

Annex 12

Timing of network deployment and use

Introduction

A12.1 This Annex considers the main timing inputs we use in our analysis. These are:

- ranges of likely timings for the deployment and use of mobile broadband technologies in the frequency bands of interest to this consultation
- illustrative network roll-out profiles for the deployment of mobile broadband networks, using the frequency bands of interest, for a number of different sizes of network (long-run number of sites) and deployment strategies

A12.2 These inputs are important for our analysis because, as a consequence of our decision to liberalise spectrum, operators with 900 MHz spectrum may be able to provide mobile broadband services at a lower cost, or to higher quality than operators without it. However, in the future, 800 MHz spectrum is likely to become available, and this may be used to provide similar services at a similar cost.

A12.3 The timing inputs presented here are used in the cost difference analysis, and in the competition effects modelling (Annex 9). The latter examines the consequences if use of 900 MHz spectrum does provide better quality, and access to 900 MHz turns out to be restricted to a small number of operators. The period during which 900 MHz spectrum may be in use, but 800 MHz spectrum may not, is of particular significance for that analysis.

A12.4 We have sought advice from relevant experts and, when possible, also used information from operators to inform the inputs used here. However, these inputs are subject to considerable uncertainty. For this reason, we have produced ranges for all dates of interest, rather than precise forecasts.

Overview

A12.5 In this Annex, we:

- Identify **milestones of relevance to the analysis**
- Identify the sequence of events and processes that will need to happen if those milestones are to be reached, and their **dependencies**
- Identify **inputs** detailing when each of these events may occur
- Chart inputs and dependencies in **Gantt charts**
- Arrive at **likely timings for the deployment of technologies in bands of interest**
- Describe our **methodology for developing roll-out profiles**
- Present our **list of illustrative roll out profiles**

A12.6 The sections on inputs, dependencies and Gantt charts show how we arrive at results in a great deal of detail. Readers that are interested mainly in the consequences for other parts of the analysis may skip these and read only the milestones, conclusions and roll out profiles sections.

Milestones of relevance to the analysis

A12.7 This section describes the main milestones that are relevant to our analysis.

A12.8 We have focused on specific technologies that are likely to use liberalised 900 MHz and 800 MHz spectrum. These are UMTS 900¹, and LTE 800².

A12.9 The milestones for each of these technologies are:

- When the service could be used by early adopters at an **initial level** of service. As an example of what this initial level of service may be, we consider deployment in urban and dense urban areas.
- When the service could be used by early adopters, at a **full level of service**, covering also suburban areas.
- When the service might be adopted by almost all data users.

A12.10 The competition effects analysis uses these milestones to identify a period of reduced competitive intensity during which only operators with 900 MHz spectrum are able to provide a high quality mobile broadband service and operators with only higher frequency spectrum are at a competitive disadvantage. The period of reduced competitive intensity is assumed to begin when incumbent operators start providing high quality mobile broadband using 900 MHz spectrum and end when other operators provide a comparable high quality mobile broadband service using 800 MHz spectrum.

A12.11 The cost difference analysis is concerned with these milestones because 900 MHz and 800 MHz spectrum allow deployment of services with a lower number of sites than 2100 MHz spectrum does, under a number of scenarios. The cost difference analysis uses these milestones to identify the dates at which operators may be able to start deploying networks using either 900MHz or 800MHz spectrum, the dates at which they may then be able to stop expanding their 2100 MHz networks, and the dates later on when they may be able to decommission parts of their 2100 MHz networks.

Dependencies

A12.12 This section explains the main processes and events that need to take place before a given level of service can be offered or take-up achieved.

¹ It is also a possibility that 900 MHz could be used for LTE, rather than UMTS. This is captured under the economic analysis where we consider the possibility that UMTS 900 is not rolled out. In this case, the competition effects and cost difference analysis become trivial, and we do not need a separate scenario.

² i.e. a future 800 MHz version of the 3rd generation partnership project (3GPP) standard for Evolved Universal Terrestrial Radio Access

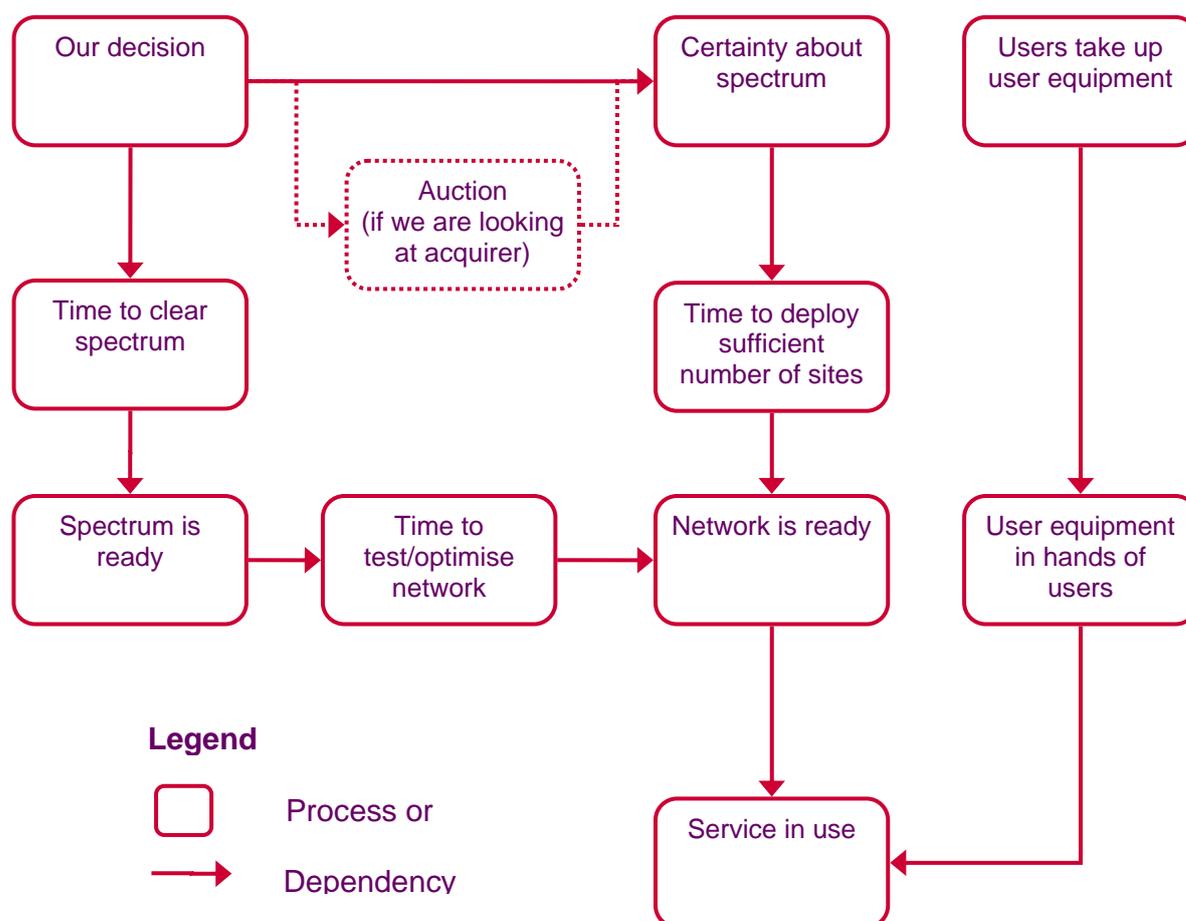
A12.13 A service will be in use when three inputs are in place: spectrum, user equipment (including handsets and dongles), and network. Each of these is also dependent on other events.

UMTS 900

A12.14 Figure 1 shows a high level view of the main processes, events and dependencies required for UMTS 900 to be in use and is explained in more detail below. The chart shows three direct dependencies for the service to be in use: spectrum, network and user equipment. Each of these have their own dependencies:

- **Spectrum** depends on our decision on liberalisation and on the necessary time for 900 MHz incumbents to clear existing GSM 900 use.
- **The network** will be ready after an operator has time to deploy a sufficient number of sites with UMTS 900 equipment, and test and optimise these sites (UMTS 900 network equipment is already available) Before starting deployment, operators need certainty about access to liberalised spectrum, which comes from our decision to liberalise (for an incumbent), or a spectrum auction (for someone acquiring some 900 MHz spectrum, if there is such an auction). Finally, before they can start testing the network, the spectrum needs to be clear and available for use.
- **User equipment** needs to be in the hands of users in order for them to benefit from use of the new network. Therefore there has to be sufficient time for UMTS 900 capable 3G handsets, dongles and data cards to be taken up by users. UMTS 900 capable user equipment is available but the great majority of user equipment currently in use does not support UMTS 900.

Figure 1 - Processes, events and dependencies preceding use of UMTS 900

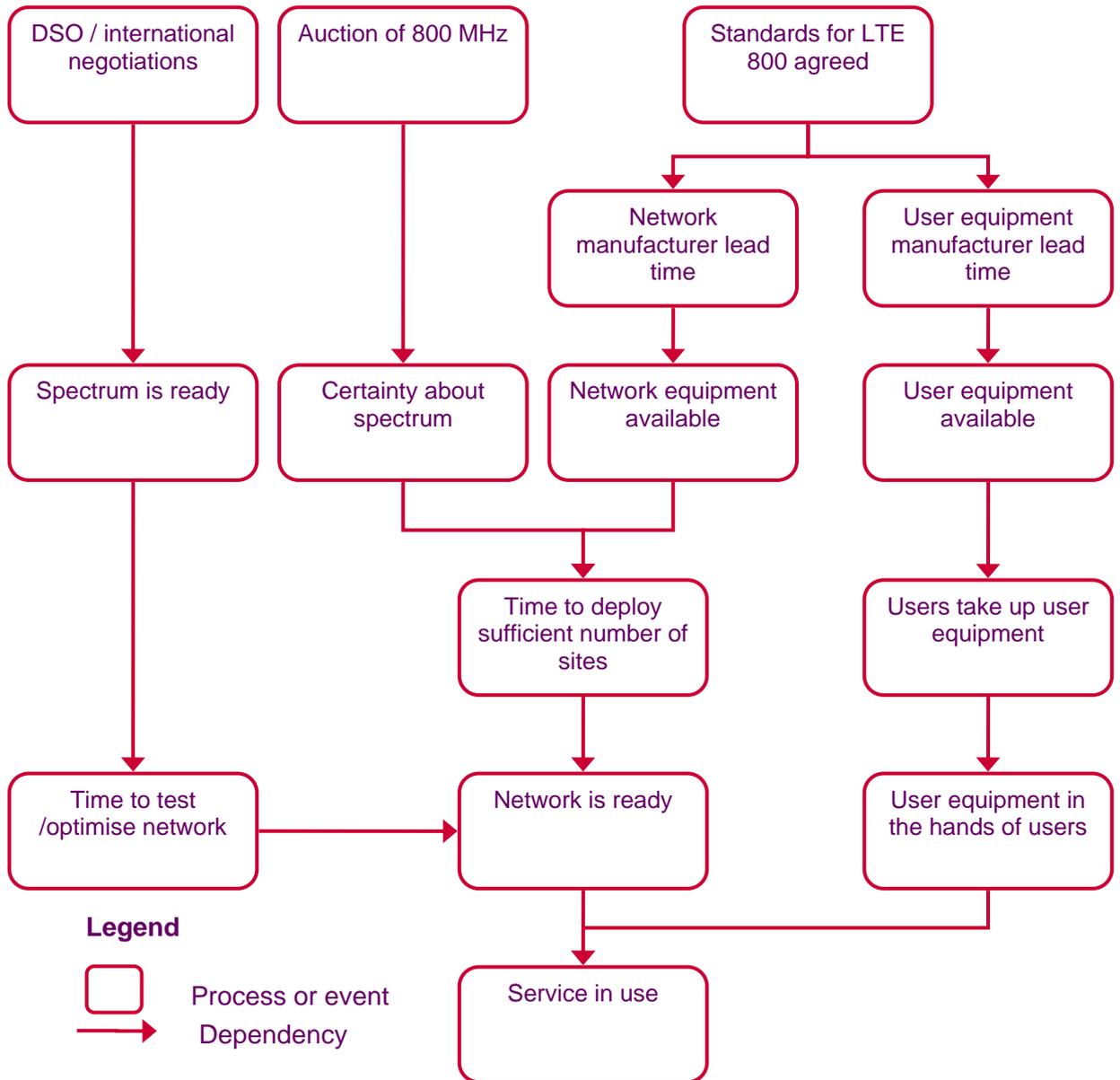


LTE 800

A12.15 Figure 2 shows the main dependencies for LTE 800, explained in more detail below. As in the previous example, each of the main inputs needed for service has its own dependencies:

- **Spectrum** depends on the Digital Switchover (DSO) process, and on international negotiations to determine how spectrum can be used for potential mobile use.
- **The network** will be ready after an operator has time to deploy a sufficient number of sites, and test and optimise these sites. Before starting deployment, they need certainty about access to the spectrum, which should come from the Digital Dividend spectrum auction. They also need network equipment, which does not yet exist for LTE 800. Network equipment will be available after standards for LTE 800 are finalised, and manufacturers have sufficient time to start production. Finally they need to be able to use the spectrum in order to test the network.
- **User equipment** needs to be in the hands of users. Again, user equipment for this band does not exist yet. Therefore, there has to be sufficient time for standards to be agreed by the industry, followed by sufficient time for the industry to make equipment available, and for equipment to be adopted by users.

Figure 2 - Processes, events and dependencies for use of LTE 800



Inputs

A12.16 This section lists plausible dates and durations for the events and processes shown under the “dependencies” section. Where there are some uncertainties over timing we present a range. These are then combined in the next section in Gantt charts.

A12.17 We show below the inputs we use for UMTS 900.

Table 1 - Inputs – UMTS 900

Input	Value
Our decision	Mid 2009 / end 2009
Time to organise an auction	1 year
Time for clearing – no intervention	18 months – 2 years
Time for clearing – intervention	2 years
User equipment take-up (by early adopters)	No later than mid – 2011
User equipment take-up (by majority of data users)	Mid 2013 (or 2.5 years after equipment adoption by early adopters)
Time to deploy first sites (in urban / dense urban areas) after certainty about spectrum	No longer than 2 years
Time to test and optimise first sites, (in urban / dense urban areas) and requiring full use of cleared spectrum (ie excluding everything that can be done before spectrum is fully cleared)	6 months – 1 year
Time to deploy sites areas across entire 80% population area	3 – 4 years

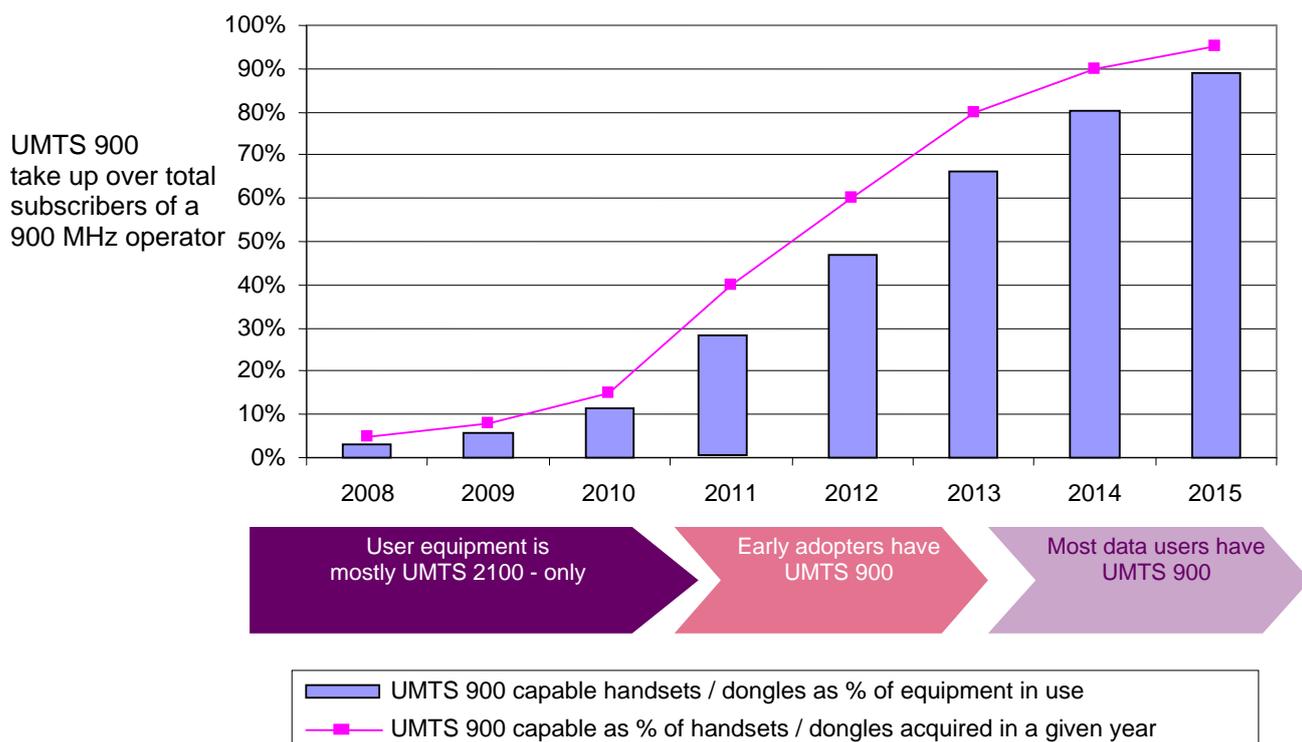
A12.18 We present below the rationale behind each of these inputs:

A12.19 **Our decision.** The range allows for the time to incorporate responses to this consultation into our analysis and decision.

A12.20 **Time to organise an auction.** This is based on our experience on auctions and our expectations of the complexity of the process.

A12.21 **Time for clearing.** We have examined the work likely to be involved in clearing spectrum in Annex 16. The time required is likely to be linked to the quantity of spectrum to be cleared. If we do not mandate any release, and in the event that each of the two operators will clear a block for their own use, the tasks required seem to be possible to complete in 18 months. We use 2 years as a conservative maximum time. If we mandate one block release, two years are likely to provide sufficient time for clearing.

A12.22 **User equipment take-up for early adopters.** We reproduce below an illustration of how take up of UMTS 900 capable equipment could grow (Figure 3). This illustrative chart was produced using a 20 month average user equipment replacement cycle. This is an example figure based on typical contract lengths of 18 months for handsets and 24 months for dongles and assumes that consumers with the most interest in mobile data are likely to upgrade their equipment at end of contract. In each given year, a growing proportion of customers replacing user equipment (handsets or dongles) would acquire a UMTS 900 capable replacement. This yearly proportion is shown below as a line; the bars show the accumulated total number of UMTS 900 capable devices in use.

Figure 3 – Illustrative take-up of UMTS 900 capable user equipment

A12.23 We believe that those users who use data the most, and care most about the quality of user experience in mobile data will be among the first to migrate to UMTS 900, as they have the most incentive to do so. One plausible view of market segmentation is that around 10%³ of users may form this category.

A12.24 The illustrative timeline above shows that a group this size could have UMTS 900 handsets as early as 2010. We conservatively use mid-2011 as an input. It is possible that adoption could happen earlier, but it turns out that earlier adoption would not impact the analysis, as there are other constraints in the critical path (as shown later in the Gantt charts).

A12.25 **User equipment take-up for almost all data users.** The sources for segmentation of users mentioned above suggest that around half of mobile subscribers are not likely to use data services, even in the medium term. Therefore, it is possible that all data users will be equipped with UMTS 900 capable devices at some point shortly after take up of UMTS 900 capable devices grows above 50% of the subscriber base. We think that there is ample opportunity for most data users to have taken up UMTS 900 capable devices by 2013, or around 2.5 years after take up by early adopters, as shown in Figure 3.

A12.26 **Time to deploy sites in urban / dense urban areas.** This process starts from the point at which an operator starts planning the network, which could be at the time of spectrum certainty, or even before, if the operator is sufficiently interested in deploying mobile broadband. We use two years to account for this initial deployment. We assume that the number of sites required in these areas should be

³ This has been checked against, and is broadly consistent with the following sources: Analysys, "3G Network Evolution from 2007 to 2012: HSPA+, LTE, WiMAX and femtocells"; Arthur D.Little, "In the eye of the telecom-media storm", 27 March 2008 Point Topic "Mobile Broadband Survey – Future usage"

no greater than 2,000 sites, as shown in Annex 13 (for the higher demand scenario).

- A12.27 **Time to test / optimise first sites (in urban / dense urban areas), following spectrum clearance.** Network operators could potentially start installing equipment as soon as they have certainty about spectrum use. However, the equipment needs to be tested and optimised using cleared spectrum. We expect that there will be a gap between spectrum availability and the time when sites in the main urban and dense urban areas can be put to full use. We expect that operators would be able to start planning the network before the spectrum is cleared, and possibly visiting sites to start equipment installation. We believe the network could be in full use between 6 months and one year after spectrum clearance.
- A12.28 In considering this timing we have taken account of the fact that operators may be conducting engineering works to allow spectrum clearance at the same time, as described in Annex 16. We do not believe that this concurrent work is likely to create significant delays in the timeline for deployment of UMTS 900, as site visits motivated by spectrum clearance could also be used to install UMTS 900 equipment.
- A12.29 **Time to deploy sites in urban, dense urban and suburban areas** We expect that the number of sites needed should be not much more than 7,000 sites (as in the results in Annex 13 for the higher demand scenario).
- A12.30 There are limits on the number of sites that can be deployed per year, because of practical difficulties of resourcing site visits, and for completely new sites, acquiring the physical site. These limits are looser for upgrades than they are for new sites.
- A12.31 We believe that a reasonable assumption is that operators are able to deploy up to 1,500 new sites or 3,000 upgrades per year, or any combination of the two. However a more moderate pace would be 1,000 new sites, or 2,000 upgrades a year; we will calculate results for both. We believe that these numbers are broadly consistent with real world business plans, based on information provided to us by operators.
- A12.32 Accounting again for the initial time for planning the network, and the number of sites mentioned above, we find that deploying the network is likely to take a total time of between 3 and 4 years.
- A12.33 The Gantt charts for LTE 800 uses similar inputs, and some additional inputs shown below:

Table 2 - Additional inputs – LTE 800

Input	Value
Auction	2010
Spectrum ready to be used	Late 2012 – end 2013
LTE 800 standards completed	Mid 2010 – mid 2011
Network manufacturer lead time (from standard to equipment available)	6 – 18 months
User equipment manufacturer lead time	1 – 2.5 years
User equipment take-up (by early adopters – 10% of subscribers) – assuming that 800 MHz operator will promote rapid take-up to catch up with 900 MHz operator	1.5 years
User equipment take-up (by majority of data users)	2.5 years after take up by early adopters

A12.34 **Auction** We are presently working towards organising auctions for the Digital Dividend spectrum. This process is still in progress. We currently believe that the relevant auction is likely to occur during 2010. (see <http://www.ofcom.org.uk/consult/condocs/800mhz/>)

A12.35 **Spectrum ready to be used.** The range shown here is for UK-wide use of the spectrum. The earliest date reflects the timing for the Digital Switchover process which is expected to conclude for the UK in late 2012. The actual date of availability will depend on whether Ofcom proceeds with its proposals to re-organise the frequencies covered by the digital dividend so that the whole of 790-862 MHz is made available⁴. If those proposals are adopted then the whole of the band will not be made available until a later date. The end of 2013 has been used below as a reasonable estimate of when that might be. However, it is possible that some of the band could be made available earlier as the process and time which will be needed to clear the band varies between different channels.

