

Section 7

Security and resilience

Overview

- 7.1 As consumers and businesses become even more dependent on communications services, our duties with regard to network resilience become increasingly important. Overall, whilst network failure incidents are not significantly increasing in volume or impact, underlying changes in network technology have implications for consumers that need an appropriate regulatory and policy response. This section summarises the major security and resilience issues that were reported to Ofcom over the past year and the key issues that need addressing in the near future.
- 7.2 Key themes are:
- 7.2.1 The majority of security incidents reported relate to **voice services**, often affecting consumer access to the 999 emergency services;
 - 7.2.2 The majority of incidents are caused by the **failure of hardware components, the loss of power supply or by software bugs**;
 - 7.2.3 Incidents with an impact above one million customer-hours are uncommon, and are often the result of a **unique and unexpected threat to security**;
 - 7.2.4 The next few years will see a fundamental change in how voice telephony services are delivered, **as obsolete PSTN⁵² legacy systems are replaced by new VoIP⁵³ solutions**. This process will bring benefits to users but it is important that it is managed in a way that minimises disruption to consumers. We outline a number of key principles that should be followed to ensure minimum disruption for consumers and businesses: that providers must communicate the migration process clearly to their customers and that no voice service users are worse off after the technology change, either financially or functionally.
 - 7.2.5 Mobile networks are increasingly important both as the main general communications channel for many users and the first choice for calls to emergency services. In this context, **the current level of resilience of mobile networks, particularly to mains power outages, is an increasing concern**. There will be a need for more focussed activity in this area involving Ofcom, Government and industry as part of the programme of securing and making key elements of critical national infrastructure more resilient.

⁵² Public Switched Telephony Network

⁵³ Voice over Internet Protocol

Our role in security and resilience

Ofcom and providers of communications networks and services are subject to certain requirements⁵⁴. These include requiring operators to appropriately manage security risks, to minimise impacts on consumers and to report any breaches of security or network failures to Ofcom.

We first published guidance on the full range of security requirements in May 2011 and updated that guidance in August 2014. We are in the process of updating the guidelines⁵⁵. The guidance sets out our expectations for a risk-based approach to the management of security. It highlights appropriate sources of industry best practice and details our incident reporting requirements.

Aside from these specific requirements, digital terrestrial television (DTT) operators have an obligation⁵⁶ to meet high standards of reliability and to provide us with an annual report on transmission performance.

Reported fixed and mobile incidents

- 7.3 The majority of security incidents reported relate to voice services, often affecting consumer access to the 999 emergency services
- 7.4 In the past year, 581 security incidents were reported to us by fixed and mobile providers. The vast majority of reports were from fixed providers regarding disruption to telephony services (including 999 access) for fewer than 10,000 customers and for less than one day. Incidents with a wider impact, which affect tens of thousands of customers, are less common. Reporting data also show that incidents are more likely to occur in, or near, large population centres.
- 7.5 Figure 31 summarises the number of incidents reported each month between September 2015 and August 2016. The monthly variation could be the result of seasonal factors such as weather or school holidays. We continue to monitor for trends over time.

⁵⁴ In accordance with Article 13a of the Framework Directive, sections 105A-D of the Communications Act 2003 place requirements on providers and Ofcom regarding the security and resilience of communications networks and services.

⁵⁵ <http://stakeholders.ofcom.org.uk/binaries/telecoms/policy/security-resilience/ofcom-guidance.pdf>

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http://stakeholders.ofcom.org.uk/binaries/broadcast/guidance/techguidance/tv_tech_platform_code.pdf

Figure 31: The number of incidents reported between September 2015 and August 2016

