database	Call forwarding

Main sources: ITU, Eurobarometer, European Commission's Digital Agenda scorecard

New Zealand is much smaller than the UK. Once corrected for this difference in scale, most market characteristics are similar. Key differences include the fact that the fixed access network business of the incumbent is structurally rather than legally separated, much of the consumer protection regulation imposed by Ofcom under its General Conditions are left to generalised consumer protection legislation or addressed through industry codes developed by the TCF, and the use of a central database rather than call forwarding for number portability.

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[94] Go to https://www.spark.co.nz/shop/landlin and look at fibre phone connections FAQs

C.12 Sources

The main sources used in compiling this case study are as follows:

- Teleconference calls with Spark and the Commerce Commission.

- Annual telecommunications monitoring report 2017 - Key facts, Commerce Commission.

- Final report on whether Spark's Resale Services should be omitted from Schedule 1 of the Telecommunications Act 2001, Commerce Commission, December 2016.

- Code for Emergency Voice Calling Services, New Zealand telecommunications Forum, 2015.

- Code for Broadband Product Disclosure Information, New Zealand Telecommunications Forum, 2013.

- Miscellaneous reports in the New Zealand press.

Appendix D   The Swiss case study

See Section D11 for a comparison of the market structures in Switzerland and the UK.

D.1   Drivers for the All-IP migration

Swisscom, the incumbent operator, has driven the All-IP migration in Switzerland and set the project timeframe. The reasons given for encouraging this migration are:

- Cost reductions: the PSTN is an end-of-life service, it has become more and more difficult to maintain – know-how and spare parts are increasingly scarce, and more and more costly – while the number of breakdowns increases.

- Improved services: Digitization enables more flexible and continuous communication services, as well as simplified collaboration and mobility.

- Economic momentum: From a wider point of view, full digitization of communications is a "necessary condition" for productivity improvements and economic growth.

D.2   The progress in the migration

Swisscom started migration in 2014 on an area by area basis, and had planned to complete its All-IP migration by end of 2017. This date has now moved to the end of 2018 for consumers and September 2019 for business customers. The extension of the migration period has allowed Swisscom to create "a balanced volume [of migrations] for fulfilment and installation".

In 2014, 3 million customers were using PSTN/ISDN telephony and 913.000 VoIP[95], when Swisscom announced that they were starting a progressive migration towards VoIP, through a program called "All-IP". From then on, all new subscribers got an All-IP offer. By 2016, around 33% of subscribers used VoIP[96].

The current state of the migration is as follows:

- Since the beginning of 2018, Swisscom's consumer customers in the early migration areas had already switched to IP. By the end of 2018, consumers in all regions will have switched completely to IP.

- By mid-2018, the first four major regions had been converted for Swisscom's business customers. In the remaining regions, smaller business customers will switch completely to IP by the end of March 2019 while larger business customers will switch to IP by the end of September 2019.

- As at October 2018 there were 180,000 lines left to migrate – that is Swisscom's migration was 93% complete.

- UPC Cablecom, the cable operator, had already built its fixed networks as All-IP from the start.

- Sunrise, the other main operator in Switzerland, depends to a large extent on PSTN-based wholesale products from Swisscom to offer voice services. These customers will migrate to All-IP over the same

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[95] Source: Ofcom Switzerland.
[96] Source: BEREC report, October 2016, Case studies on migration from POTS/ISDN to IP on the Subscriber Access Line in Europe.

timescales as Swisscom's retail customers. But Sunrise also offers its own PSTN access to customers. It has not yet announced when these will migrate to All-IP.

Migration from PSTN in Switzerland has been done using full voice over IP. As described in the BEREC report (2016) and in Figure D.1 "*during the migration phase from Subscriber Access Line based on POTS/ISDN to VoIP-based SAL, the following steps need to be taken simultaneously:*

- At the central office: The Subscriber Access Line (SAL) needs to be disconnected from the local exchange and connected to the multi-service access node (MSAN).

- 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. "

This form of migration applies to all fixed line customers including those who use only analogue voice telephony connections. Swisscom has developed a router with analogue ports especially for single line connections[97]. This has proved popular with end-users. When needed it is supplied free of charge to end-users. For an additional CHF89 the customer can also purchase an uninterrupted power supply[98] if required as an optional extra. Elderly customers are also entitled to a free home visit to install the new equipment.