A12.36 **LTE 800 standards completed.** We expect that LTE at 800 MHz is not likely to be part of release 9 of the 3GPP LTE standards, which is expected by around end of 2009. The standardisation is likely to have to wait for current work at CEPT. Overall, we believe that between mid 2010 and mid 2011 is a reasonable range for this milestone.

A12.37 **Network equipment manufacturer lead time.** This measures the gap between standards completion and standards-compliant network equipment being made available. We think this is subject to some uncertainty, and we use a wide range of between 6 months and 18 months.

A12.38 **User equipment manufacturer lead time.** This measures the gap between standards completion and user equipment being available, with sufficient choice so that it is attractive to consumers. Because of the larger scale of production, and more complex issues surrounding consumer choice, we think this lead time is longer and more uncertain than for network equipment. We use a range between one and two and a half years to reflect this added uncertainty.

A12.39 **User equipment take-up (for early adopters).** The overall arguments are similar to those in the UMTS 900 case. However, we use a shorter time scale in this case (1.5

⁴ see www.ofcom.org.uk/consult/condocs/800MHz

years), as the 800 MHz operator would be likely to be under pressure to catch up with a 900 MHz competitor who has launched earlier. Under these circumstances, they are more likely to use strategies to encourage user equipment take up, for those subscribers who care most about mobile data.

A12.40 **User equipment take-up** (for majority of data users). As described in the UMTS 900 case.

Gantt charts

A12.41 The dependencies and inputs shown in the previous sections can be put together in Gantt charts in order to generate results. We generate separate Gantt charts covering the scenarios described below. For each scenario, we provide an early version of the scenario, and a late version, to derive a range.

Scenario	Spectrum band	Option	Operator	Early / late version
A	900 MHz	Liberalisation in hands of incumbents	Incumbent	Early
B	900 MHz	Liberalisation in hands of incumbents	Incumbent	Late
C	900 MHz	Partial spectrum release	Incumbent	Early
D	900 MHz	Partial spectrum release	Incumbent	Late
E	900 MHz	Partial spectrum release	Acquirer	Early
F	900 MHz	Partial spectrum release	Acquirer	Late
G	800 MHz	Any	Acquirer	Early
H	800 MHz	Any	Acquirer	Late

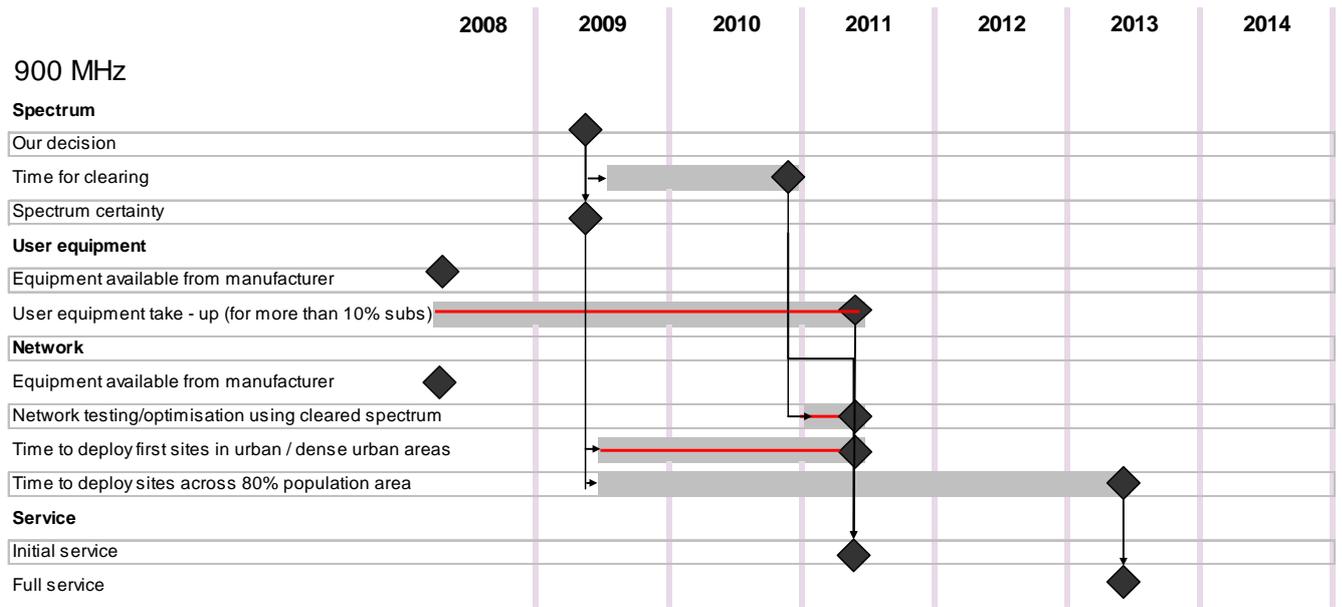
A12.42 Each of the Gantt charts that follow highlights the critical path (for the initial level of service) in red, and shows the points at which the initial level of service (in urban / dense urban areas) and full level of service (including suburban) are reached.

A12.43 The charts show milestones, processes and dependencies as illustrated in Figure 4 below. Some dependencies are omitted for legibility, but should be readily understandable in the context. For the full list of dependencies, refer to the dependencies section.

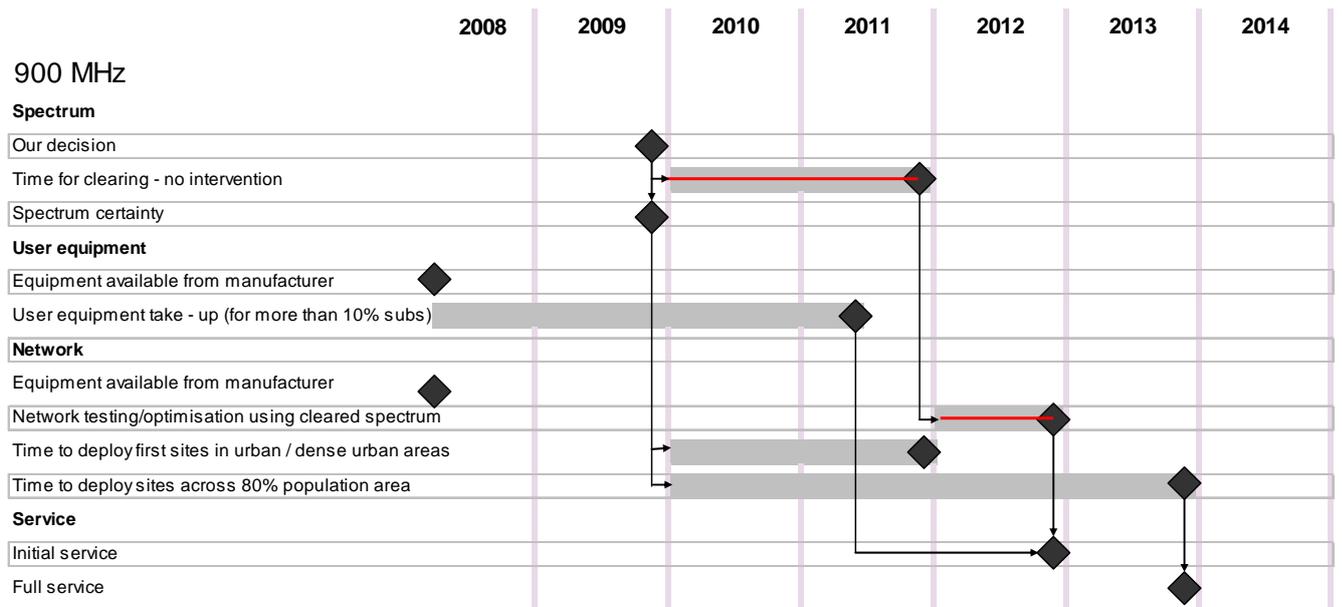
Figure 4 – Key to Gantt charts

A12.44  Milestone Task/process Critical path Dependency

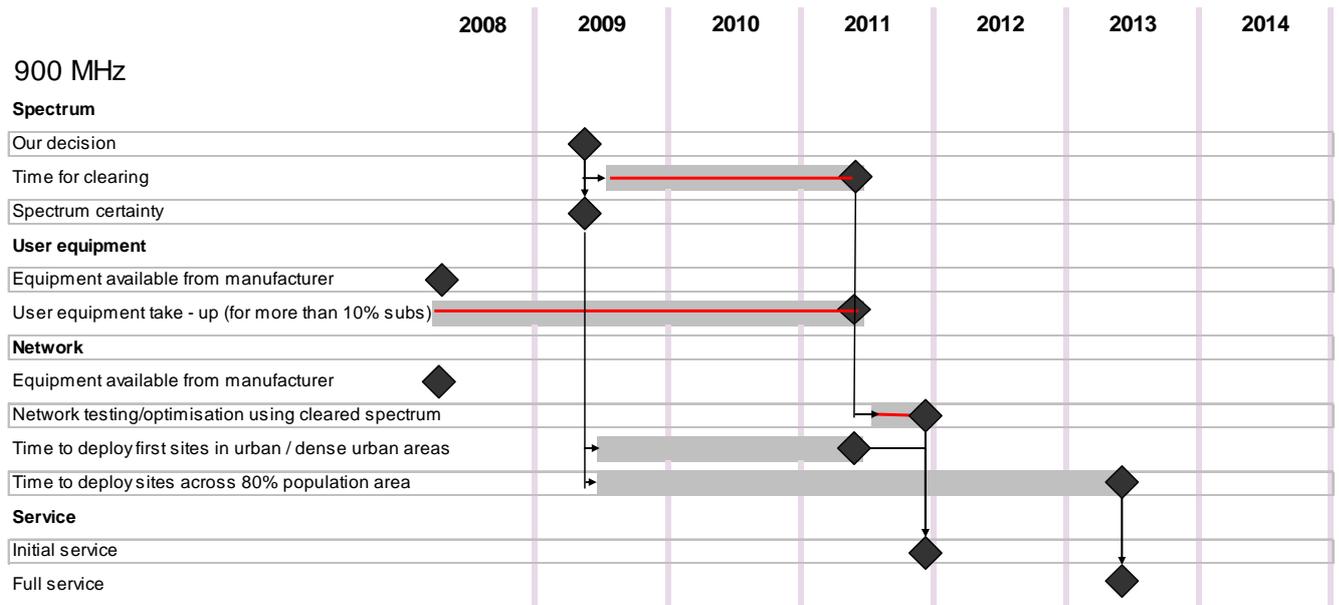
A – 900 MHz, Liberalisation in hands of incumbents, Incumbent, Early



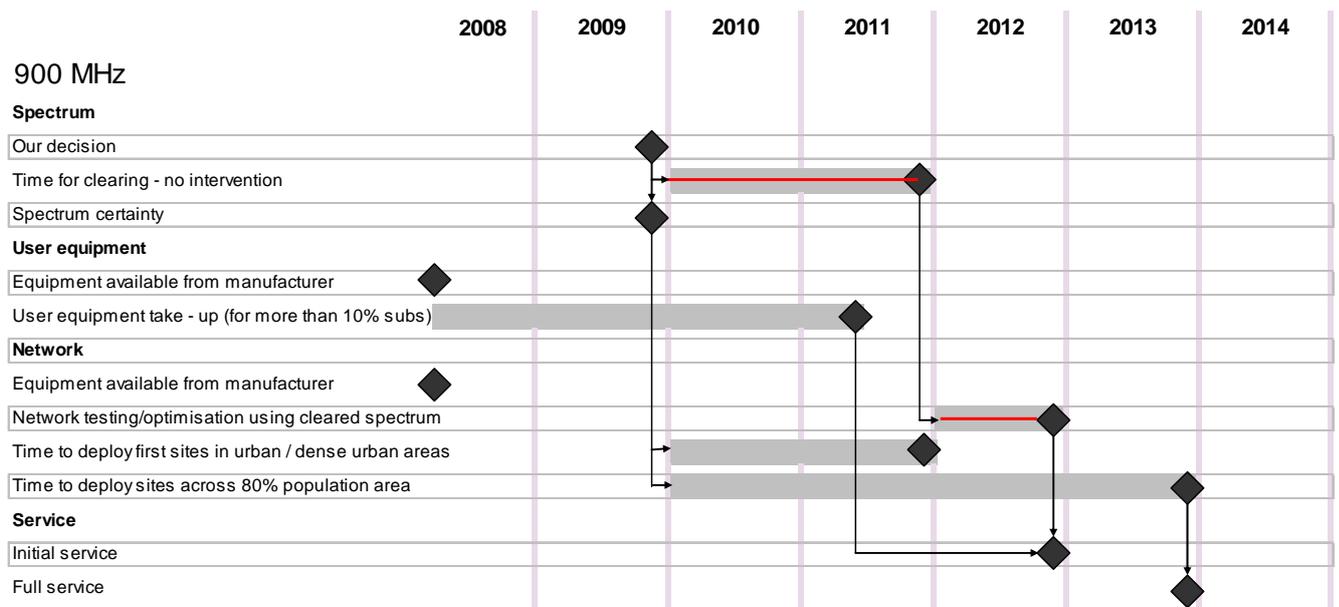
B – 900 MHz, Liberalisation in hands of incumbents, Incumbent, Late



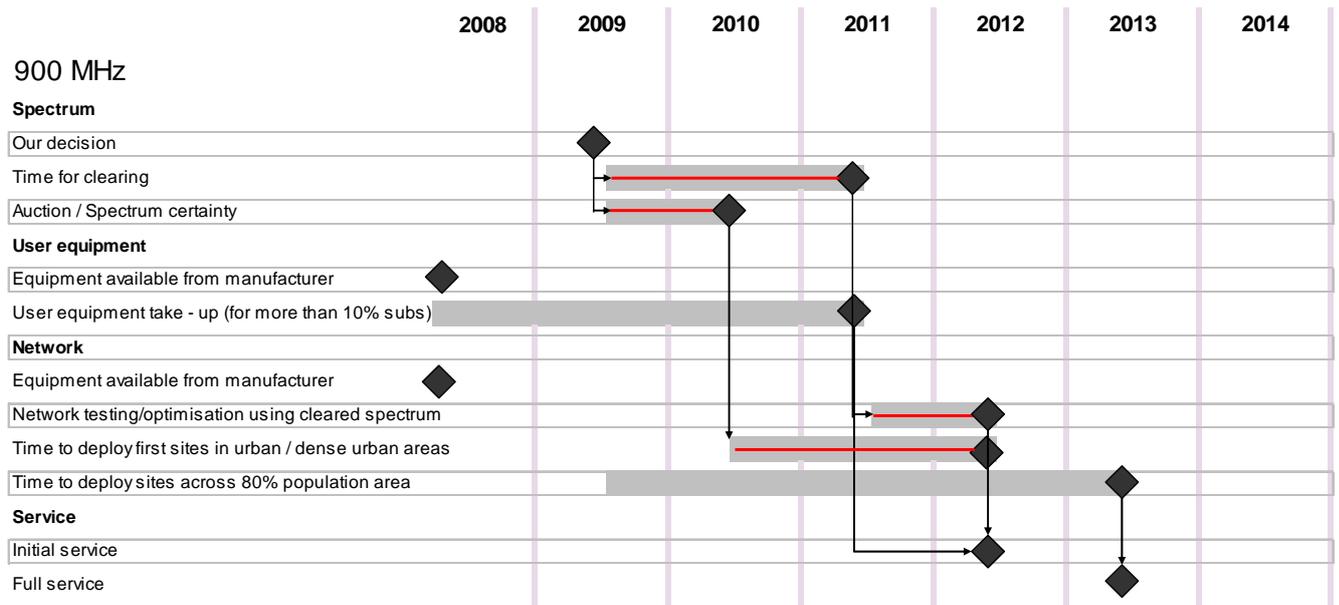
C – 900 MHz, Partial spectrum release, Incumbent, Early



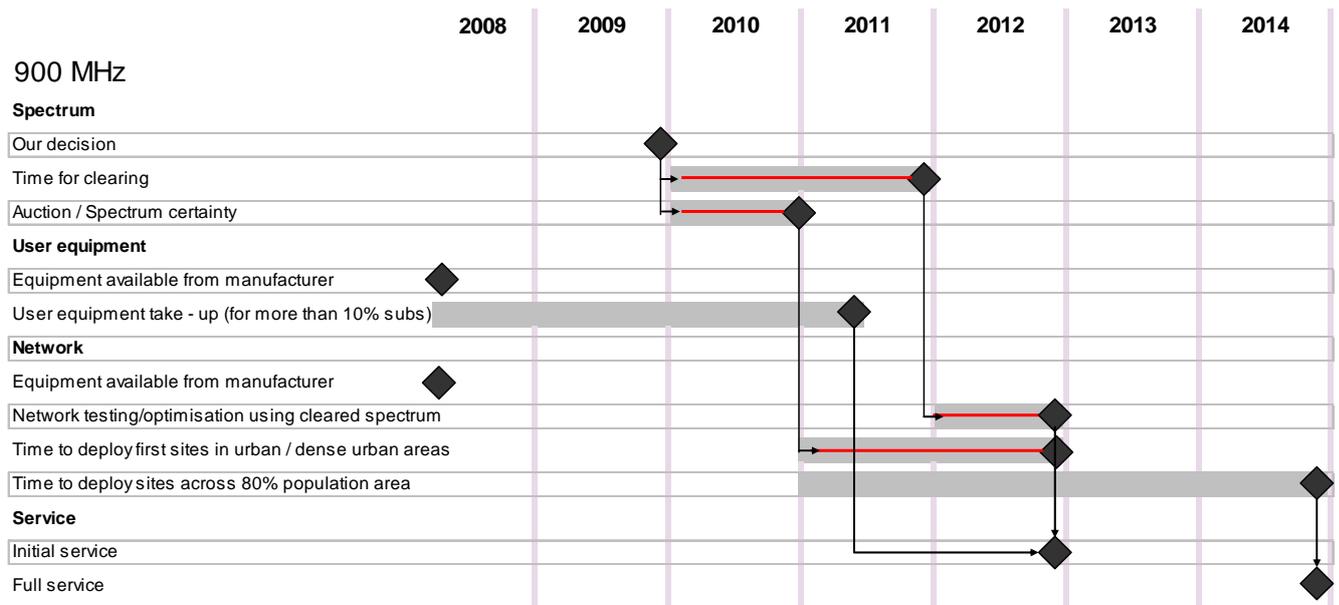
D – 900 MHz, Partial spectrum release, Incumbent, Late



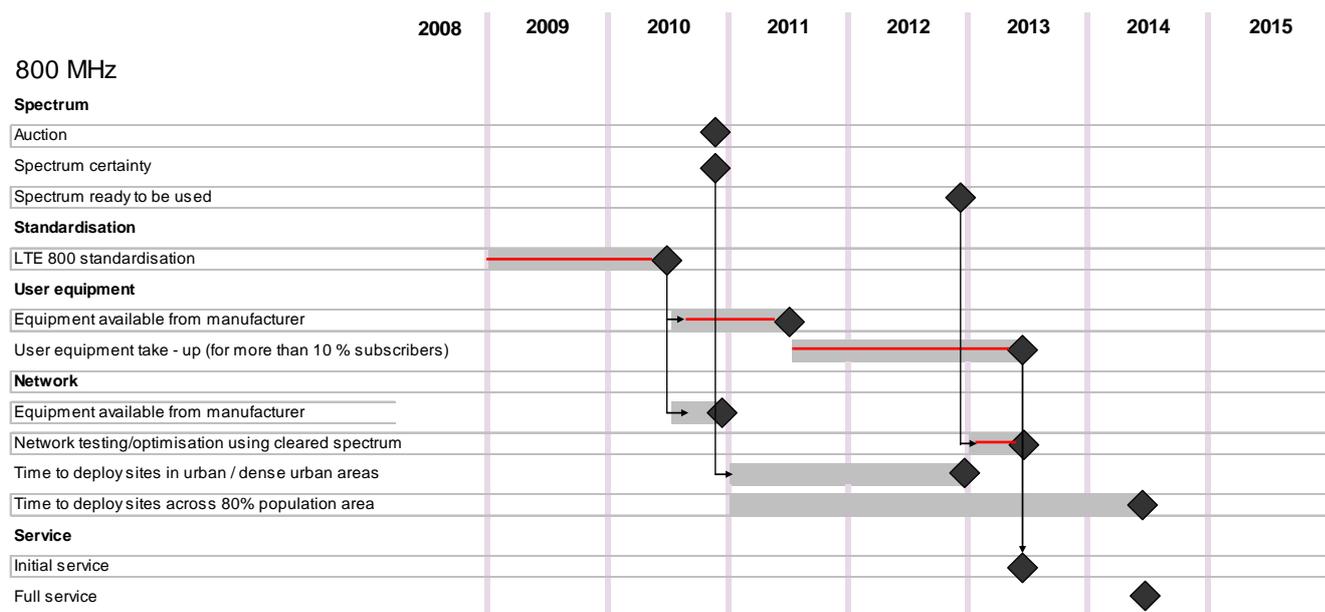
E – 900 MHz, Partial spectrum release, Acquirer, Early