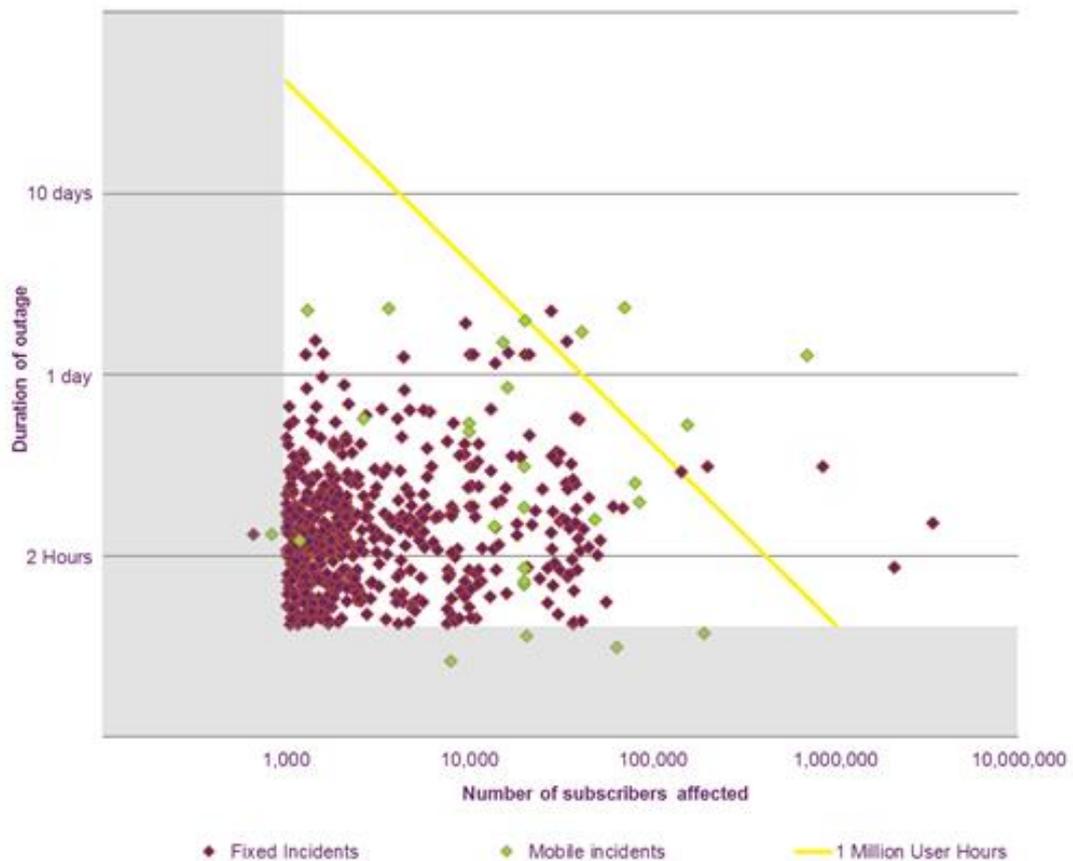


Source: Ofcom analysis of operator data

Scope of Ofcom reporting guidance/ framework

- 7.6 Ofcom's guidance provides quantitative criteria, or thresholds, against which a provider can gauge the impact of an incident and determine if it should be reported. The most critical is the 'emergency services access' threshold which applies to incidents that affect voice access to the emergency services for 1000 customers, for one hour. There will be incidents that occur but which are not reported to us, since they do not have 'significant impact' as defined in relevant guidance.
- 7.7 We measure the impact of an incident in 'customer-hours'. This is the product of an incident's duration and the number of consumers affected. While customer-hours is not the only metric by which incidents may be measured, it provides a useful basis for comparison. Figure 32 shows the customer-hours impact of the 581 incidents reported to Ofcom.

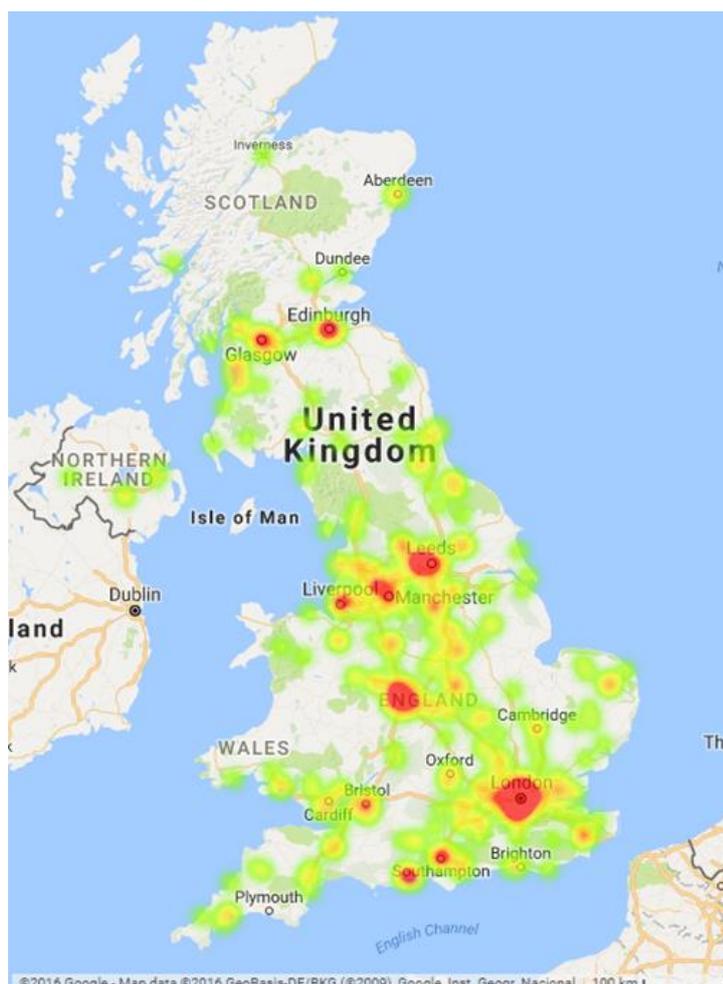
Figure 32: The impact of incidents reported to Ofcom, between September 2015 and September 2016