Figure D.1: Migration from subscriber access line based on POTS/ISDN to VoIP-
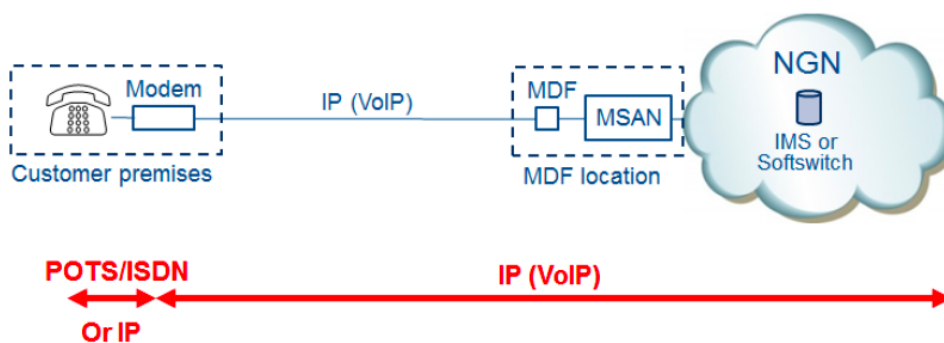
Source: BEREC 2016

D.3   The role of the regulator (OFCOM)

The OFCOM (Federal Office of Communications) has remained largely on the side-lines during the migration of the PSTN to All-IP. Two main reasons might have led to the fact that OFCOM intervention was not needed:

- A "natural" substitution of fixed networks by mobile networks has progressively happened in Switzerland, leading to a steady decline of fixed telephony traffic since the sector liberalisation in 1998[99].

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[97] Internet box light
[98] Developed with Schneider Electric
[99] Source: Ofcom Switzerland.

- No issue or service interruptions were reported during the initial migration phase[100] (BEREC report, 2016).

In addition, the OFCOM can rely on the fact that Switzerland has introduced a Universal Service Obligation (USO) for basic broadband, while maintaining it for publicly available telephone services, which takes account of the All-IP migration.[101] As well as requiring Swisscom to provide affordable basic voice telephony and broadband services, the new USO also requires that, until the end of 2021, Swisscom must provide an interface for analogue and ISDN equipment free of charge at the network termination point, to allow sufficient time for terminals to be replaced following the All-IP migration.

D.4   Coordination within the industry

There is no formal coordination within the telecommunication industry in Switzerland around the issue of migration from PSTN to All-IP. But Swisscom tells us that it has shared its findings on data over PSTN devices with other operators on an informal basis.

D.5   Contractual and competition issues

When faced with a forced or passive migration, Swisscom customers can terminate their contract without penalty. Swisscom has found that the migration has led many large business customers not to replace contracts for single PSTN lines with VoIP lines

Migration from PSTN to All-IP has been used by non-incumbents to attract new customers, through their corporate communication. For example the UPC (Cablecom) website states: "*The right time to switch to IP telephony from UPC. This year, all households which are still using analogue telephony from Swisscom will need to switch to digital fixed network technology (called IP telephony or VoIP). Make sure your home is safe with us by making the easy switch – our customers already love making calls with our fibre optic technolog*y."

D.6   The migration process

Swisscom has been the main party in communicating with end-users on the subject of All-IP migration. The incumbent operator has communicated about the need for the migration and provided instructions to end-users on how to deal with the migration. Its website gives explanations to end-users and details the major steps to be taken in moving to All-IP.

The overall number of PSTN/ISDN connections is decreasing, Figure D.2 shows the position up to 2016. By October 2018 93% of Swisscom customers had migrated to All-IP.

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[100] BEREC report 2016

[101] A Universal Service Obligation was awarded by the ComCom to Swisscom for the period 2018 to 2022.