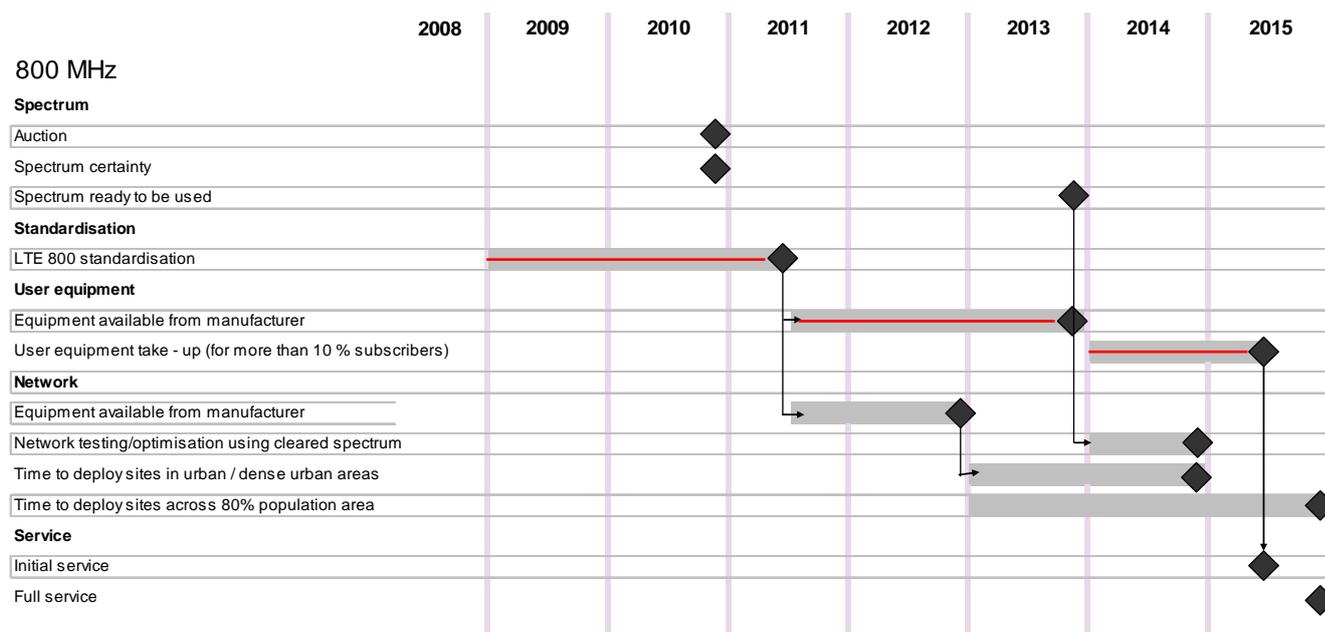
F – 900 MHz, Partial spectrum release, Acquirer, Late



G – 800 MHz, Early



H – 800 MHz, Late



Likely timings for the deployment of technologies in bands of interest

A12.45 We show here the main conclusions for the competition effects analysis and the cost difference analysis. As described previously, the competition effects analysis is concerned with the existence of a period of reduced competition, when a limited number of operators with 900 MHz spectrum may be able to offer a differentiated service, before operators with 800 MHz spectrum can do likewise.

A12.46 Table 3 and Table 4 summarise the main conclusions of the Gantt analysis, from this point of view.

Table 3 Conclusions of interest for the competition effects analysis: Milestones for use of 900 MHz if we were to liberalise in the hands of the incumbents

Milestone	Early date	Late date
Initial service (in urban / dense urban areas)	Mid 2011	End 2012
Full service (including suburban areas)	Mid 2013	End 2013

Table 4 - Conclusions of interest for the competition effects analysis: Milestones for use of 800 MHz

Milestone	Early date	Late date
Initial service (in urban / dense urban areas)	Mid 2013	Mid 2015
Full service (including suburban areas)	Mid 2014	End 2015

A12.47 Note that, when an operator with 800 MHz spectrum launches an initial level of service (mid 2013-mid 2015), the UMTS 900 network is already reaching full service (mid 2013-end 2013)). Therefore, the operator with 800 MHz spectrum is only able to catch up when they too are able to move to full service (mid 2014-end 2015).

A12.48 On the basis of this analysis, the maximum time during which an operator with 900 MHz spectrum would be ahead is 4.5 years (between UMTS 900 launching an initial service early in mid 2011, and LTE 800 reaching a developed level of service at end of 2015).

A12.49 The minimum time would be 1.5 years (between end of 2012 for UMTS 900, and mid 2014 for LTE 800).

Methodology for developing roll out profiles

A12.50 Having determined the likely timing ranges for deployment of mobile broadband technologies in the various frequency bands of interest, we now go on to develop illustrative network roll-out profiles for the deployment of mobile broadband networks. These roll-out profiles consider each of the frequency bands of interest, a number of different sizes of network (long-run number of sites) and are used for different comparisons. These network roll-out profiles form an essential input to our assessment of the differences in the costs to deploy and operate various scales of mobile broadband network, using spectrum in different frequency bands.

A12.51 This section explains the methodology for setting up illustrative roll-out profiles, the main variables used and their values.

A12.52 Our main interest is in understanding the differences in cost of mobile broadband networks built to deliver essentially the same level of service but using spectrum in different frequency bands. The majority of our analysis is therefore concerned with pairs of network roll-out profiles – one for each of two different operators, having access to different bands of spectrum, both of whom are faced with the challenge of remaining competitive in the face of network enhancements by the other. These pairs of roll out profiles are intended to represent networks that match the same level of quality, on a year-by-year basis. For this reason, we refer to these comparisons as “matching” comparisons.

A12.53 We are also interested in cases where this year-by-year matching does not occur. These profiles are used to help understand the differences in speed and coverage of mobile broadband that could plausibly arise as a result of differences in spectrum holdings. We refer to this second type of comparison as “non matching”.

A12.54 The comparisons shown here are between operators with 900 MHz spectrum, who deploy UMTS 900, and operators without 900 MHz spectrum, who expand their existing UMTS 2100 networks initially and may eventually deploy networks using 800 MHz spectrum (e.g. LTE 800). We have not developed roll out profiles for operators with and without 1800 MHz spectrum because the technical work shows that the differences between 1800 MHz and 2100 MHz spectrum are very small (as mentioned in Annex 10).

A12.55 The network roll-out profiles identify, for each year (2008 to 2028), and for each type of site, the number of sites that the network operator would build, upgrade, operate and decommission. The different types of site being modelled reflect the different types of site and network equipment that operators in different circumstances would be likely to deploy. This reflects the different technologies and frequencies available to each – for example a stand-alone UMTS 2100 site, or a combined UMTS 2100 and UMTS 900 site.

A12.56 The full list of site types of interest is as follows:

- UMTS 2100-only sites
- UMTS 900-only sites
- Combined UMTS 2100 and UMTS 900 sites
- 800 MHz-only sites
- Combined UMTS 2100 and 800 MHz sites

A12.57 Some of these sites are also GSM (2G) sites. However, the roll out profiles in this annex show the deployment of new technologies, and do not show GSM sites. The existing GSM network is taken into account in the cost modelling described in Annex 15, by assuming that a certain proportion of sites are upgrades rather than new site acquisitions.

A12.58 The key additional assumptions necessary to develop these illustrative network roll-out profiles are as follow:

- The **initial number of sites**
- The **long term target number of sites** that are needed for a given scenario
- The **maximum number of sites per year** that an operator can build and/or upgrade.
- How quickly early adopters take up new technology to the point where an operator that deploys such new technology **no longer needs to expand its existing UMTS 2100 network** in order to remain competitive.

- How quickly the majority of customers take up new technology to the point where an operator that deploys such new technology can start to **decommission part of its existing UMTS 2100 network** whilst remaining competitive.

A12.59 We describe next how we set each of these variables, and how they are combined to generate roll out profiles for each type of comparison.

Initial number of sites

A12.60 Until at least some point around 2010, UMTS 900 will not be of much relevance, as discussed in the previous sections of this annex, and 3G operators with or without 900 MHz spectrum will be on a level footing on this account. If a pair of operators is interested in competing with each other's mobile broadband offerings, they would both need to use 2100 MHz spectrum during this period.

A12.61 We believe that, for operators interested in mobile broadband, this could lead to deployments of around 9,000 sites by around 2010, in the area where 80% of the population lives. We use this as a starting point for roll out profiles associated with both types of operators, with and without 900 MHz spectrum.

Long term target number of sites

A12.62 In each roll out profile we specify a long term target number of sites. In the "matching" comparisons, the target number of sites for both profiles relate to the same level of service. This is determined by demand scenarios, which specify what level of service we aim to model, and by the technical analysis, which determines the number of sites needed for that level of service.

A12.63 Roll out profiles for an operator without 900 MHz spectrum require two target numbers of sites, one for UMTS 2100 and another for LTE 800. Each describes the number of sites needed to meet the demand scenario, using that band or technology as the main means of service delivery.

A12.64 In our baseline inputs, we make the simplifying assumption that the number of sites needed to serve a given level of demand using 800 MHz spectrum is the same as those needed using 900 MHz spectrum.

A12.65 This assumption is based on the fact that the physical characteristics of the two bands are very similar, and that many of the scenarios examined turned out to be coverage rather than capacity constrained (this means that adding more spectrum adds little or no improvement).

A12.66 It is possible that the technology that will be used to deliver services at 800 MHz (such as LTE), being more distant in the future, will be more advanced and efficient than that at 900 MHz. Therefore, the number of sites required at 800 MHz may be smaller than that required at 900 MHz.

A12.67 In this analysis, we did not conduct specific modelling of the technology that will be used at 800 MHz. Instead, we assumed parity of sites as a baseline, and investigated also a range of cases where the number of sites required at 800 MHz is smaller than those required at 900 MHz.

A12.68 For the full list of values used for this variable, refer to the table in the next section.

Maximum number of sites per year

- A12.69 As explained earlier in this annex, we believe that deployment of up to 1,500 new sites or 3,000 upgrades per year is likely to be achievable by an operator interested in mobile broadband. A less aggressive pace of deployment would be 1,000 sites or 2,000 upgrades.
- A12.70 The roll out profiles showing the deployment of UMTS 900 are always bound by the above constraints. However, in many scenarios the number of sites needed to provide a given level of service using UMTS 2100 is several times larger than that needed using UMTS 900.
- A12.71 It follows that it is often not possible to produce pairs of roll out profiles that provide the same level of service, using UMTS 900 and UMTS 2100, and enforce the maximum number of sites per year for both operators. In other words, the number of sites per year that the operator without 900 MHz may need to deploy to keep pace with the UMTS 900 operator may be impractical.
- A12.72 A cost difference can be interpreted as a financial barrier for the UMTS 2100 operator to match the service offered by an operator with UMTS 900. The difficulty in acquiring sites at the required pace is an additional, non-financial barrier. In order to show the full amount of the financial barrier separately from the non-financial barrier, we measure the costs of the full number of sites they would need to acquire, even if the acquisition of sites at that pace may be impractical.
- A12.73 For this reason, the roll out profiles for “matching” comparisons do not enforce a maximum number of sites per year for the UMTS 2100 roll out when it is being matched to a UMTS 900 roll out.
- A12.74 Instead, we derive the number of sites that the UMTS 2100 network would have to have in order to match the same service as that offered by the operator with 900 MHz spectrum. This is calculated via the site ratio provided by the technical analysis, which is scenario dependent. The number of UMTS 2100-only sites that the operator with 900 MHz spectrum has is also added to the total number of sites that the operator without 900 MHz needs.
- A12.75 The table below summarises the values for this variable, in “matching” and “non matching” comparisons. For each case, we show maximum site deployments for new sites, and for upgrades. We also consider feasible any mix of the two numbers. For example, the lower end of the range below is enforced as 1,000 new sites, or 2,000 upgrades. We consider a combination of 500 new sites plus 1,000 upgrades to be equally feasible. In other words, one new site can be traded for two upgrades, for the purposes of this cap.

Table 5 – Values used for “maximum number of sites per year” in different comparisons

	Operator with 900 MHz spectrum	Operator without 900 MHz spectrum
“Matching” comparison	1,000 – 1,500 new sites or (2,000 – 3,000 upgrades)	As many sites as needed to match 900 MHz service (even if impractical)
“Non matching” comparison	1,000 – 1,500 new sites or (2,000 – 3,000 upgrades)	1,000 – 1,500 new sites or (2,000 – 3,000 upgrades)

Date when operators no longer need to expand their existing UMTS 2100 network

A12.76 We believe that this will be possible when **an initial level of service** is provided using 900 MHz or 800 MHz spectrum (as described previously, coverage in urban and dense urban areas), and user equipment is in the hand of those users who care about mobile data the most (“early adopters”).

A12.77 The range of dates when this may happen is taken from the roll out profiles shown earlier, and are summarised below in Table 6.

Table 6 - Range of dates when operators can stop expanding their UMTS 2100 network

	Earliest	Latest	Source
Operators with 900 MHz spectrum	2011	2012	Gantt charts A-F
Operators without 900 MHz spectrum (but who acquire 800 MHz spectrum)	2013	2015	Gantt charts G-H

Date when operators can decommission part of their UMTS 2100 network

A12.78 We believe that this will be possible when a developed level of service is provided using 900 MHz or 800 MHz spectrum (coverage in urban, dense urban and suburban areas), **and** user equipment is in the hand of the majority of subscribers with an interest in mobile data. These dates are extracted from the Gantt charts, as shown in Table 7.

A12.79 After this date, the roll out profiles show all UMTS 2100-only sites being decommissioned. However, UMTS 2100 equipment is kept in sites shared with 900 MHz or 800 MHz equipment. This is intended to reflect the likely desire of operators to provide continuing service for legacy users.

Table 7 – Derivation of range of dates when UMTS 900 operators can decommission part of their UMTS 2100 network

	Earliest	Latest	Source
User equipment – early adopters	No later than mid 2011		Gantt charts A-F
User equipment – for most data users	No later than end 2013		The date in the previous row, plus 2.5 years (as discussed in the inputs section)
Full level of service	Mid 2013	End 2014	Gantt charts A-F
Date when operators can start decommissioning part of their UMTS 2100 network	2013	2014	Point at which user equipment is in hands of most data users and there is a full level of service, as described in rows above

Table 8 - Derivation of range of dates when 800 MHz operators can decommission part of their UMTS 2100 network

	Earliest	Latest	Source
User equipment – early adopters	Mid 2013	Mid 2015	Gantt charts G-H
User equipment – for most data users	End 2015	End 2017	The dates in the previous row, plus 2.5 years (as discussed in inputs section)
Full level of service	Mid 2014	End 2015	Gantt charts G-H
Date when operators can start decommissioning part of their UMTS 2100 network	2015	2017	Point at which user equipment is in hands of most data users and there is a full level of service, as described in rows above

A12.80 In addition to the ranges above, we also present a roll out profile where decommissioning never happens.

An example pair of roll out profiles using a fixed maximum of sites per year

A12.81 We show next a pair of matching roll out profiles, in Figure 5. The inputs used to create these roll out profiles are shown below, in Table 9 and Table 10.

Table 9 – Inputs used in example pair of roll out profiles for operator with 900 MHz

Target UMTS 900 sites	Stop growing 2100 MHz network	Decommission 2100-only sites	Sites deployed per year
7,300	2011	2013	1,000

Table 10 - Inputs used in example roll out profile for operator without 900 MHz

Target UMTS 2100 sites	Target 800 MHz sites	Stop growing 2100 MHz network	Decommission 2100-only sites	Sites deployed per year
21,096	7,300	2013	2015	As many as needed to match 900 MHz service

A12.82 We quote the limit of sites deployed per year for the case where all sites are new sites. But as mentioned earlier, twice as many upgrades are also allowed in lieu of new sites. Although GSM sites are not shown for simplicity; we simply assume that a fixed percentage of GSM sites may be suitable for upgrades, as explained in Annex 15.

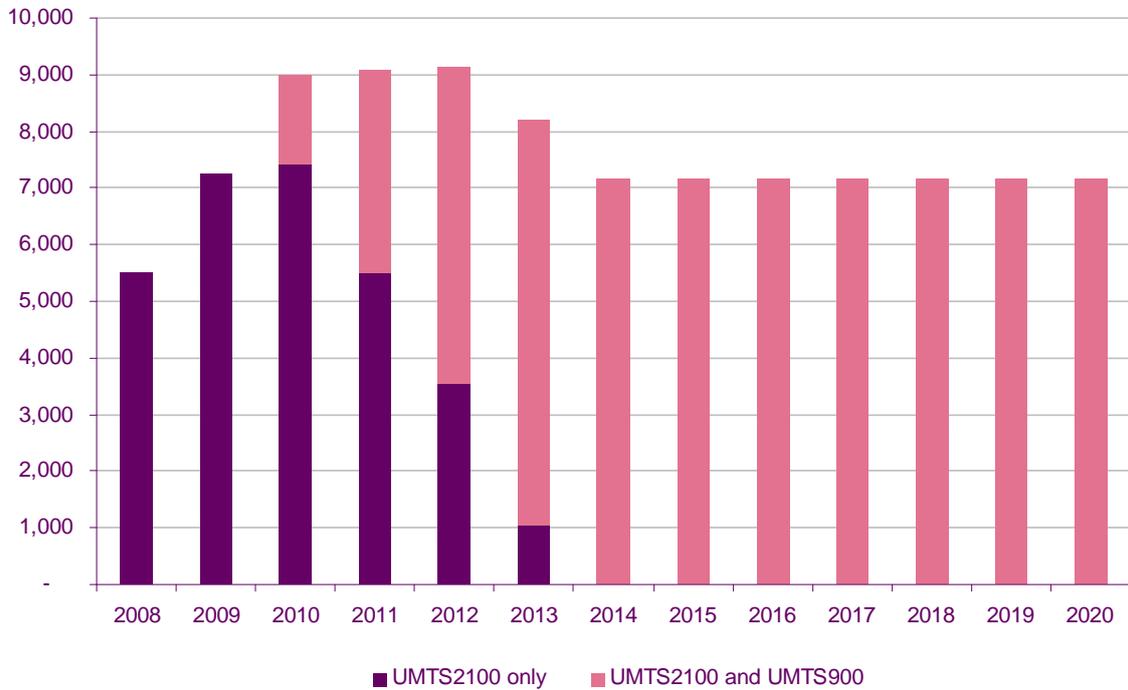
A12.83 For the operator without 900 MHz spectrum the absence of a limit on the number of sites deployed per year implies that the roll-out profile is not intended to be a realistically achievable roll-out target, as discussed earlier. The following features may strike a reader as unrealistic, but are explained by the purposes of the cost difference metric as follows:

- There is a sudden surge in sites in 2011. This is the year when UMTS 900 take-up is sufficiently high so that the UMTS 900 operator can benefit from its UMTS 900 network. As a result, an operator without 900 MHz would have to deploy a large number of sites to keep up.

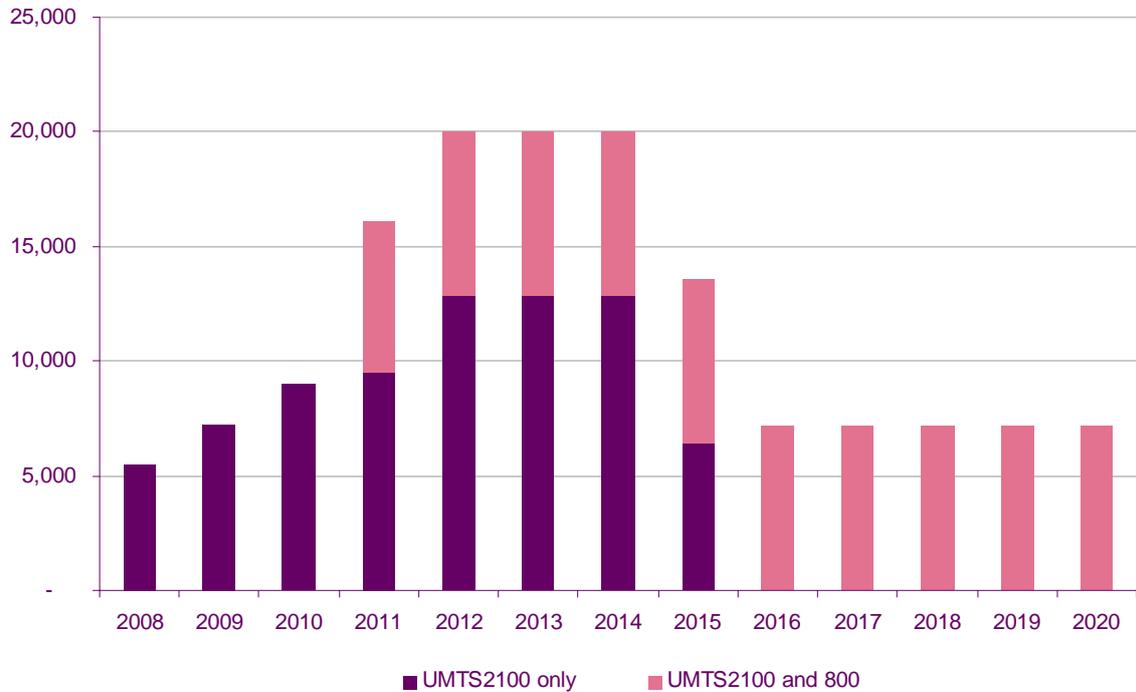
- A large number of 800 MHz sites is deployed in 2011. This is to avoid overstating the cost difference. When the operator is expanding its 2100 MHz network (in 2011), it also deploys 800 MHz equipment, to avoid the costs of two visits to the site. We consider this to be realistic so long as the operator has access to equipment by then.