Source: Ofcom analysis of operator data

- 7.8 The majority of incidents have a relatively low customer-hours impact and are reported under the 'emergency services access' threshold.
- 7.9 Of the 581 reported incidents, 548 affected fixed networks and 33 affected mobile. The difference between these figures is explained by the emergency roaming agreement in place between mobile operators. This means that mobile operators have significant resilience in place for emergency service availability and therefore do not report often under the 'emergency services access' threshold.
- 7.10 Our revised guidance, published in August 2014, places a particular emphasis on receiving more incident reports from the mobile sector, given the growing importance of mobile services to consumers.

Figure 33: Heat map showing the distribution of incidents throughout the UK



Source: Ofcom analysis of operator data

7.11 Figure 33 shows how the 581 incidents are geographically distributed across the UK, and reveals that there is a correlation between incident frequency and population density. Where population densities are higher, a higher concentration of network equipment, or assets, is required to provide services.

7.12 It is logical to expect that where there are more assets, there is a greater likelihood of incidents. However, our minimum incident threshold of 1,000 end-users affected may result in some rural incidents not being reported.

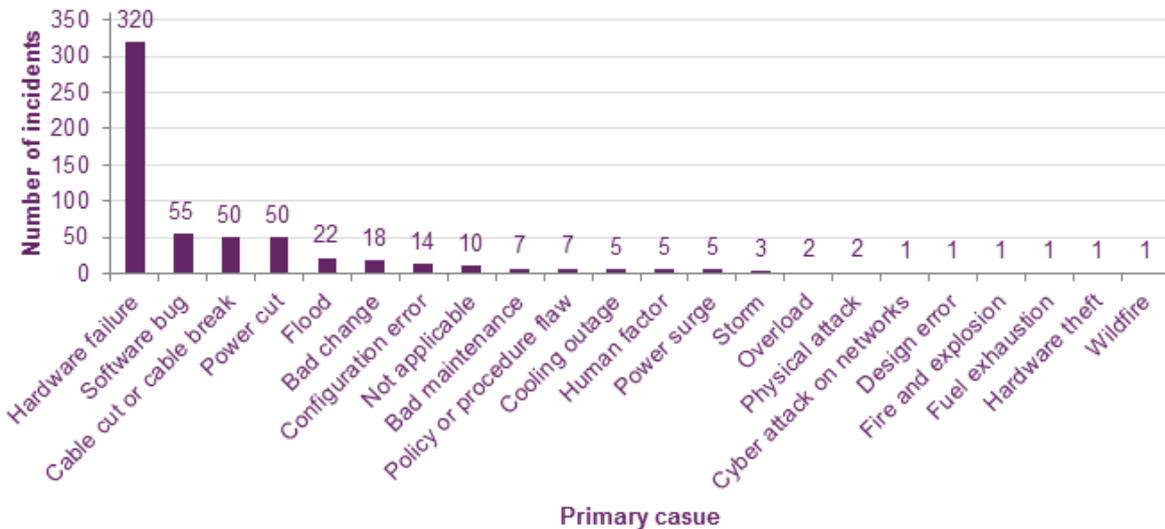
The majority of incidents are caused by the failure of hardware components, the loss of power supply or by software bugs

7.13 Establishing the root causes of incidents is central to understanding risks to the security and resilience of networks and services. System failure is overwhelmingly the root cause of significant network incidents; over 89% of reported incidents fall into this category. This includes hardware and software failures, and the failure of systems, processes and procedures.