Figure D.2: Fixed telephony: Number of customer contracts
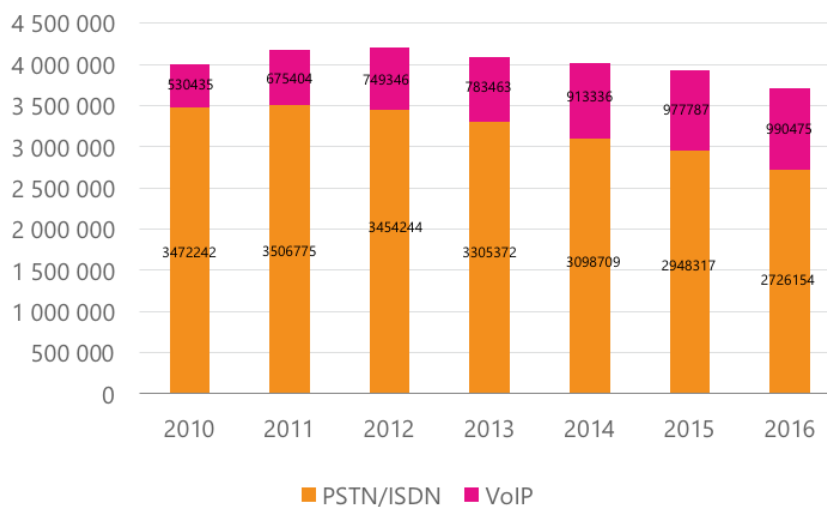
End-users have been encouraged to migrate as early as 2014, based on some key sales messages:

- Private customers can easily switch to All-IP, while continuing to use their existing devices.

- They can then enjoy the most-advanced technology and IP -based services such as HD voice quality, easy phone number blocking, automatic display of caller's name, etc.

- Business customers can enjoy a permanent access to their data and documents, independently of the place they work. Online conferences offer savings opportunities for companies.

- Swisscom has published the following list of advantages provided by the All-IP system

  − call filtering for protection against unwanted advertising calls

  − HD voice quality

  − personalized blocking lists

  − the display of the name of all the numbers registered on www.local.ch

  − the possibility to conduct two conversations simultaneously.

- With "Swisscom Line plus", customers can make unlimited calls for a monthly flat fee, without needing to subscribe to Internet or TV services.

In addition Swisscom has encouraged coincidental or voluntary migration by consumers by launching its TV over broadband service only on its VoIP broadband products. However it has found that, while many business customers have migrated voluntarily, there are a significant number who only respond to a forced migration.

D.7   Numbering and number portability

Number portability in Switzerland uses a central database operated by Teldas for the routing of calls to ported numbers. This system has continued to function well during the migration period and there are no plans to change it.

D.8   Devices which deliver data over the PSTN

Devices associated with special service providers

Swisscom underlines that special attention must be paid to services like alarm and home automation systems, fire alarms, mailing machines, payment devices, and elevator phones. In particular it recommends that customers notify their alarm service provider about the switchover beforehand, in order to avoid unintended alarm signals during the process.

A large proportion of alarm systems are already mobile-based or IP-based and these are not impacted by the migration. In addition some systems only have a local alert (sound or light signal). Nevertheless, IP-compliance of the systems must be checked case-by-case and for some applications, the process is simple, as it is only about changing the transmission device[102].

Swisscom has published recommendations for each type of service. For example:

- "For owners of elevators: Ask the lift service provider for migration to mobile telephony: Swisscom recommends the migration of all communication systems of elevators to a mobile-based system to be done by the elevator service provider, without delay. The mobile telephony is proven, a place is served generally by several antennas and the latter are generally equipped with a power supply backup and will continue to run for one hour in the event of a large power outage. An IP fixed telephony solution is offered as an alternative to customers who do not want to migrate their analogue elevator phones to a mobile phone solution. It includes: IP fixed telephony, UPS (uninterruptible power supply with battery) for router power supply in case of local power failure and automatic computer failover on mobile phone (in case of failure of fixed telephony, calls are diverted to the mobile telephone network with the possibility of extension of the antenna). As an option, Swisscom offers installation by a service technician for a flat rate." Swisscom has also cooperated closely with Schindler[103] on the migration of lift telephones to All-IP.

- "For owners of alarm systems: Ask the service provider for the most appropriate solution (double transmission IP/mobile is the most secure one and the only authorized one for mandatory alarm systems; mobile-only systems or IP-only systems are relevant for most alarms."