Figure 5 - Example pair of roll out profiles

Operator with 900 MHz



Operator without 900 MHz



List of illustrative roll out profiles

A12.84 The following table show the inputs used in all of the roll out profiles to follow. The table is organised as follows:

- **Matching comparisons** This includes variations on the number of target sites, and on timing inputs. It also includes profiles meant to represent less densely populated areas
- **Non-matching comparisons** These are roll out profiles developed for comparisons where the level of service provided by the pair of networks are not designed to match year-by-year

A12.85 Site numbers are rounded to the nearest hundred.

Table 11 - List of pairs of roll out profiles and inputs

Rollout pair Number	Name	Operator with 900 MHz				Operator without 900 MHz				
		Target UMTS 900 sites	Stop growing 2100 MHz network	Decommission 2100 – only sites	New sites deployed by year	Target UMTS 2100 sites	Target 800 MHz sites	Stop growing 2100 MHz network	Decommission 2100 – only sites	New sites deployed by year
Matching comparisons - Variations in number of sites										
1	Lower demand, baseline	2,900	2011	2013	1,000	8,600	2,900	2013	2015	As many as needed to match 900 MHz service
2	As "lower demand" but high volume	6,800	2011	2013	1,000	9,000	6,800	2013	2015	As many as needed to match 900 MHz service
3	As "lower demand" but deep indoor coverage	4,000	2011	2013	1,000	12,700	4,000	2013	2015	As many as needed to match 900 MHz service
4	As "higher demand" but low data rates	6,800	2011	2013	1,000	13,100	6,800	2013	2015	As many as needed to match 900 MHz service
5	As "higher demand" but low indoor depth	5,900	2011	2013	1,000	14,400	5,900	2013	2015	As many as needed to match 900 MHz service
6	Higher demand	7,300	2011	2013	1,000	21,100	7,300	2013	2015	As many as needed to match 900 MHz service
7	As "higher demand" but 60 MB	11,800	2011	2013	1,000	21,400	11,800	2013	2015	As "higher demand" but 60 MB
8	As "higher demand" but 40 MB	7,900	2011	2013	1,000	21,200	7,900	2013	2015	As "higher demand" but 40 MB

9	Higher demand with highest technical parameters	10,000	2011	2013	1,000	74,100	10,000	2013	2015	As many as needed to match 900 MHz service
10	Higher demand with example lower parameters (no body loss)	5,900	2011	2013	1,000	11,100	5,900	2013	2015	As many as needed to match 900 MHz service
11	Lower demand, 800 MHz target is 85% of 900 MHz target	2,900	2011	2013	1,000	8,600	2,500	2013	2015	As many as needed to match 900 MHz service
12	Lower demand, 800 MHz target is 50% of 900 MHz target	2,900	2011	2013	1,000	8,600	1,400	2013	2015	As many as needed to match 900 MHz service
13	Lower demand, 800 MHz target is 33% of 900 MHz target	2,900	2011	2013	1,000	8,600	1,000	2013	2015	As many as needed to match 900 MHz service
14	Higher demand, 800 MHz target is 85% of 900 MHz target	7,300	2011	2013	1,000	21,100	6,100	2013	2015	As many as needed to match 900 MHz service
15	Higher demand, 800 MHz target is 50% of 900 MHz target	7,300	2011	2013	1,000	21,100	3,600	2013	2015	As many as needed to match 900 MHz service
16	Higher demand, 800 MHz target is 33% of 900 MHz target	7,300	2011	2013	1,000	21,100	2,400	2013	2015	As many as needed to match 900 MHz service
Matching comparisons - Variations in timing and decommissioning inputs										

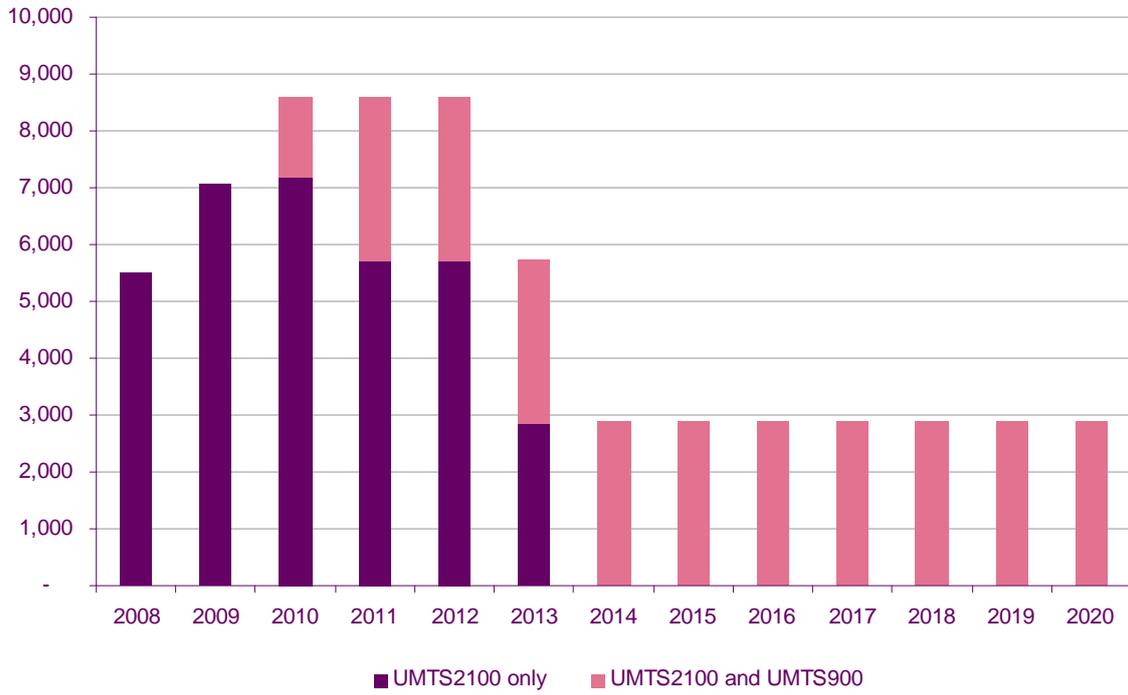
Application of spectrum liberalisation and trading to the mobile sector – A further consultation

17	Higher demand - Late 800 MHz	7,300	2011	2013	1,000	21,100	7,300	2015	2017	As many as needed to match 900 MHz service
18	Higher demand - Late UMTS 900	7,300	2012	2014	1,000	21,100	7,300	2013	2015	As many as needed to match 900 MHz service
19	Higher demand - Late 900 and 800 MHz	7,300	2012	2014	1,000	21,100	7,300	2015	2017	As many as needed to match 900 MHz service
20	Higher demand - decommission an year later	7,300	2011	2014	1,000	21,100	7,300	2013	2016	As many as needed to match 900 MHz service
21	Higher demand- no decommissioning	7,300	2011	Never	1,000	21,100	7,300	2013	Never	As many as needed to match 900 MHz service
22	Higher demand - faster roll out	7,300	2011	2013	1,500	21,100	7,300	2013	2015	As many as needed to match 900 MHz service
23	Lower demand - Late 800 MHz	2,900	2011	2013	1,000	8,600	2,900	2015	2017	As many as needed to match 900 MHz service
24	Lower demand - Late UMTS 900	2,900	2012	2014	1,000	8,600	2,900	2013	2015	As many as needed to match 900 MHz service
25	Lower demand - Late 900 and 800 MHz	2,900	2012	2014	1,000	8,600	2,900	2015	2017	As many as needed to match 900 MHz service
26	Lower demand - no 800 MHz	2,900	2011	2013	1,000	8,600	2,900	N/A	N/A	As many as needed to match 900 MHz service

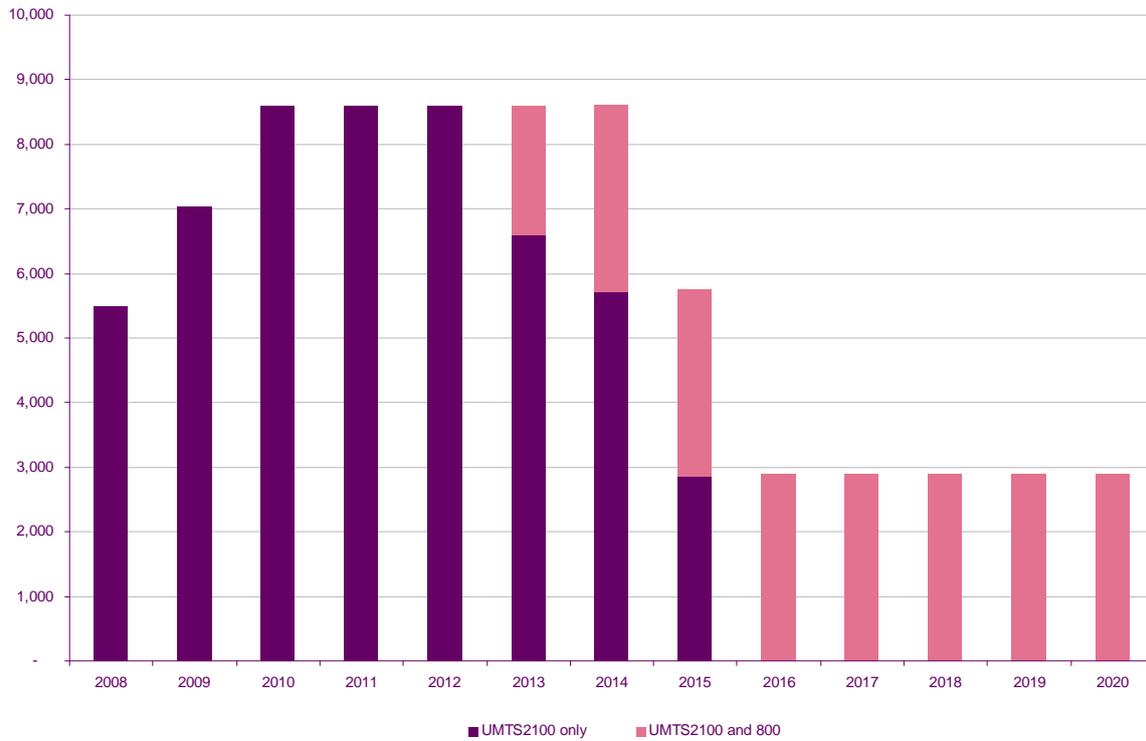
27	Higher demand - no 800 MHz	7,300	2011	2013	1,000	21,100	7,300	N/A	N/A	As many as needed to match 900 MHz service
Matching comparisons – Less densely populated areas										
28	Less densely populated areas, slower deployment	900	2011	2013	125	2,600	900	2013	2015	As many as needed to match 900 MHz service
29	Less densely populated areas, faster deployment	900	2011	2013	250	2,600	900	2013	2015	As many as needed to match 900 MHz service
Non-matching comparisons										
30	Non-matching roll out, 6000 vs. 15,000	6,000	2011	2013	1,500	15,000	6,000	2015	2017	1500
31	Non-matching roll out, 7,300 vs. 15,000	7,300	2011	2013	1,500	15,000	7,300	2015	2017	1500
32	Non-matching roll out, 7,300 vs. 9,000	7,300	2011	2013	1,500	9,000	7,300	2013	2015	1500