7.14 The remaining categories are human error, natural phenomena (which includes severe weather) and malicious actions, which were responsible for 5%, 5% and <1% of the reported incidents, respectively.

7.15 Figure 34 shows that incidents were reported against a wide range of primary causes⁵⁷ 'Hardware failure' is the most common primary cause, followed by 'software bug', 'power cut' and 'cable break'. Together these causes account for over 80% of the incidents that are reported to us.

Figure 34: Primary cause of incidents reported to Ofcom, September 2015 to August 2016



Source: Ofcom analysis of operator data

Incidents with an impact above one million customer-hours are uncommon, and are often the result of a unique and unexpected threat to security

7.16 The European Union Agency for Network and Information Security (ENISA) is a centre of network and security expertise for the EU. ENISA provides guidance⁵⁸ on the reporting of security incidents. This includes the requirement for national regulatory authorities, such as Ofcom, to report annually on incidents with a significant impact; this is defined as those incidents with an impact above one million customer hours.

7.17 In the reporting period of September 2015 to August 2016 there were 10 incidents which met this threshold: three affected mobile networks and seven affected fixed networks. System failure is still the main root cause, at 70%.

⁵⁷ We categorise the root and primary cause of reported incidents according to the taxonomy provided in the ENISA Article 13a Technical Guideline on Threats and Assets, https://resilience.enisa.europa.eu/article-13/guideline_on_threats_and_assets

⁵⁸ ENISA Technical Guidance on Incident Reporting. https://resilience.enisa.europa.eu/article-13/guideline-for-incidentreporting/Article_13a_ENISA_Technical_Guideline_On_Incident_Reporting_v2_1.pdf

Evolution of voice services

The way that voice services are being delivered is changing

- 7.18 Internet-based providers such as Skype and WhatsApp are already offering consumers low-cost calls, usually coupled with additional features such as messaging or photo and video sharing. Many businesses are exploiting the reduced costs and enhanced capabilities of voice-over-IP (VoIP) technology. In response, traditional communications providers are looking to improve the services that they offer.
- 7.19 At the same time, the Public Switched Telephone Networks (PSTN) that have traditionally delivered voice services are coming to the end of their economic life. Globally, it is becoming increasingly difficult to maintain them, as the availability of spare parts and the engineering knowledge to effect repairs reduces.
- 7.20 Different communications providers are at different stages of managing this process:
- 7.20.1 BT is planning to fully migrate customers off its PSTN network by 2025 and is currently trialling the first IP-based voice services that will replace those offered by the PSTN. It is expecting to start piloting a range of new services in late 2017 leading to a full commercial launch thereafter.
 - 7.20.2 Virgin Media is deploying fibre to the home under Project Lightning between now and 2019 and we can expect it to move to the adoption of IP voice services to replace its current PSTN based offering.
 - 7.20.3 KCOM expects around three quarters of its network will have ultrafast capability by the end of 2017 under its Project Lightstream. Consequently, we would expect introduction and increasing adoption of IP voice services over roughly the same timetable.
 - 7.20.4 TalkTalk and Sky both already operate an IP-based voice network, albeit still using analogue transmission over the LLU copper connections it buys from Openreach. With the increasing adoption of superfast services, both may choose to migrate customers to “broadband voice”, using the experience gained in the full fibre trial they are undertaking in York with CityFibre.
- 7.21 The UK is not alone in this process. Internationally, operators are also considering strategies for this “PSTN switch off”. An Ofcom-commissioned study for the 2014 Infrastructure Report noted that Verizon and AT&T in the US are looking to migrate customers, as are various European countries (e.g., Germany). More recently, the Body of European Regulators for Electronic Communications (BEREC) has published a report of case studies on migration to voice over IP across Europe⁵⁹.

Migration to new services will bring consumer benefits

- 7.22 Moving voice services to broadband, away from traditional delivery, means that new voice services will have different characteristics. New services can support new features and new functionality.