The end-user bears the cost of migration of his/her special service. When migrating their current system to fixed All-IP or to a mobile service, there were no end-user complaints reported.[104]

Devices purchased independently by end users

Swisscom also provides recommendations for fax users:

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[102] Source: Swisscom
[103] Which holds a 50% share in the lift market in Switzerland
[104] Source: BEREC report

- "In general, fax machines can still be used after switching to IP telephony. Analogue fax machines can be connected directly to the router, just like fixed-line telephones. The number of digital solutions, such as fax services over e-mail, are also increasing.

- Faxes and other modulated services in the voice transmission bandwidth do not have the same level of reliability in the IP environment.

- To business customers: If an analogue fax machine must be used, please note that Swisscom cannot guarantee that it will be possible to transmit faxes. The reasons for this are the variety of parameters of the IP network, which are network and location-specific and could possible cause issues with fax transmission. This is why, for the transmission of business-critical data, we recommend switching to a new solution."

Assuming that analogue communication services will disappear from the market in the medium to short term, the incumbent proposes to its business customers a ZeroFax Business solution, which is an alternative for sending and receiving fax documents (Combox® pro).

D.9 Battery backup and access to emergency services

Battery backup

This IP fixed telephony service can include a UPS (Uninterruptible Power Supply) for the router power supply. While the router is supplied without charge if required, the user pays CHF89 for a UPS if required.

In addition to UPS, an option of automatic switching is offered by Swisscom: In case of local power breakdown, calls can be automatically switched to the mobile network. With this option, Swisscom primarily targets elevator operators, property managers and property owners. Other target groups include special service providers and users of emergency call devices (such as remote alarm devices for the elderly). In case of emergency, this option ensures with high reliability the guarantee of a contact by a backup telephone thanks to the double security, even in case of network power failure. The end-user bears the cost of this automatic switching option.

Access to the emergency services

The issue of mains power failure is dealt with above.

There are no problems in delivering caller location information to the emergency service call centres at least for Swisscom, which operates a central database that contains both location information and IP addresses. This database is used to deliver the required information to the emergency services.

D.10 The cost to end-user

In principle end-users bear the customer premises equipment costs of switching to an All-IP service, whereas Swisscom bears the network cost of investment for IP-migration.

For most basic Internet and telephony services, Swisscom provides the equivalent service for the same price. For instance, fixed telephony subscriptions are sold at a price of CHF25.25 (£19.47) plus a call cost per minute

(Swisscom Line Basic[105]) and at CHF39.50 (£30.90) with calls to national fixed/mobile phone included (Swisscom Line Plus[106]):

There are no additional costs for any normal installation that the customer can carry out himself. If a new router is needed, it is delivered for free (and automatically sent when a new subscription is taken). But special terms apply for removing ISDN systems.

D.11 Relevance to the UK

Figure D.3 provides a comparison between Switzerland and the UK on key market statistics which are relevant to an All-IP migration. The Swiss market is clearly substantially smaller than that of the UK and the incumbent faces significantly stronger infrastructure-based competition from cable.

Figure D.3: Switzerland vs. the UK

Measure	Switzerland	UK
Population	8,5m	66m
Fixed line connections	3,9m	34m
% ISDN	High	Low
% households fixed voice but not mobile voice	Na	7%
Fixed broadband connections	3.7m	25m
Percentage fixed broadband: incumbent retail access seekers infrastructure-based competitor	53% 7% 40%	37% 42% 21%
Fixed number portability technology	Central database	Call forwarding

D.12 Sources

The main sources used in compiling this case study are as follows:

- Discussion with Swisscom

- BEREC report, October 2016, Case studies on migration from POTS/ISDN to IP on the SAL in Europe

- OFCOM CH website[107]

- Swisscom website[108]

- Miscellaneous reports in the Swiss press

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[105] https://www.swisscom.ch/content/dam/swisscom/de/res/public/tv-internet-festnetz/festnetz/swisscom-line-basic-2018-06-en.pdf
[106] https://www.swisscom.ch/content/dam/swisscom/de/res/public/tv-internet-festnetz/festnetz/swisscom-line-plus-2018-06-en.pdf
[107] https://www.bakom.admin.ch/bakom/en/homepage.html
[108] https://www.swisscom.ch/en/residential.html