Pair 1 - Lower demand, baseline

Operator with 900 MHz

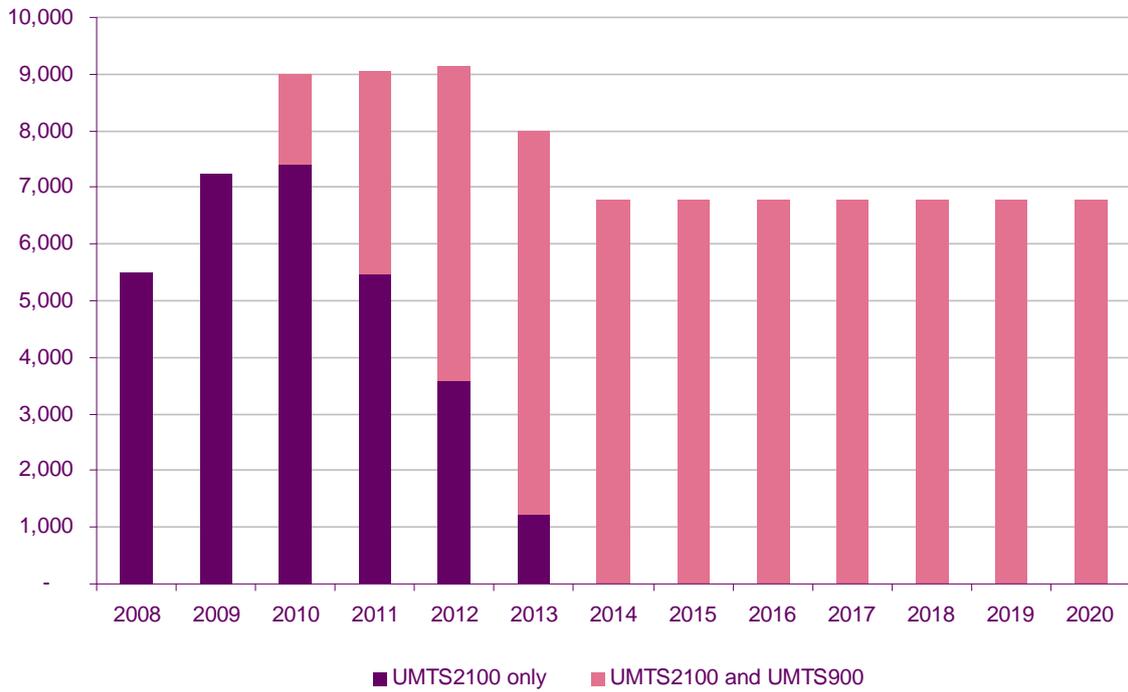


Operator without 900 MHz

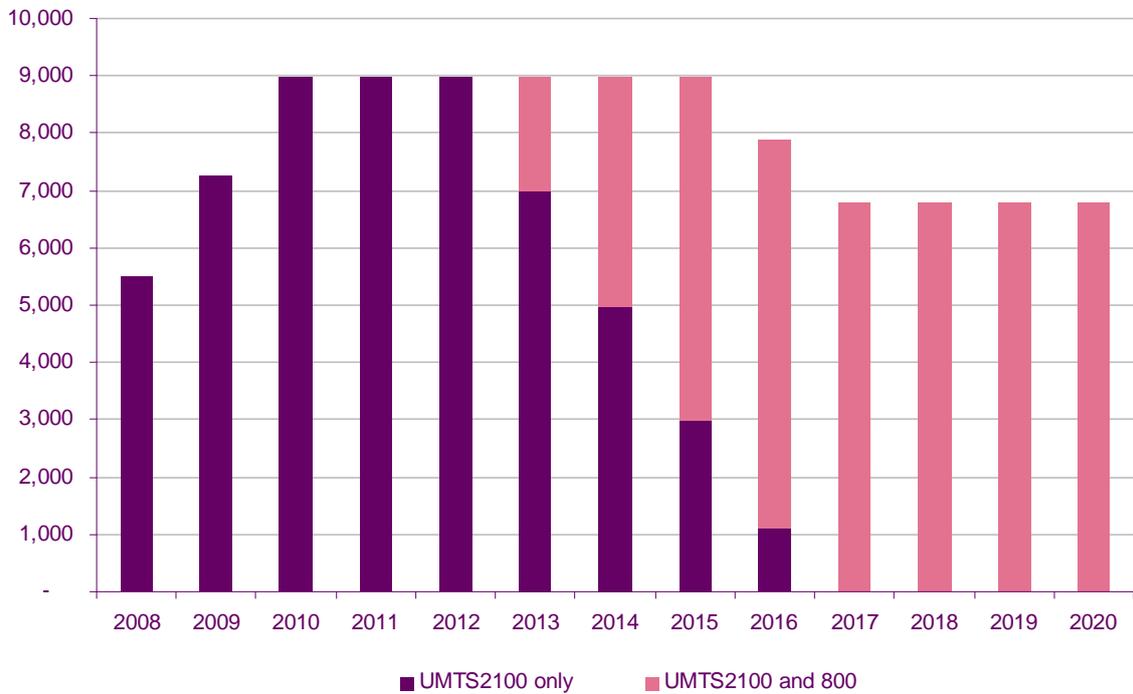


Pair 2 - As "lower demand" but high volume

Operator with 900 MHz

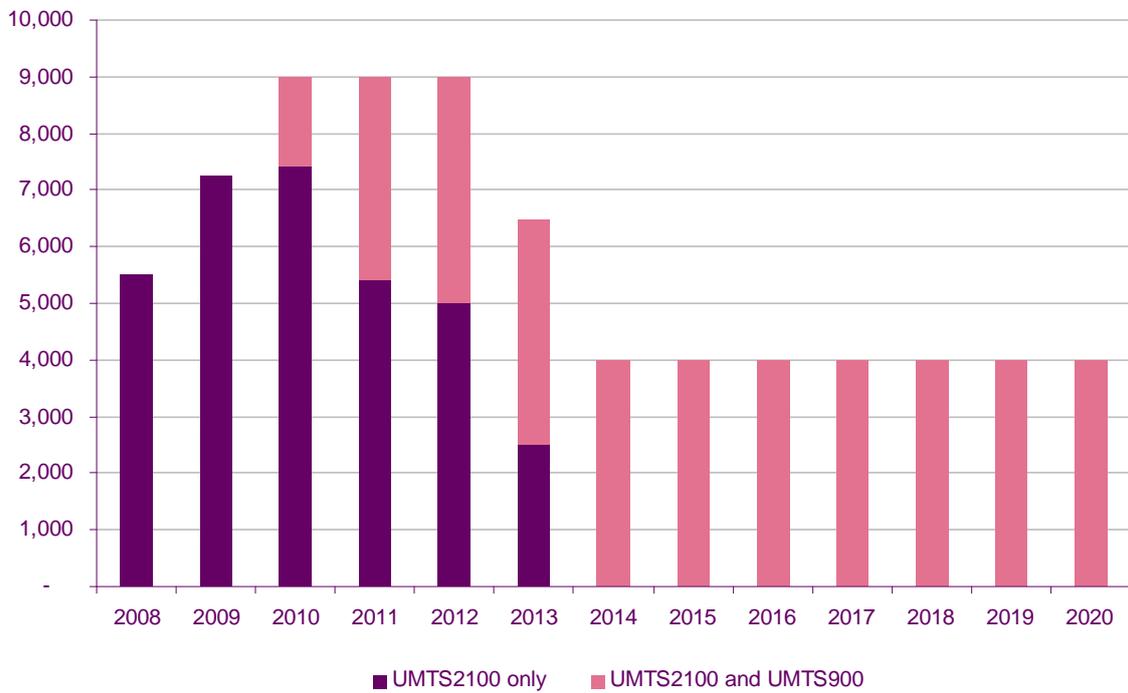


Operator without 900 MHz

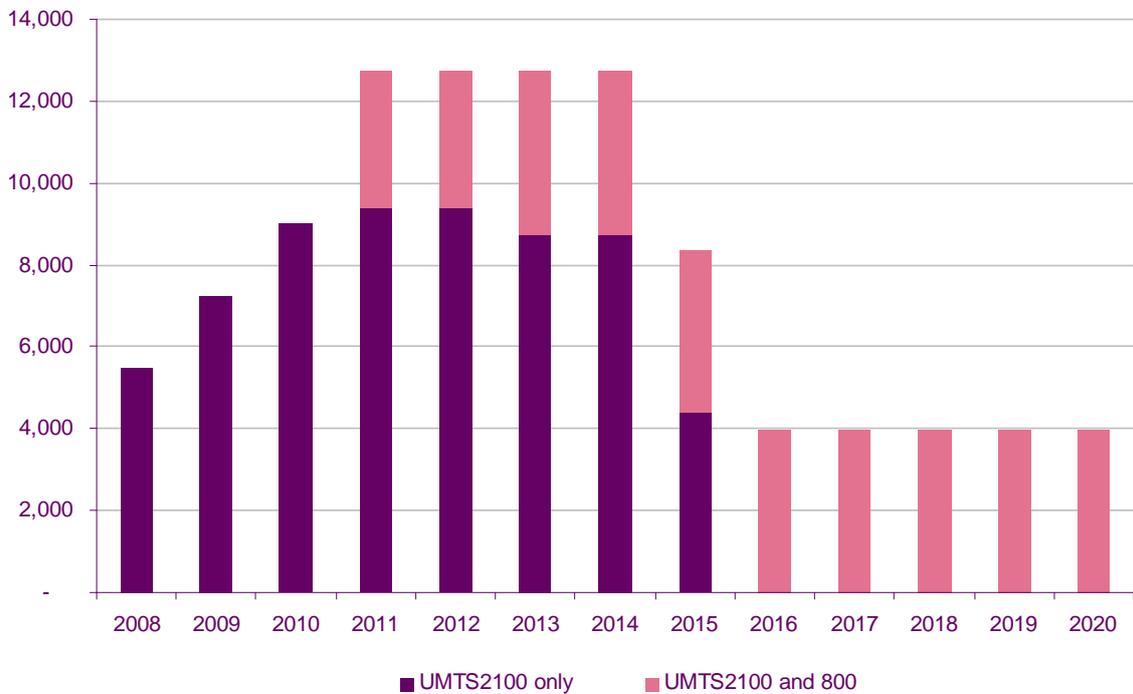


Pair 3 - As "lower demand" but deep indoor coverage

Operator with 900 MHz

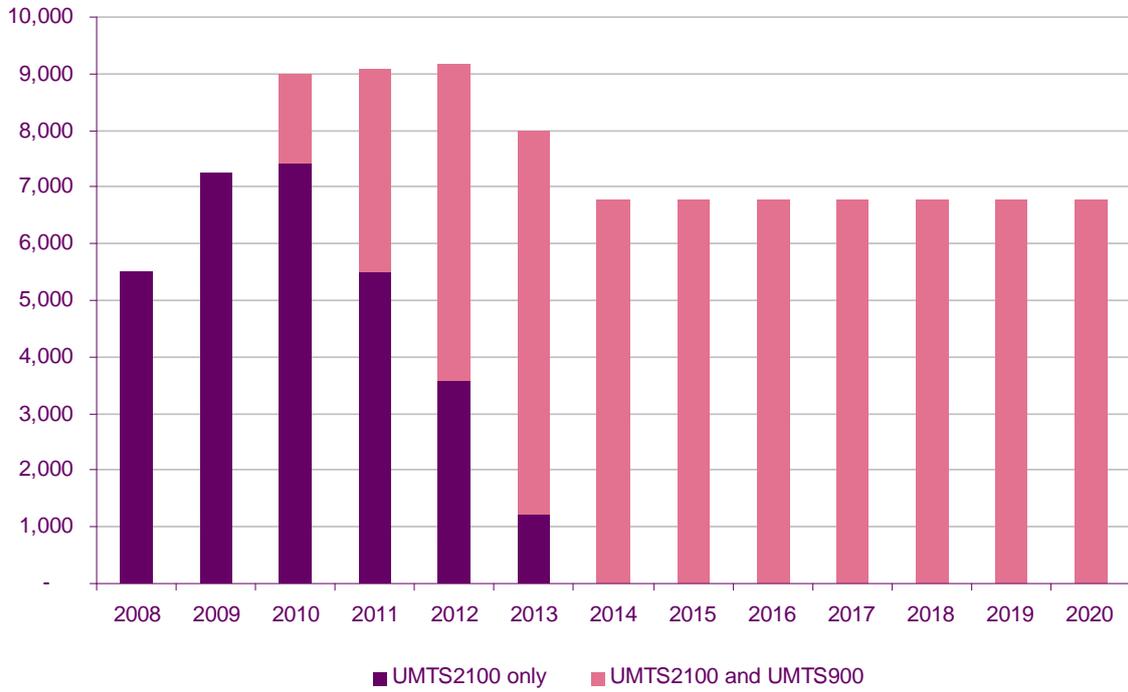


Operator without 900 MHz

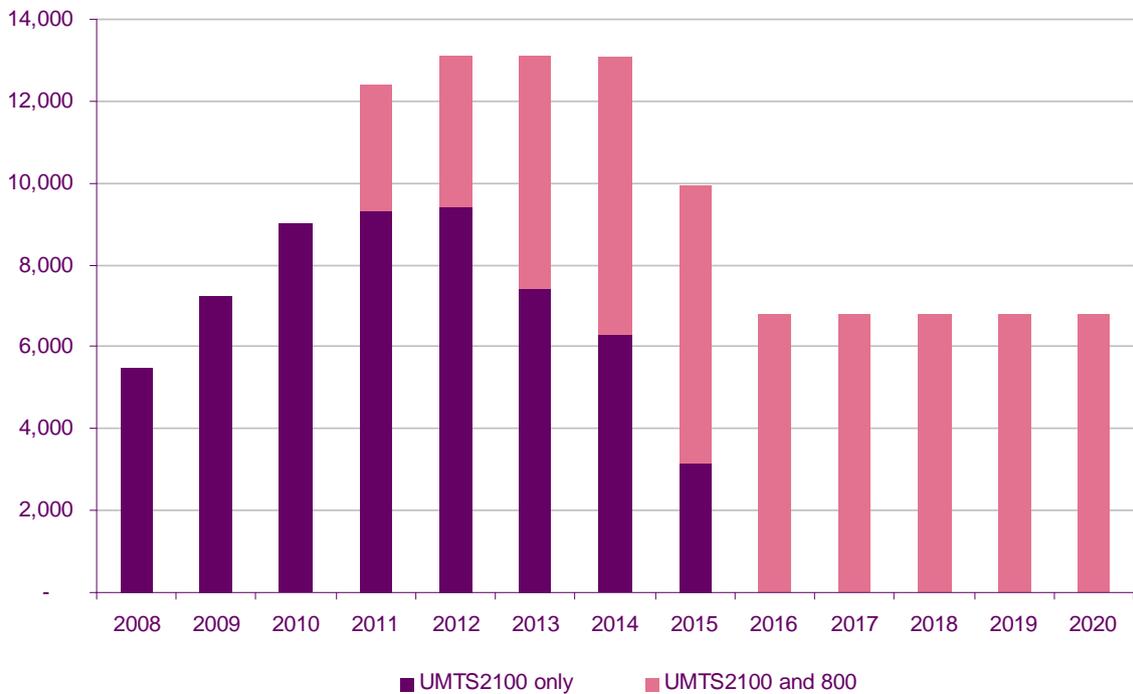


Pair 4 - As "higher demand" but low data rates

Operator with 900 MHz



Operator without 900 MHz

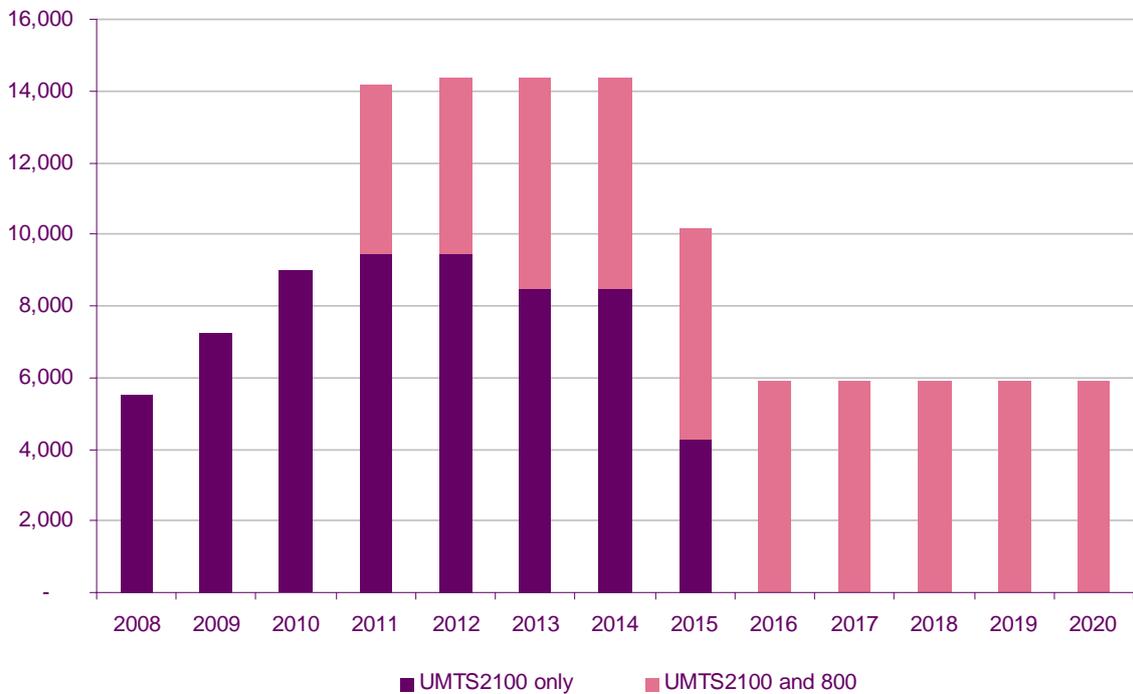


Pair 5 - As "higher demand" but low indoor depth

Operator with 900 MHz

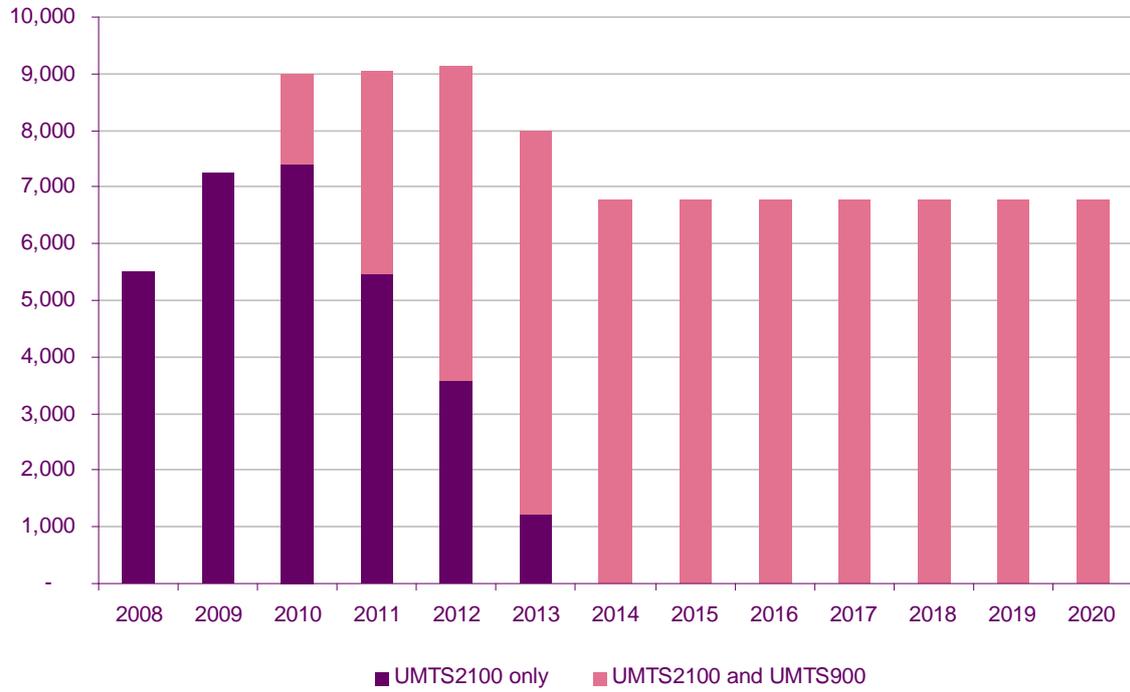


Operator without 900 MHz