⁵⁹ http://berec.europa.eu/eng/document_register/subject_matter/berec/reports/6486-berec-report-case-studies-on-migration-from-potsisdn-to-ip-on-the-subscriber-access-line-in-europe

- 7.23 The evolution of voice services lowers barriers to entry to the provision of primary fixed voice and messaging services, and the cost of providing the service will fall to very low levels. We may see more companies enter, with better prices and more innovation; for example, intelligent call-blocking to combat nuisance calls, redirection and measures to improve digital inclusion. Using voice over broadband for fixed voice-only consumers may also help achieve 'universal broadband' by default. If connections to all homes are broadband-enabled even if only to allow an IP-based voice service, it should be possible to quickly (and potentially remotely) enable data services on demand to any household.

In many cases, the consumer experience will be largely unaffected

- 7.24 It is important that migration itself does not cause disruption. Migration will work best where people migrate voluntarily, and where operators' migration strategies rely on developing new services which make it attractive to move. The BEREC report on migration across Europe found there tended to be fewer issues with the migration process where it was customer-driven.
- 7.25 For many, migration to voice over IP will be voluntary. Consumer and business use of voice services is already changing, as more people use mobile voice services instead of fixed, and as a number of users, especially businesses, are already choosing to move to voice over IP. In new-build housing developments, where providers are already deploying full fibre broadband services, residents are already using VoIP, as there is not a copper wire over which to deliver a voice service.
- 7.26 For those who have and use a fixed telephone line within the home, PSTN migration should result in little noticeable change, both in terms of the consumer experience, and of the steps required to make the change. For consumers who already use a broadband connection for data services, it should be a relatively simple matter of moving their existing telephones from the PSTN to their broadband connection, via an adapter or suitable broadband router. Below, we consider those consumers who do not already have a broadband connection.

However, there are challenges to managing migration for some consumers

- 7.27 Whilst switch off should have few implications for the majority of consumers, for others there may be important challenges which require careful consideration.
- 7.28 There are 3.2m voice-only consumers in the UK. For these customers, broadband technology will need to be installed in the home in order for fixed telephony services to continue. While this technology may be capable of supporting telephony and broadband, it may have only the telephony elements of the service activated, depending on customer requirements and demands. Alternatively, customers who want voice-only services may be offered a telephony-only router.
- 7.29 Where required, voice services can be delivered to consumers in a manner that looks just like traditional telephony, and consumers may not even be aware that the underlying connection is now broadband. We estimate that it will be particularly important for around a half of voice-only customers to continue to benefit from a service that is delivered in a manner that they recognise as fixed telephony.

For businesses, outstanding compatibility issues need to be resolved

- 7.30 There are a number of non-voice legacy applications which run over the PSTN which are typically used by business customers. These include the use of fax machines and

dial-up modems (for point of sale card readers for example) as well as point to point connections for industrial purposes such as process monitoring.

- 7.31 BT's previous work to move to broadband-based voice services during the 2005/6 21CN programme identified a number of the relevant issues which we are aware still exist today⁶⁰. This programme revealed that there were a number of applications which depended on technical characteristics of legacy networks beyond basic delivery of voice, such as way that the PSTN handles signalling tones in the network. As the industry again looks to make this migration, it is clear the process will need to take into account the needs of these specialist service providers and end users.
- 7.32 Ofcom has addressed similar issues during other technology migrations. For example, we are overseeing an effective migration away from analogue leased lines used for critical applications such as the protection against overload conditions in the National Grid or to control water supplies. We have already publicly signalled that these are approaching end of life, and are actively monitoring migration to modern equivalent services.

Resilience in emergency situations is a particular concern for Ofcom

- 7.33 One of the highest profile concerns about PSTN switch off is the ability of individuals to make 999 calls within the home during a power outage. Traditional telephones on fixed lines provided this capability, because they are powered from the local exchange. IP-based services require an alternative solution – typically some form of battery backup in the home and for any electronics in the access network, or a fall back solution such as the ability to send calls over a mobile network when power to the fixed network fails. Ofcom's initial conclusions from the Strategic Review of Digital Communications⁶¹ stated that we will "assess what operators are doing on a case-by-case basis, provided the technical solution delivers a level of protection equivalent to that provided by traditional means".
- 7.34 In this context, it is important to note that two thirds of calls to emergency services are now made on a mobile phone. Of the remaining third, it is likely that the majority are made on cordless phones, which also do not currently work during a power outage. Nonetheless, there remains a significant minority of people for whom the capability for the landline to continue to work during a power cut could offer a lifeline in an emergency.
- 7.35 PSTN switch off also raises concerns about other services which may be required in an emergency. Certain social care devices, such as personal alarms, have traditionally run over the PSTN. The calls that these devices make can traverse a number of different networks between source and destination, and as some of these intermediate networks migrate to IP-based technologies, interoperability issues are beginning to manifest.
- 7.36 The scale of these problems may increase as widespread migration of networks from traditional to IP-based technologies increases. However, as network technologies are evolving, so too are the services and devices that run over them, in order to become more IP-compatible, and therefore able to offer additional functionality and features. The providers of such services have already engaged with Ofcom and with their CPs