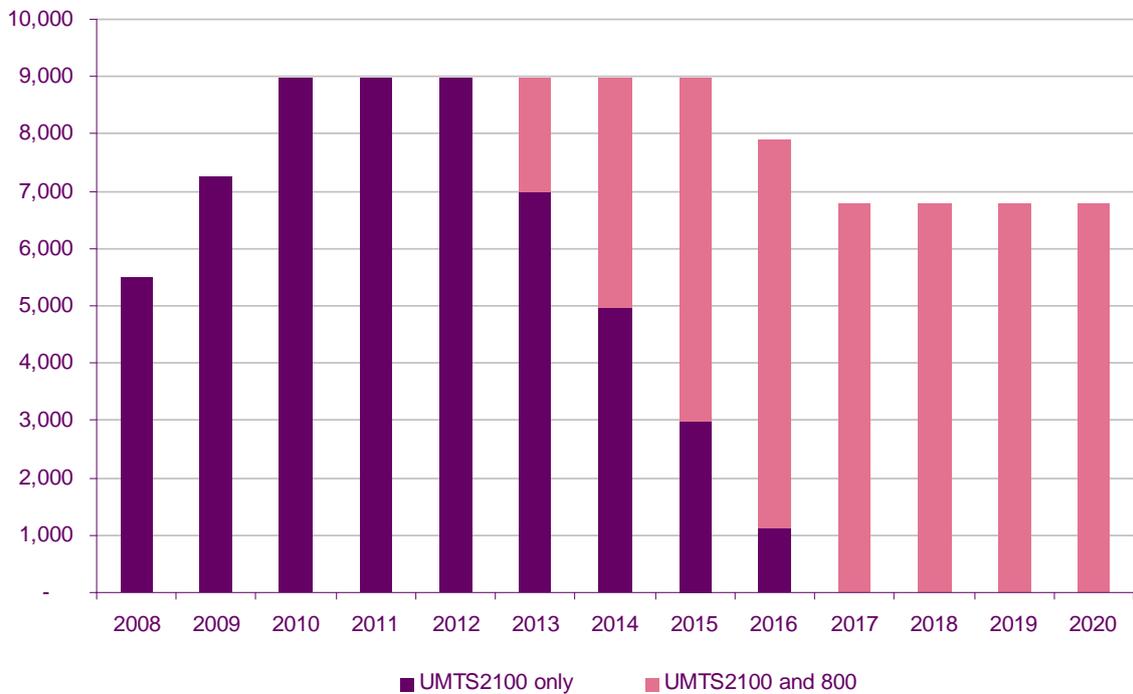


Pair 6 - Higher demand

Operator with 900 MHz

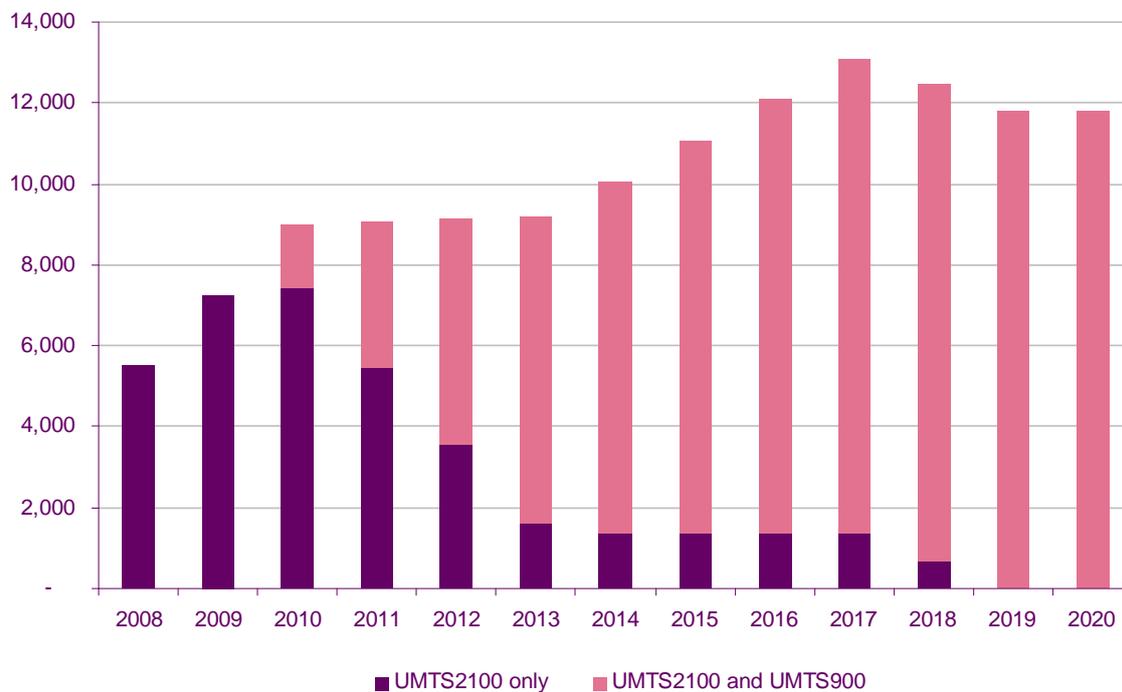


Operator without 900 MHz

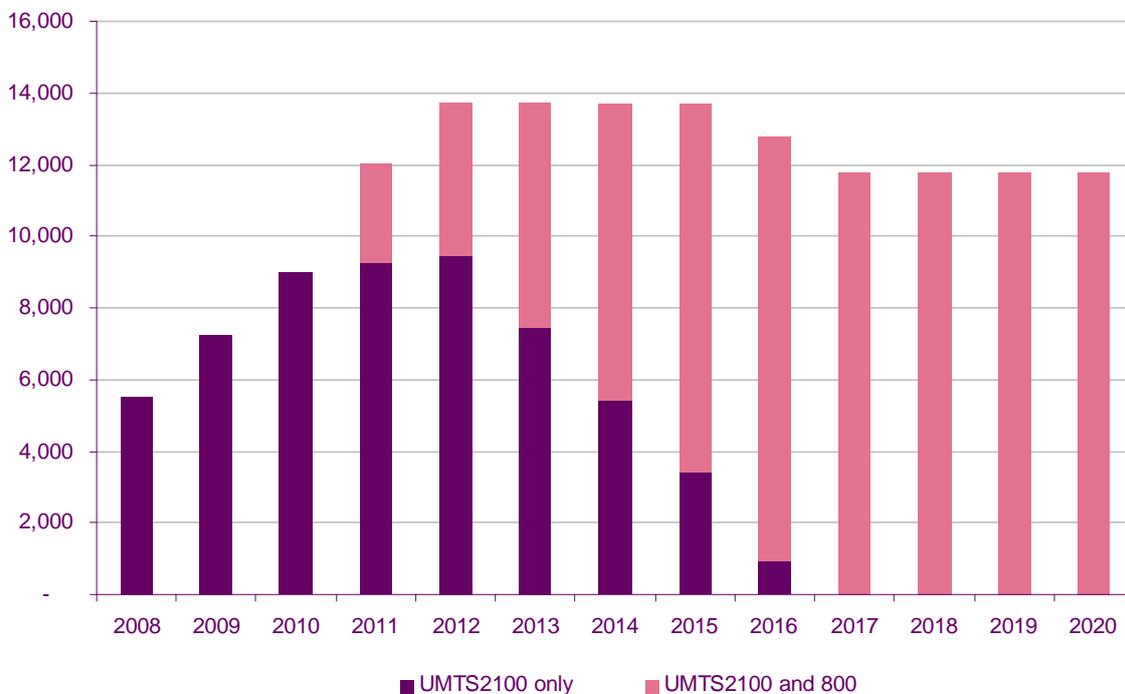


Pair 7 - As "higher demand" but 60 MB

Operator with 900 MHz

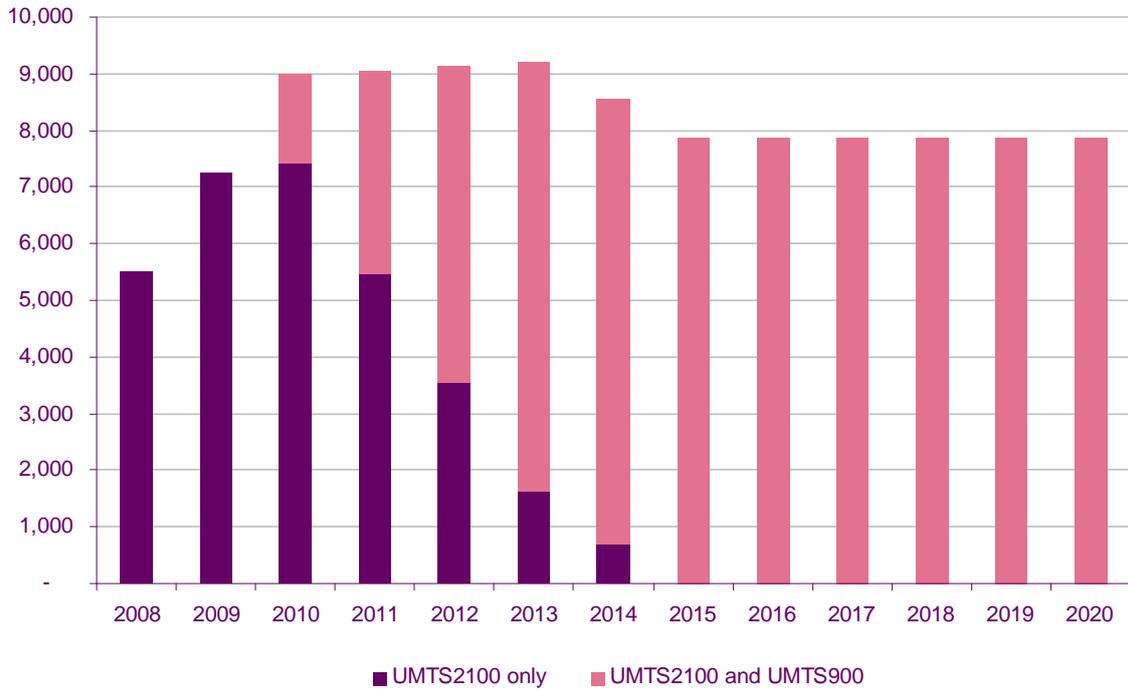


Operator without 900 MHz

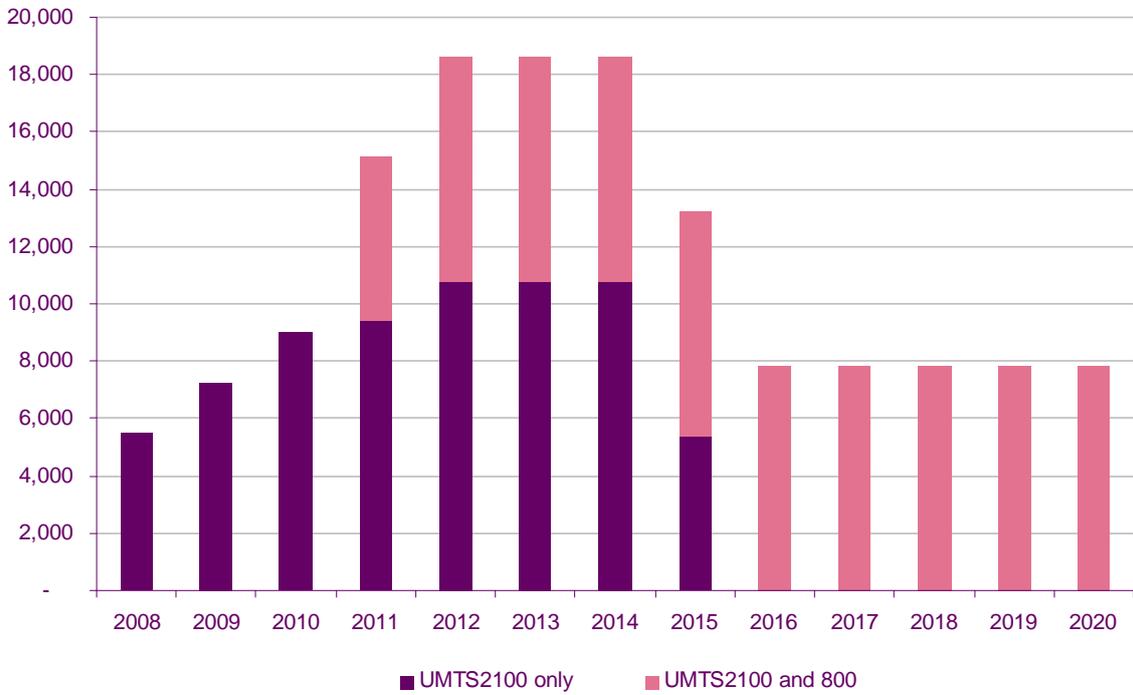


Pair 8 - As "higher demand" but 40 MB

Operator with 900 MHz

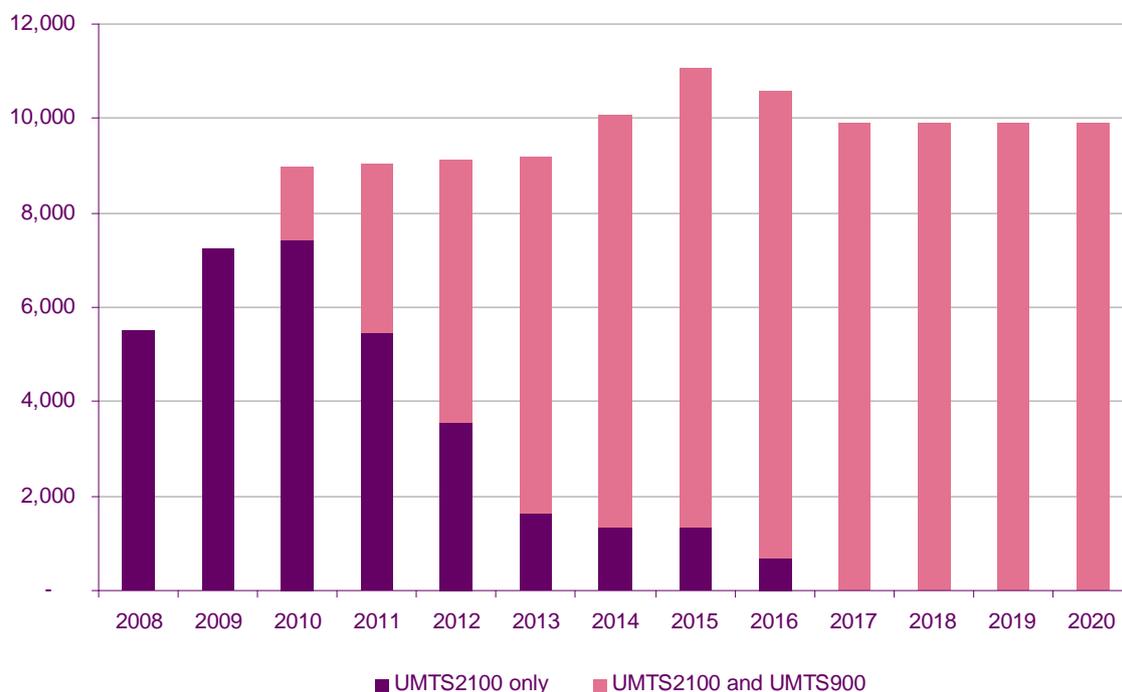


Operator without 900 MHz

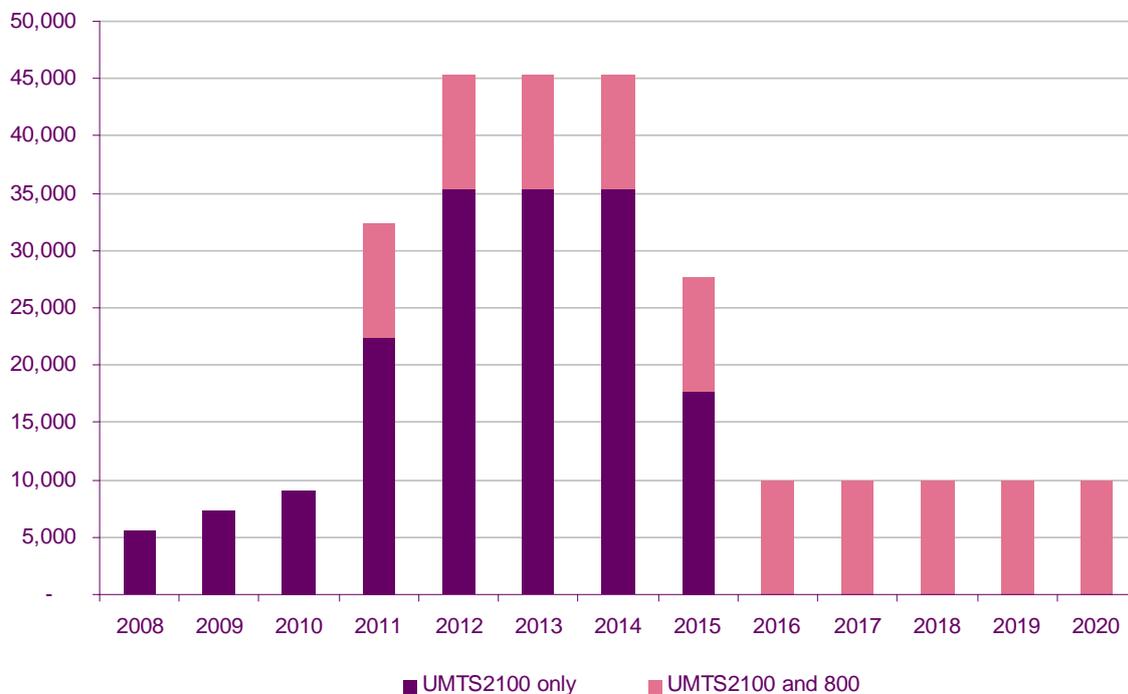


Pair 9 - Higher demand with highest technical parameters

Operator with 900 MHz

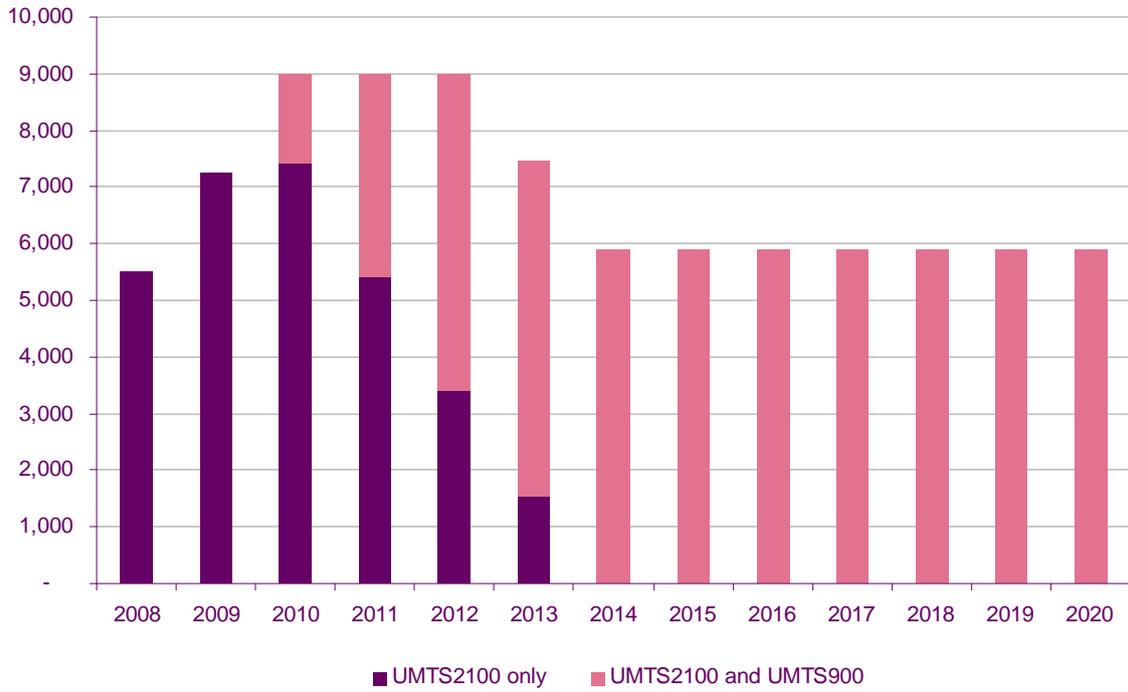


Operator without 900 MHz

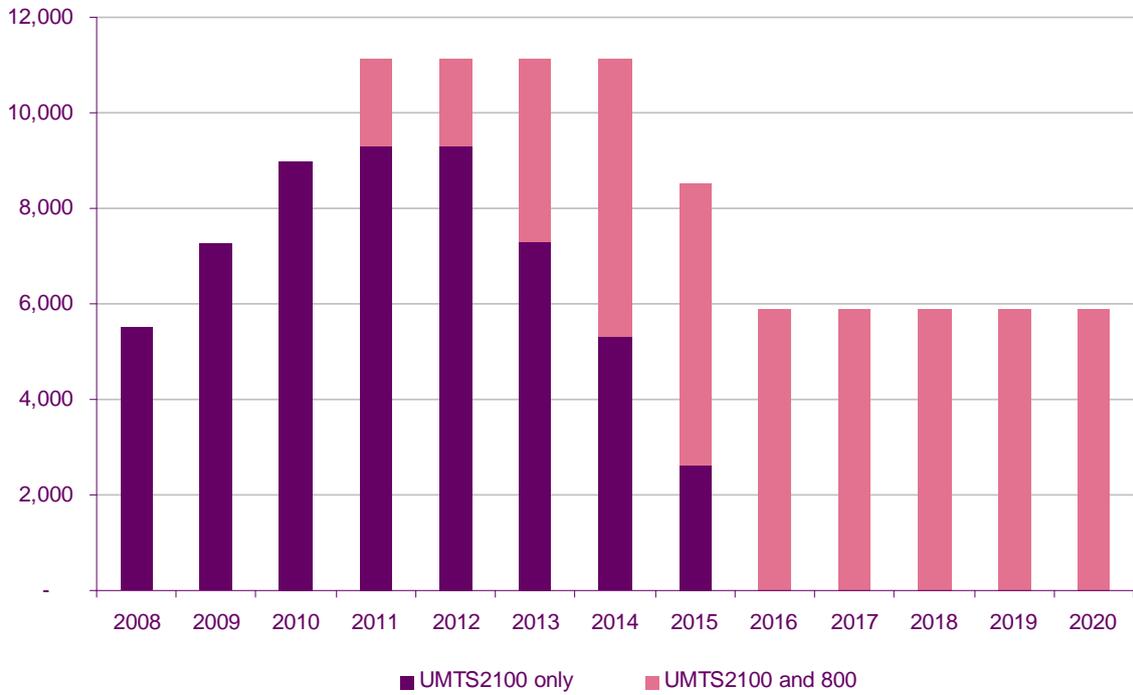


Pair 10 - Higher demand with example lower parameters (no body loss)

Operator with 900 MHz

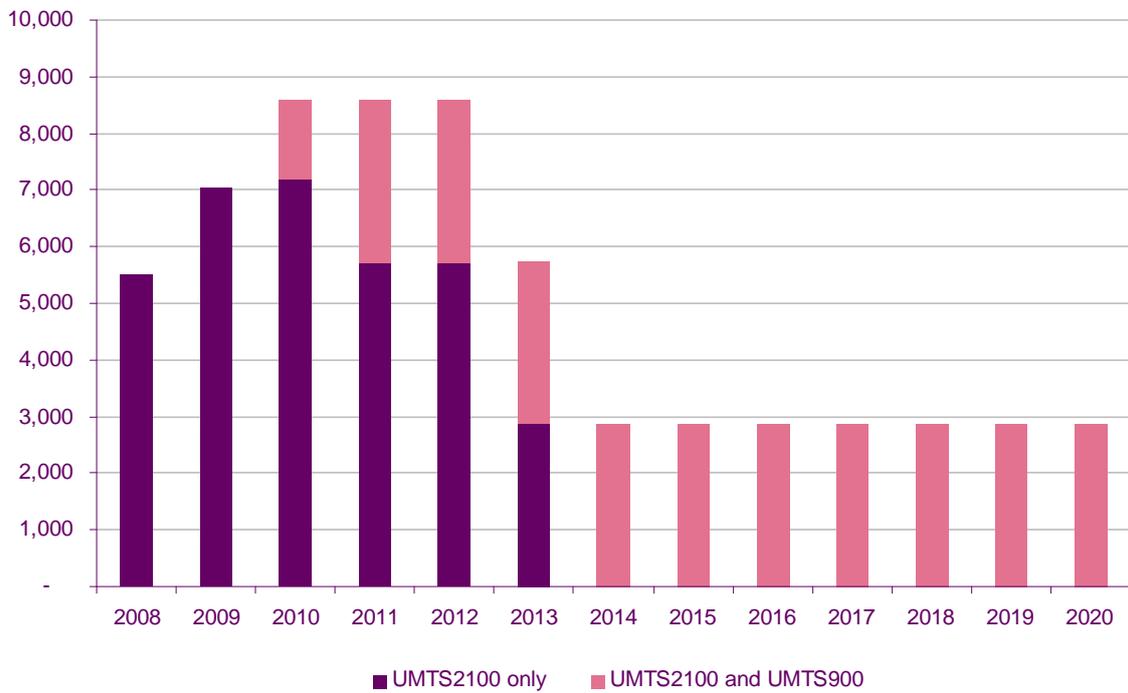


Operator without 900 MHz

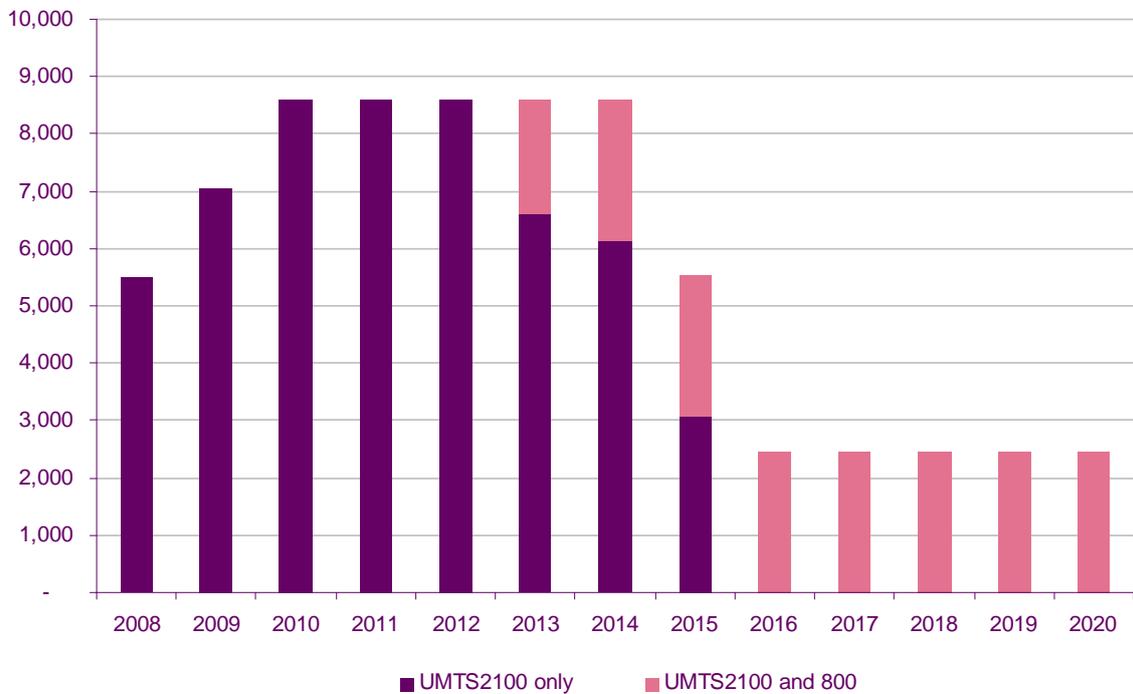


Pair 11 - Lower demand, 800 MHz target is 85% of 900 MHz target

Operator with 900 MHz

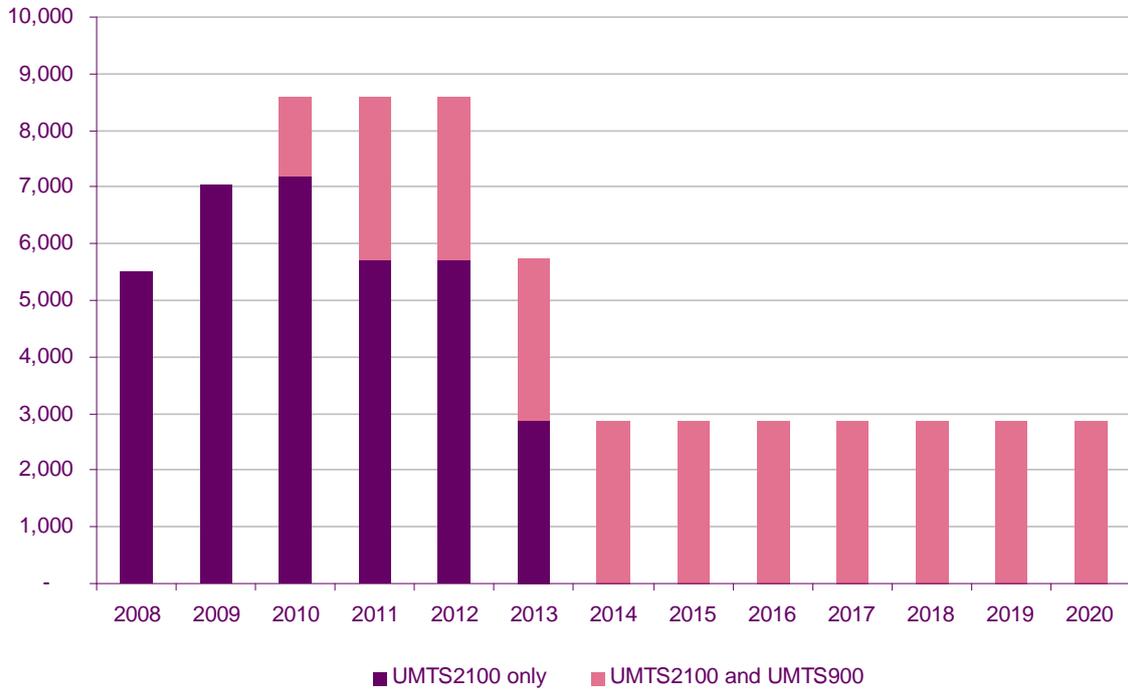


Operator without 900 MHz

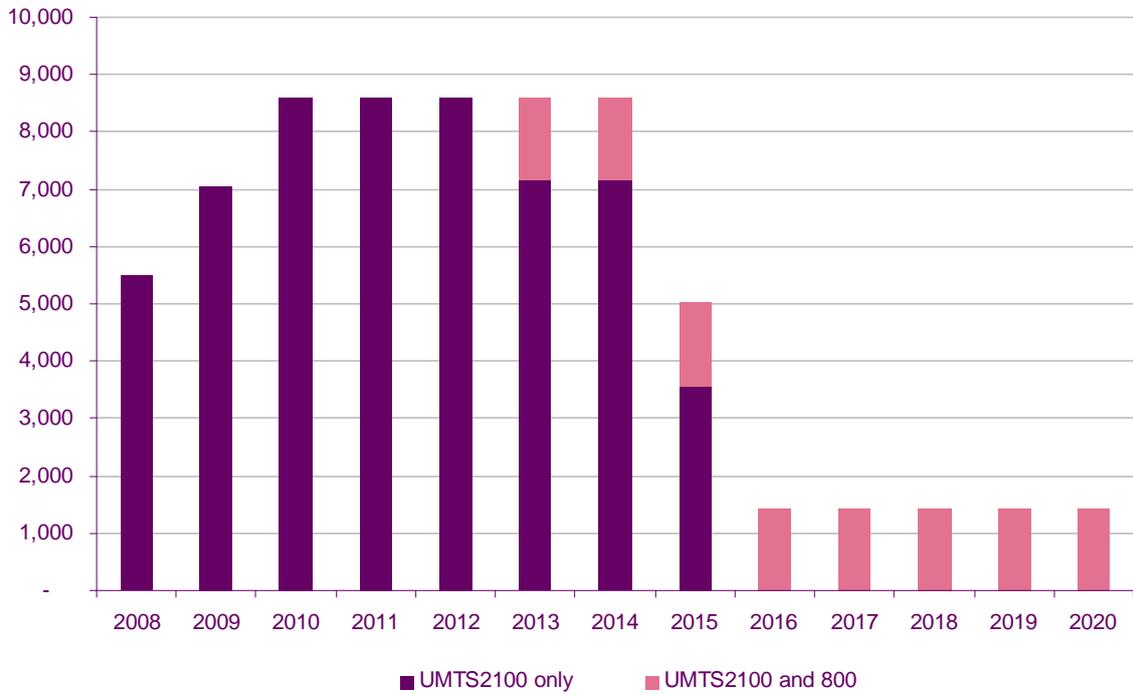


Pair 12 - Lower demand, 800 MHz target is 50% of 900 MHz target

Operator with 900 MHz



Operator without 900 MHz

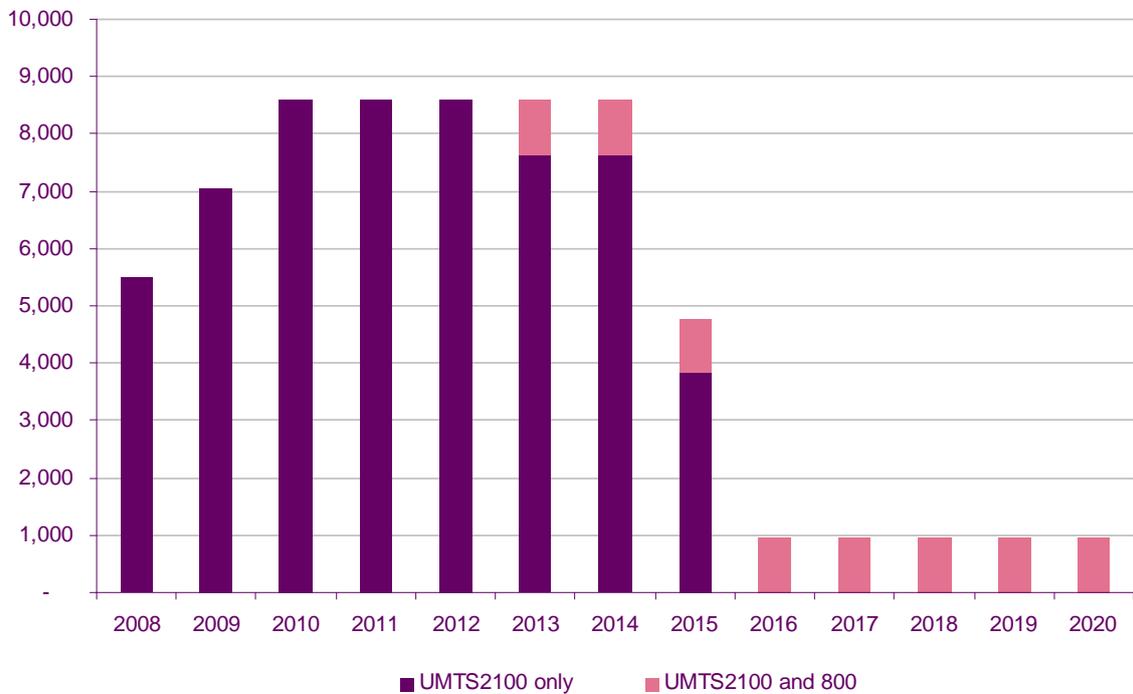


Pair 13 - Lower demand, 800 MHz target is 33% of 900 MHz target

Operator with 900 MHz

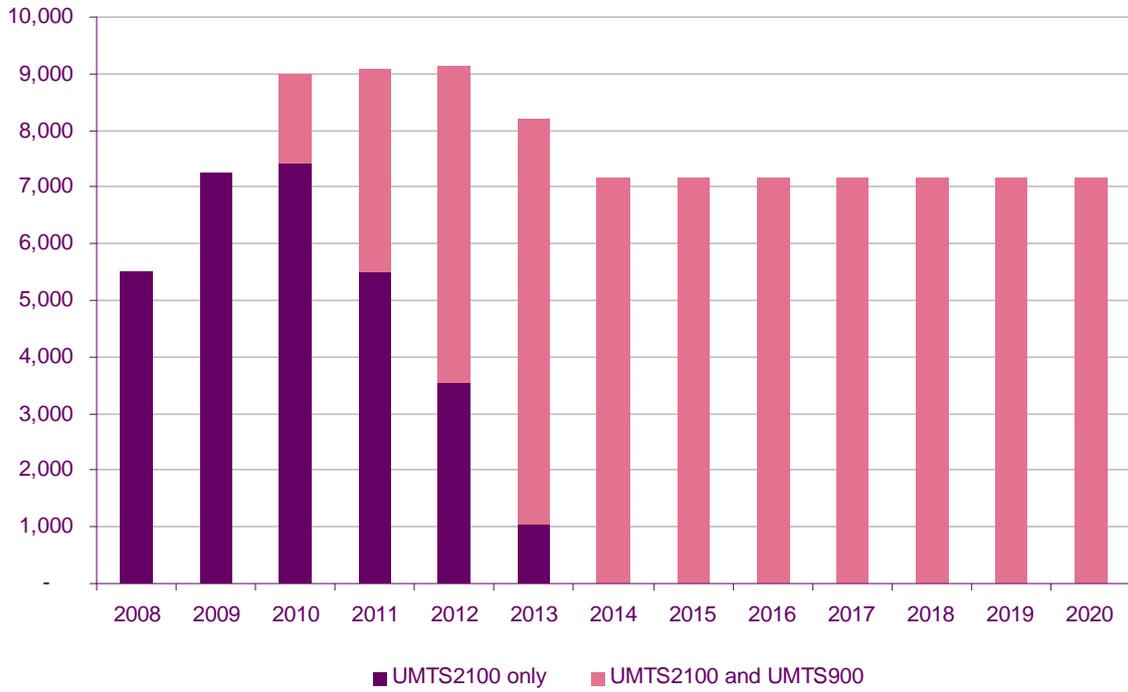


Operator without 900 MHz

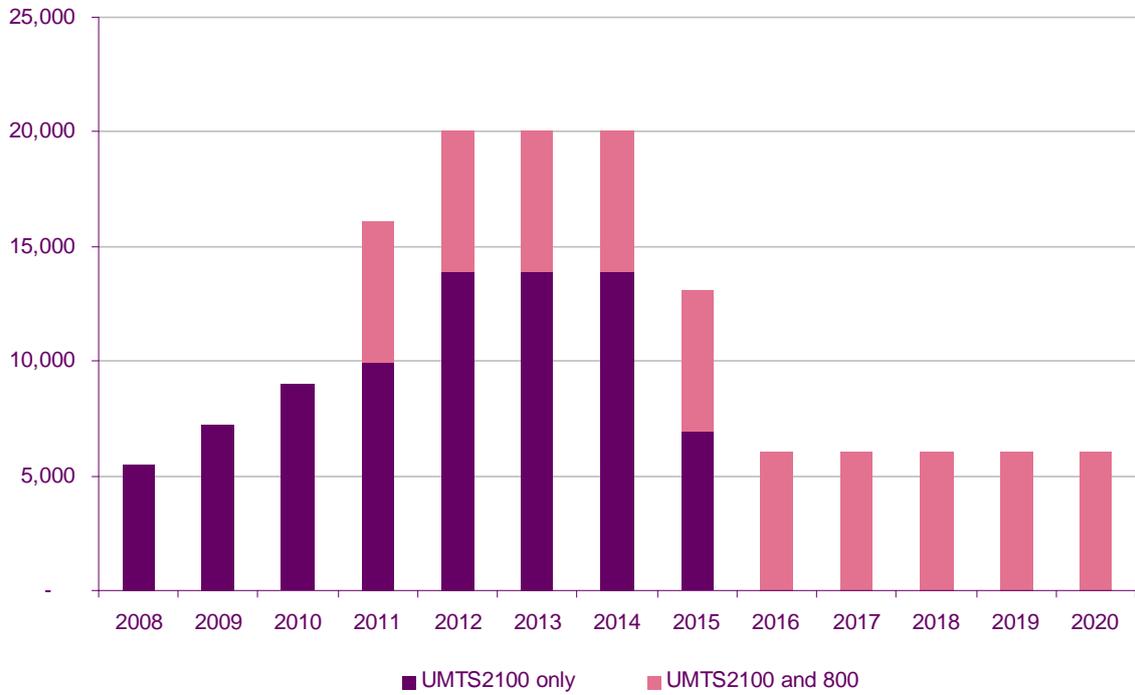


Pair 14 - Higher demand, 800 MHz target is 85% of 900 MHz target

Operator with 900 MHz

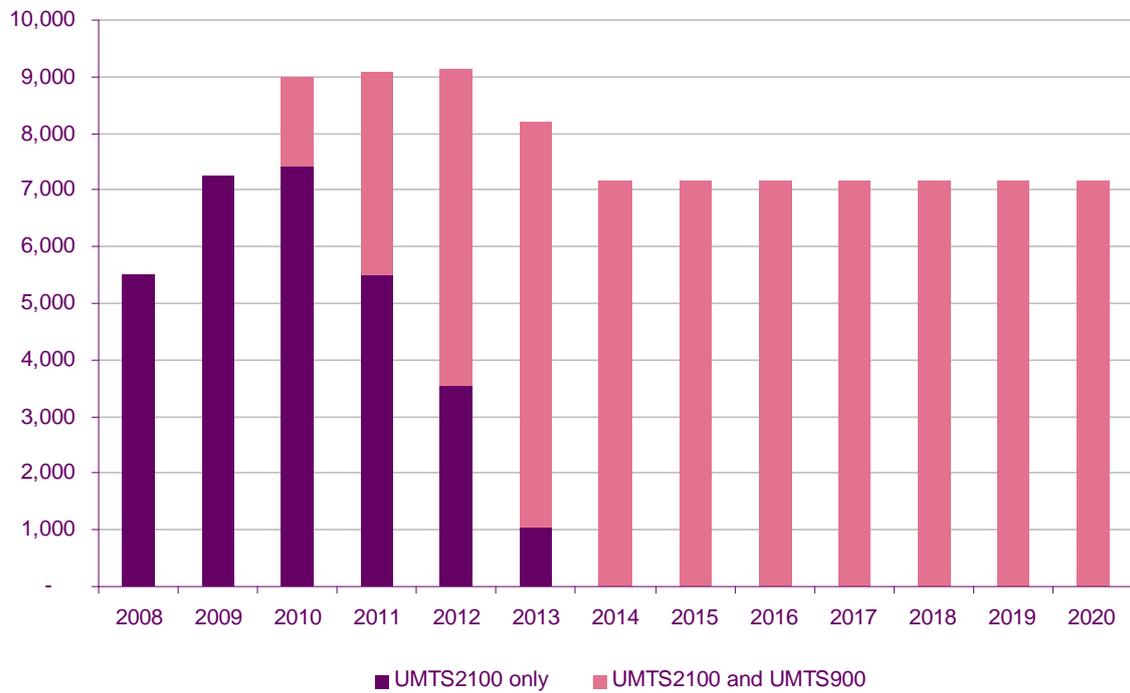


Operator without 900 MHz

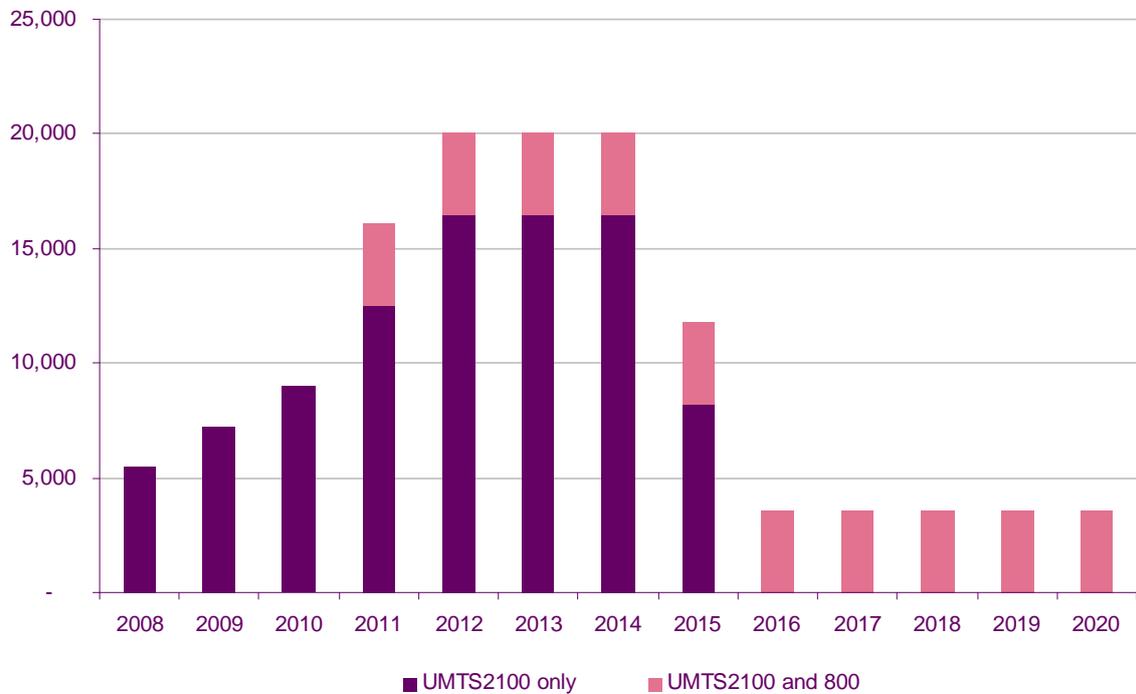


Pair 15 - Higher demand, 800 MHz target is 50% of 900 MHz target

Operator with 900 MHz

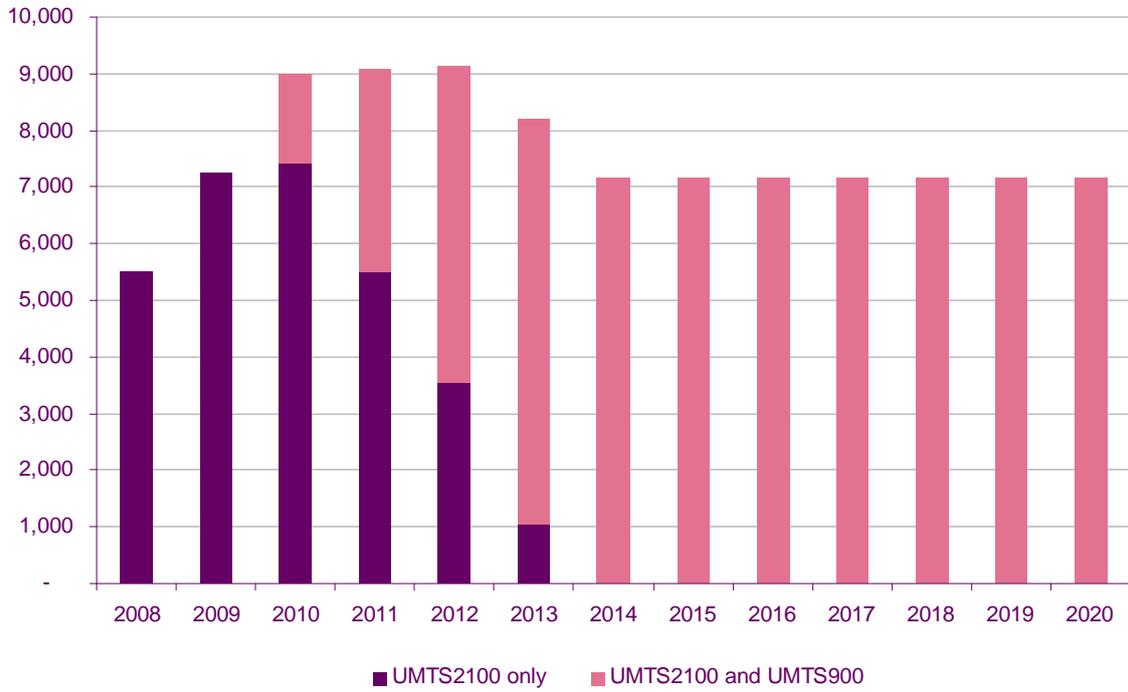


Operator without 900 MHz

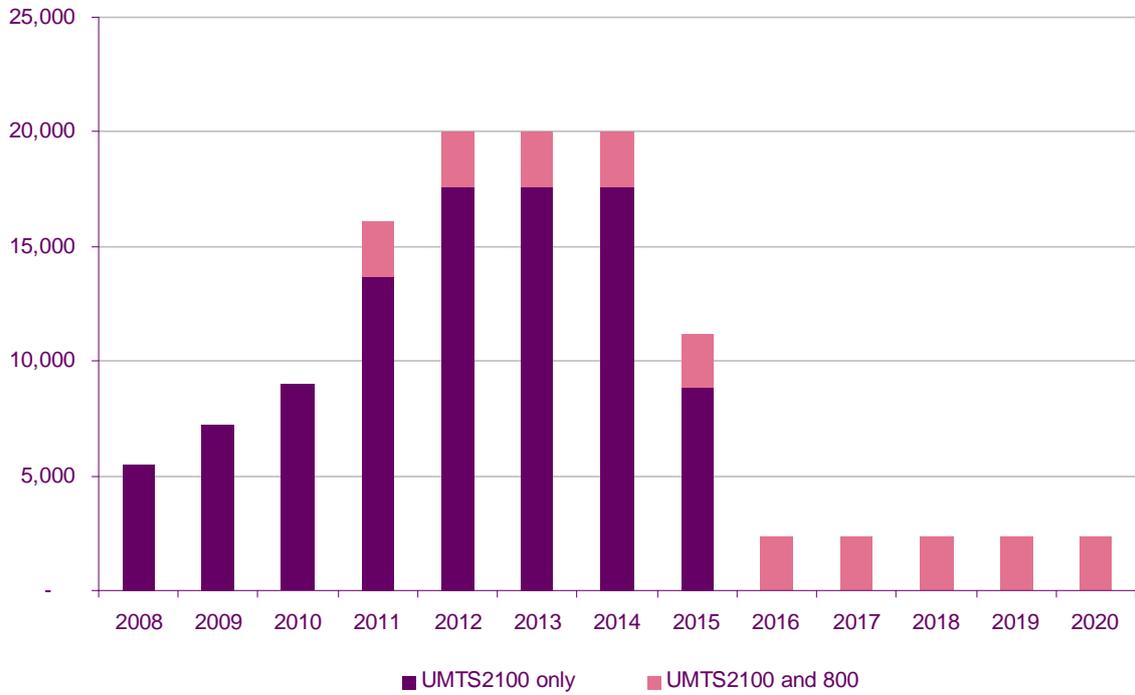