⁶⁰ Many of these were identified in our NGN consultation:

https://www.ofcom.org.uk/_data/assets/pdf_file/0016/43018/main.pdf

⁶¹ https://www.ofcom.org.uk/_data/assets/pdf_file/0016/50416/dcr-statement.pdf, February 2016

regarding migration, to ensure that services can remain operational or are superseded in good time before PSTN switch-off occurs.

Consumer protection principles Ofcom will apply during migration

- 7.37 We have set out above that it is important that migration itself does not cause disruption. It is important that Ofcom is satisfied that proposed migration processes will not result in bad outcomes for consumers and businesses. Fundamentally we are seeking to ensure that migration does not result in undue disruption to customers, and that they are no worse off, either financially or functionally, as a result of it.
- 7.38 As such, we will seek to uphold the following principles during any such migration:
- 7.38.1 Emergency services access should be provided by all voice services in accordance with the relevant General Conditions (GCs). Note that these GCs are currently being reviewed, and we expect to publish revised Conditions in Spring 2017.
 - 7.38.2 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. We will assess the suitability of such solutions on a case-by-case basis, taking into account the technical limitations and customer usage of both the traditional and new services.
 - 7.38.3 New voice services will maintain existing protections for vulnerable consumers in a manner which is appropriate for the technology they employ and their usage.
 - 7.38.4 Equivalents to the current social phone tariffs and rules on the sensitive handling of debt will be applied to future voice services where appropriate.
 - 7.38.5 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. In particular, voice service providers should make all reasonable efforts to ensure their changes do not cause excessive disruption to services used by vulnerable customers, such as personal alarm systems.
 - 7.38.6 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.
 - 7.38.7 Customers who do not migrate on a voluntary basis should be no worse off than they were before migration.
 - 7.38.8 Vulnerable consumers must receive any assistance they require for the migration process and continue to receive a service they recognise as a telephony service.

Ofcom will need advance sight of operators' plans for migration

- 7.39 In order to ensure migrations proceeds in line with the principles set out above, there are a number of particular areas where Ofcom expects to have early sight of operators' planned approach.

- 7.40 Firstly, implications for the end user experience:
 - 7.40.1 Prior notification to end users - how will users be notified and when?
 - 7.40.2 The migration process - what form will this take, both for customers who move voluntarily, and those who do not?
 - 7.40.3 Replacement services - what alternative options will be offered to consumers and businesses? In particular, for consumers, what replacement service will be offered to BT Basic customers?
 - 7.40.4 Consumer access services - what is the migration process for access services, such as text relay?
 - 7.40.5 Pricing - how will replacement services be priced? It is essential that voice-only customers do not face additional costs as a result of moving to VoIP.
- 7.41 Secondly, implications for emergency services:
 - 7.41.1 Emergency access obligations - to what extent will the current requirements (free access, caller location, prioritisation) apply to new services, including over-the-top (OTT) services, i.e. services delivered over the internet?
 - 7.41.2 Power resilience of replacement services - for how long will services continue to work during power outages, or by what other means would access to the emergency services be possible?
 - 7.41.3 General resilience of replacement services - what level of resilience can be expected?
- 7.42 Thirdly, implications for downstream service providers:
 - 7.42.1 Third party providers - how will these providers be consulted with ahead of migration? How will it be ensured that end customers are aware of the changes and their options in good time?
 - 7.42.2 Alternative service providers - what will be the impact on competition?

Ofcom will work with industry to prepare for PSTN switch off

- 7.43 We understand that preparation for PSTN switch off will necessarily involve complicated dialogue, involving a wide range of parties, both across the telecoms industry and beyond. As such, we recognise that there will be a need for co-ordination, which will likely require a new, specific forum to ensure that discussion can progress efficiently and effectively.
- 7.44 The responsibility to ensure that migration does not result in disruption to end users lies with industry. Ofcom has an important role to play in setting out our expectations for switch off, whilst it is industry's role to set out how this will be achieved. Ofcom will monitor industry's progress, and enforce specific obligations in due course, as the process takes place.

Mobile network resilience

Mobile services are increasingly used as the first choice and the last resort

- 7.45 As discussed above, the way that fixed voice services are delivered is changing and this raises particular concerns in relation to emergency services access, and more general communications during emergencies, particularly for vulnerable customers. Already though, fixed voice has made way to mobile voice as the primary mechanism used to contact the emergency services. We have also seen that in major emergencies native and "over the top" services on mobile networks are playing an essential role in allowing people to continue to communicate effectively and obtain information. This will soon include the communications systems used within the emergency services, as they move away from their current dedicated wireless network onto the public mobile network.
- 7.46 These trends shift the role of mobile services from desirable to essential. Major outages, such as those caused by the UK winter floods of 2015, have raised concerns about the resilience of mobile networks, and this issue is likely to become more prominent over time.

This places requirements on both coverage and reliability

- 7.47 Understanding and improving mobile coverage is rightly an area which has received significant attention. However, coverage alone is not enough to discharge the role mobile services now play; services also need to be reliable in order to be available to perform their essential functions when required.
- 7.48 In common with fixed network operators, mobile operators take steps in the design and operation of their networks to ensure they are reliable. The mobile nature of the service provides additional levels of resilience, for example offering the possibility of a customer relocating to avoid a localised failure or perhaps taking advantage of overlapping coverage from adjacent cells in order to maintain service without doing anything at all. In the UK, calls to the emergency services can also be made from any other available network if the customer's own network is unavailable.

Mobile networks are more vulnerable to widespread power outages than legacy fixed networks

- 7.49 The resilience to a loss of mains power is very different between fixed and mobile networks. The customer equipment used with fixed voice services requires an external source of power in order to operate. In the case of the cordless phone basestations used in most homes, this comes from the customer's own mains power, and so the ability to make a phone call will immediately be lost if the customer's home experiences a power cut. Traditional "wired" phones however, receive their power over the copper phone line that connects them to their network provider. Virgin Media supplies this power from its street cabinets and BT from its exchanges, the former typically having batteries capable of maintaining service for several hours, and the latter's back-up power typically sufficient for power cuts lasting several days or more.
- 7.50 Mobile handsets have their own power and will continue to operate until they next need charging. However, the extent to which the network itself will continue to operate during a power failure is variable. The central, or "core" network elements which can affect the services of a large proportion of an operator's customer base typically have similar protection to fixed networks, lasting several days. However,

individual base stations may have little or no ability to offer service during power cuts, but this varies by operator and by individual base station. Some base station locations impose practical limitations on aspects such as size, weight, noise generation and environmental impact which can limit the ability to install back-up power. In other cases, the operator may simply decide the cost of installing and maintaining additional back-up power is not justified.

- 7.51 The features such as mobility, emergency call roaming and overlapping base station coverage make it difficult to represent the relative levels of reliability between fixed and mobile services in a simple fashion. However, the evidence from recent winter storms suggests that when there is a widespread loss of mains power, mobile voice services typically suffer more than fixed voice. Although in practice many households will lose fixed voice service because their cordless phones rely on mains power, they do have the option of keeping a corded phone for such situations. In contrast, even if a mobile customer can keep their handset charged, there is little they can do if the network has failed due to power loss.
- 7.52 As the role of mobile services as the primary communications channel for many customers increases, a significant investment in the networks will be required if their vulnerability to loss of mains electricity is to be reduced.
- 7.53 As part of a project on cross sector resilience undertaken by the United Kingdom Regulators Network (UKRN)⁶² and led by Ofcom, we identified this vulnerability in what is becoming an increasingly important element of the UK's "Critical National Infrastructure". Government has been working with industry to understand how this can be rectified, and the scope and scale of the network changes needed. It is vital that this work is progressed and brought to fruition.

⁶² See <http://www.ukrn.org.uk/wp-content/uploads/2016/07/2015AprCSR-Phase1Report.pdf>