Pair 16 - Higher demand, 800 MHz target is 33% of 900 MHz target

Operator with 900 MHz

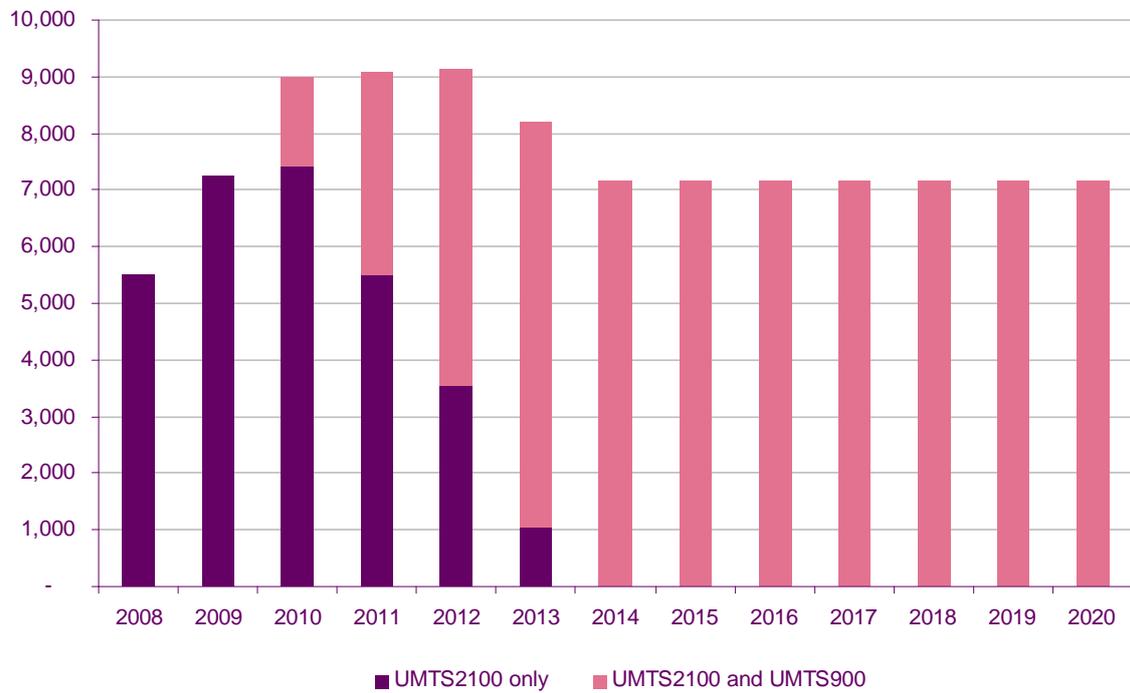


Operator without 900 MHz

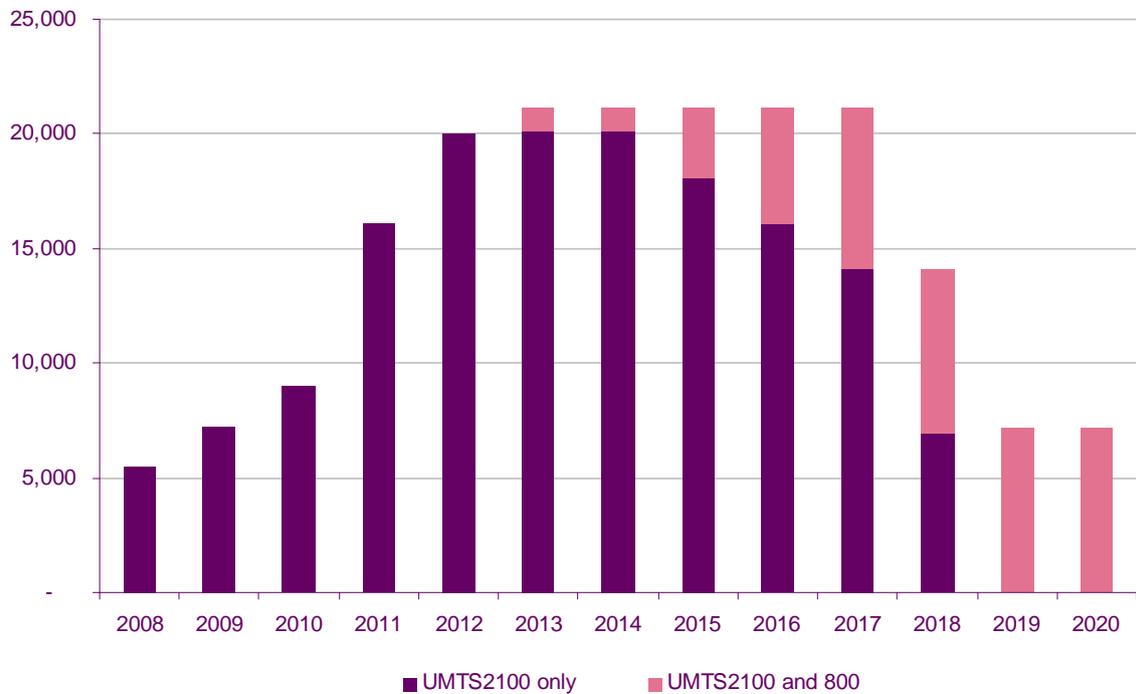


Pair 17 – Higher demand - Late 800 MHz

Operator with 900 MHz

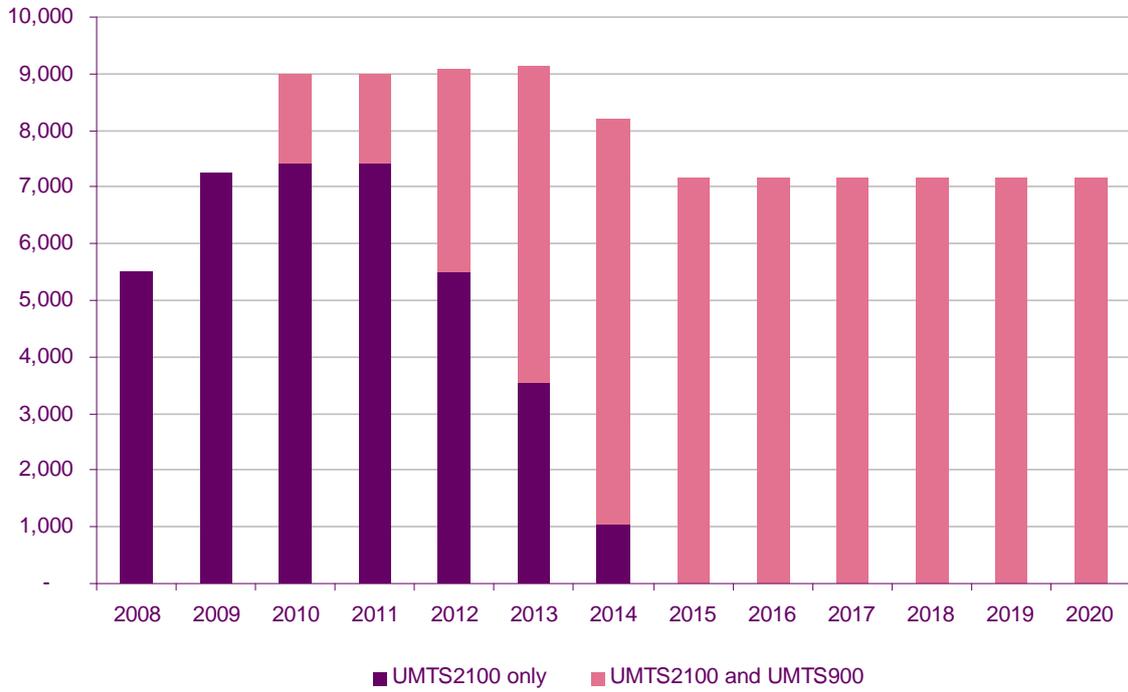


Operator without 900 MHz

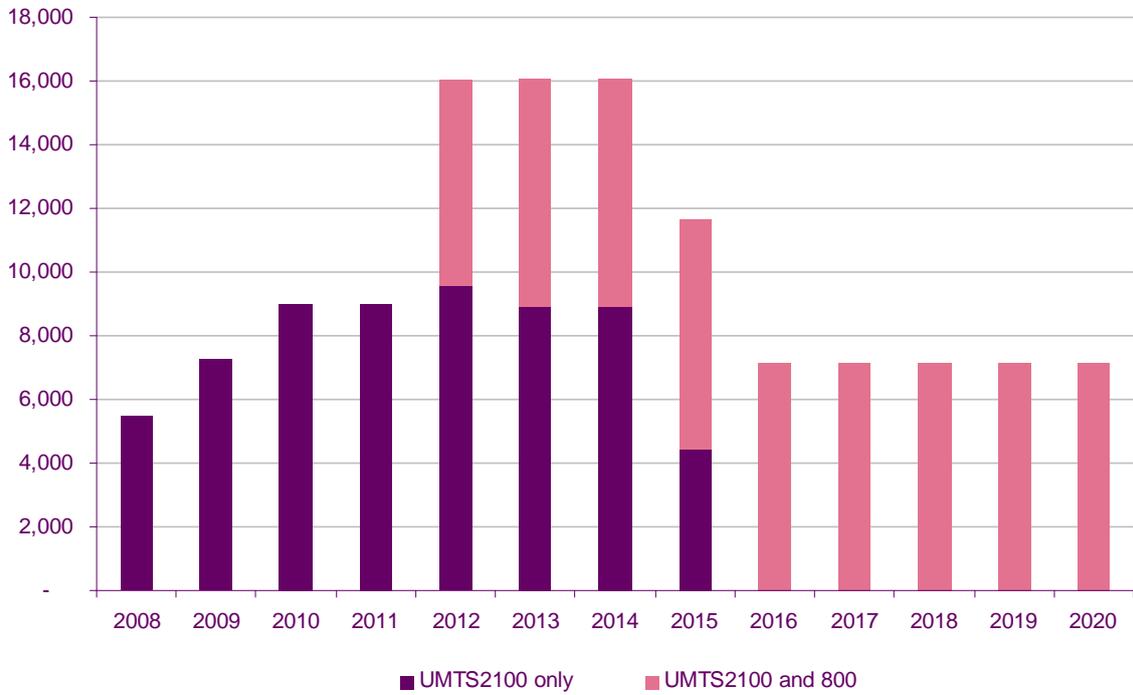


Pair 18 – Higher demand - Late UMTS 900

Operator with 900 MHz

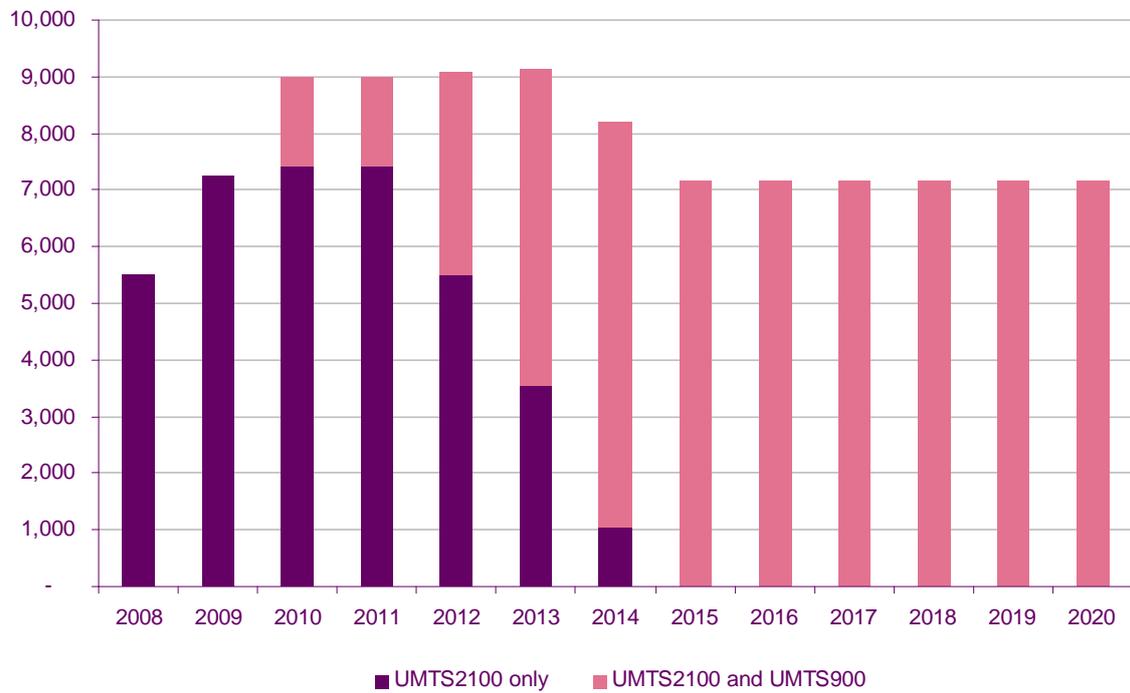


Operator without 900 MHz

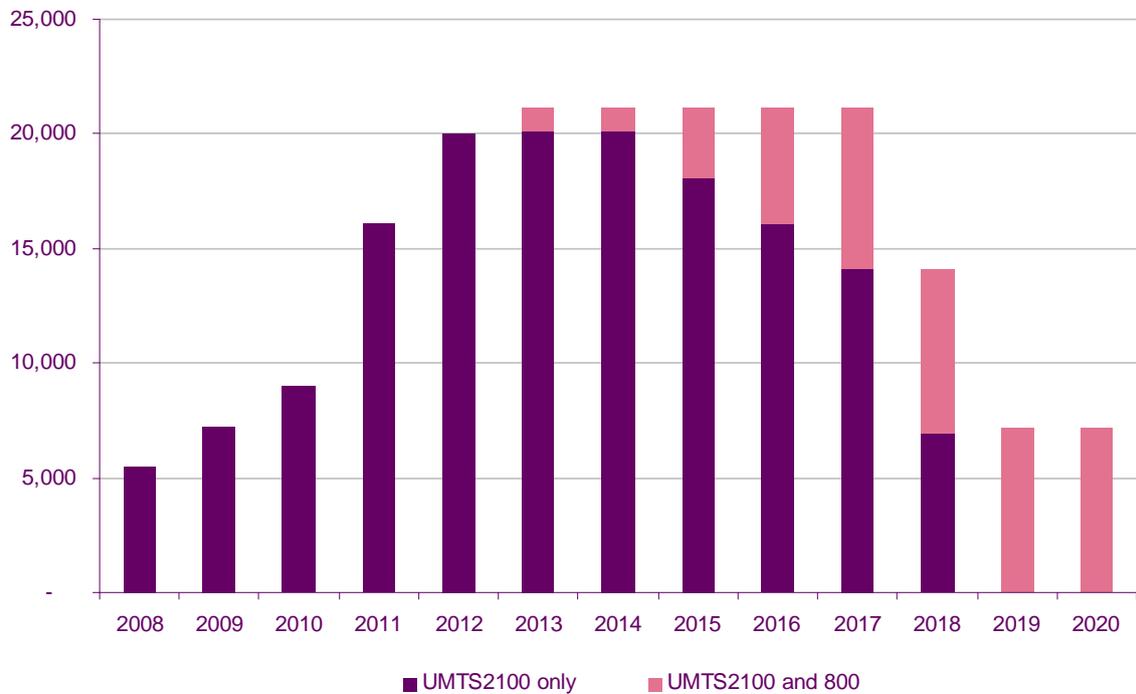


Pair 19 – Higher demand - Late 900 and 800 MHz

Operator with 900 MHz

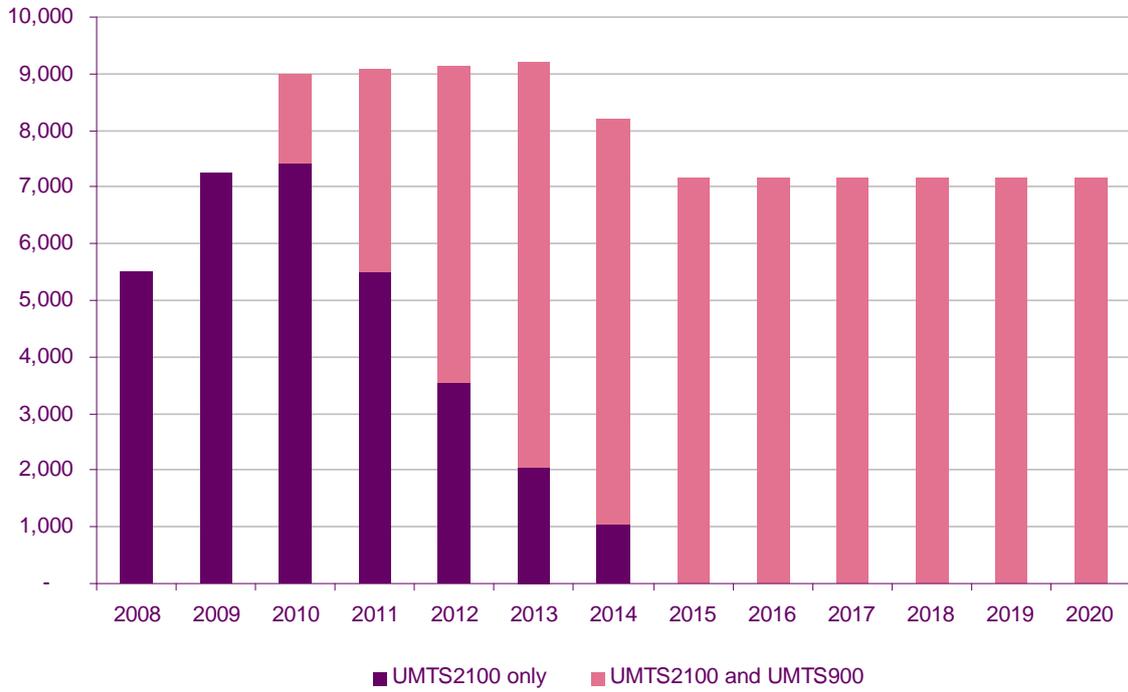


Operator without 900 MHz

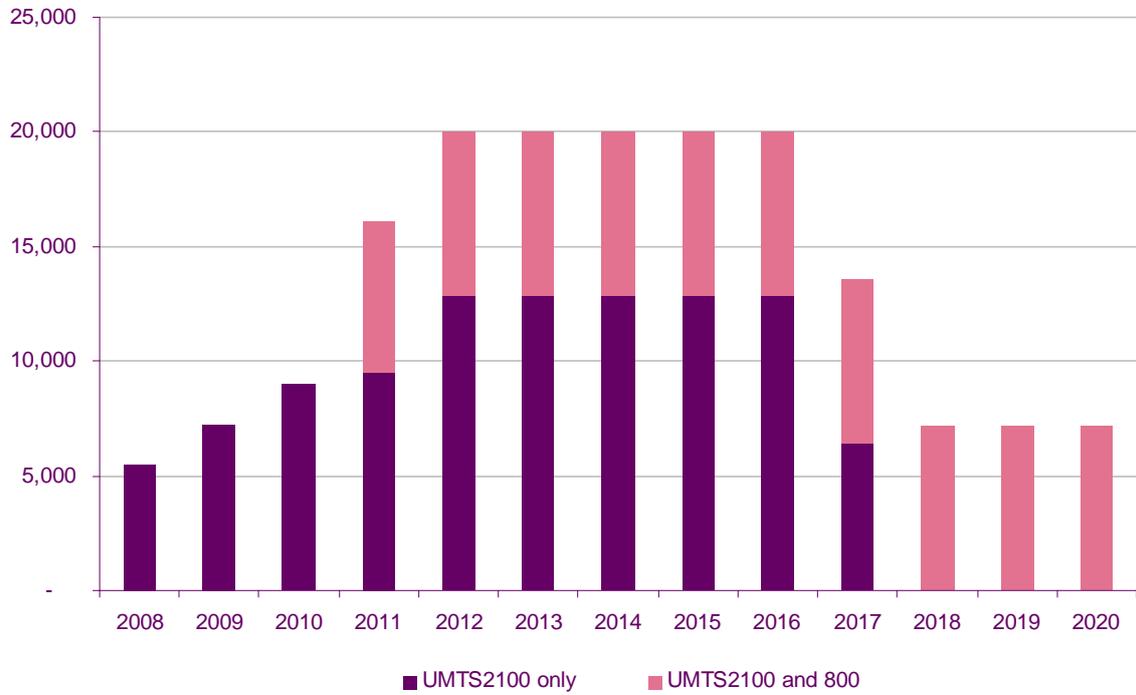


Pair 20 – Higher demand - decommission a year later

Operator with 900 MHz



Operator without 900 MHz

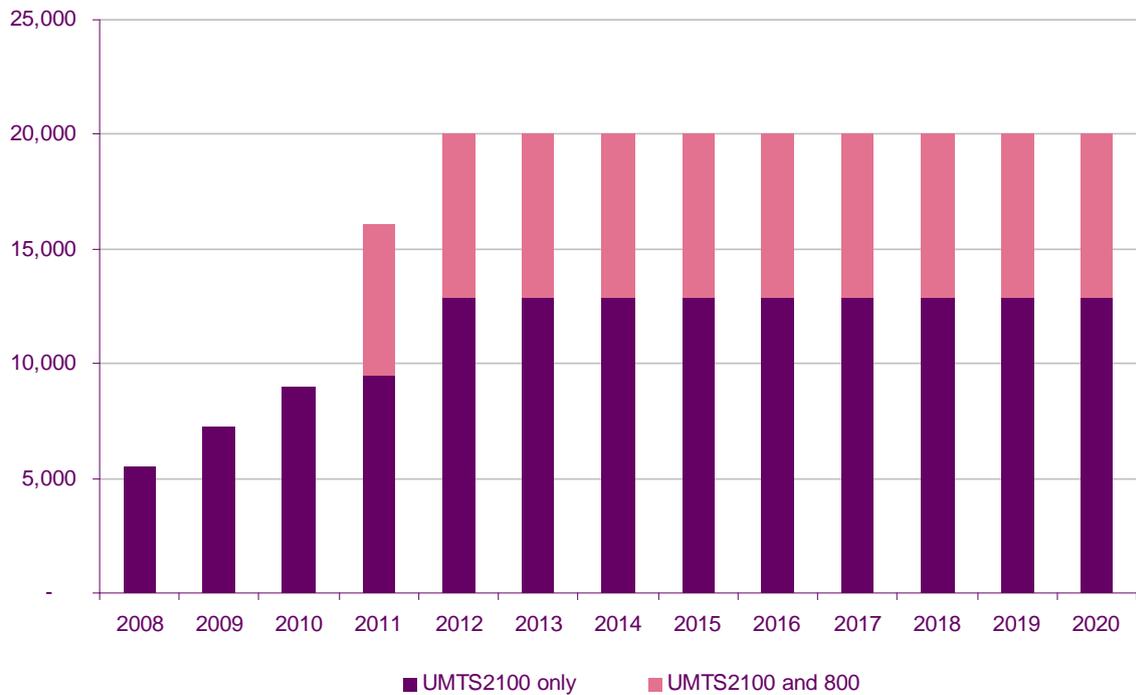


Pair 21 – Higher demand - no decommissioning

Operator with 900 MHz

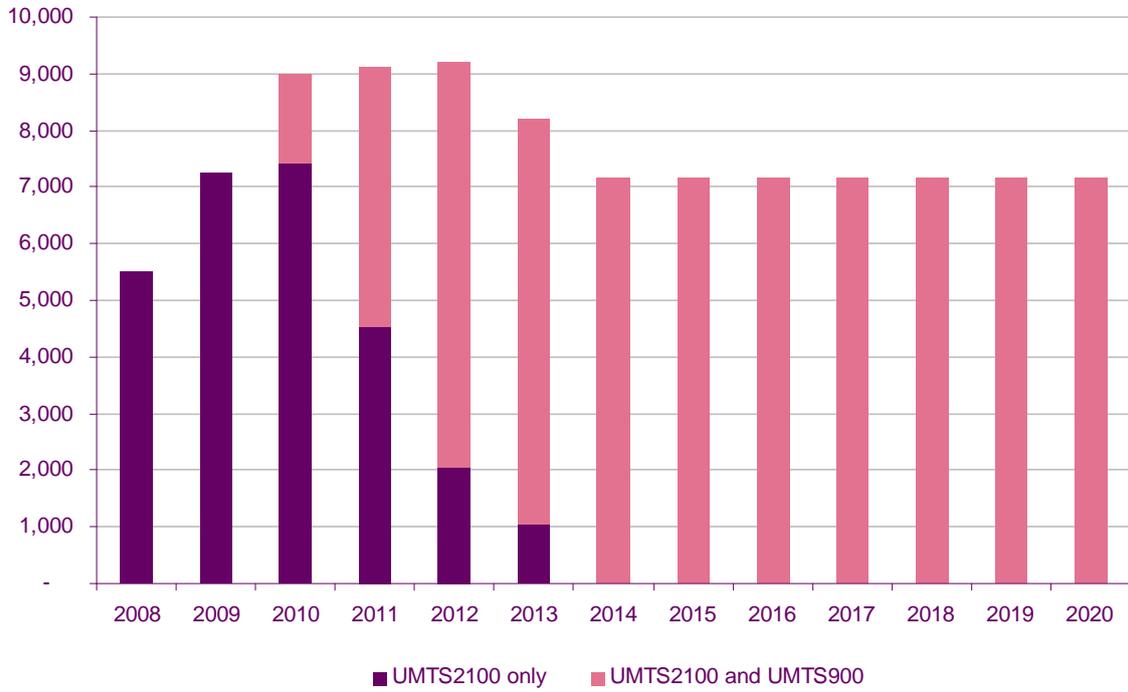


Operator without 900 MHz

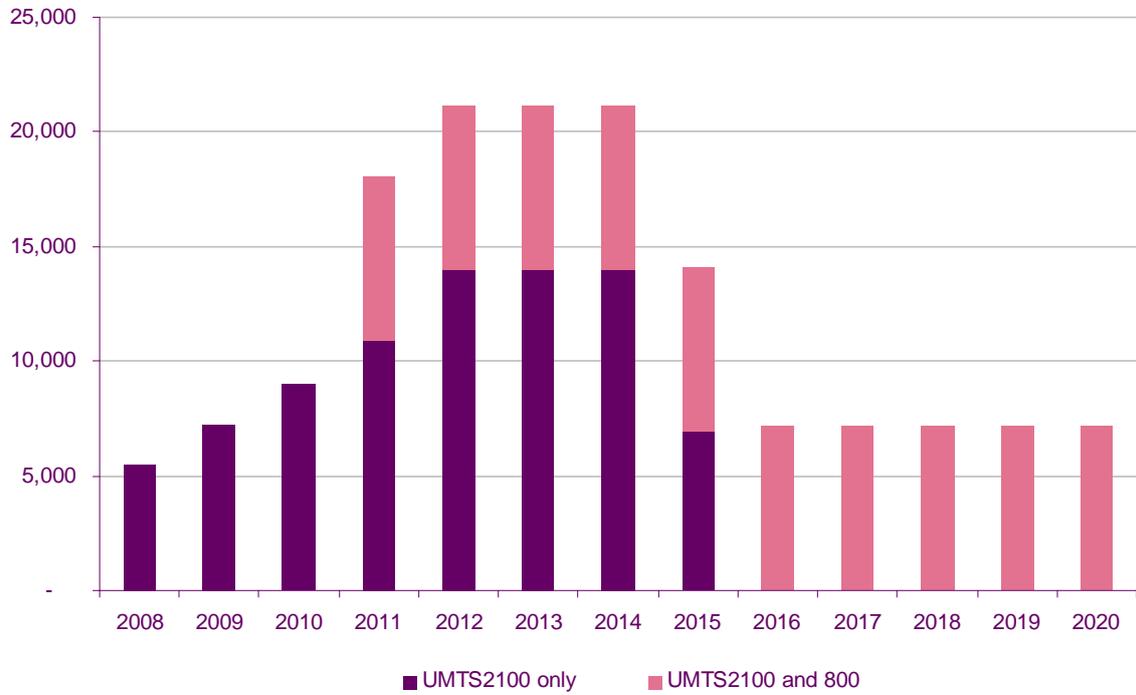


Pair 22 – Higher demand - faster roll out

Operator with 900 MHz



Operator without 900 MHz

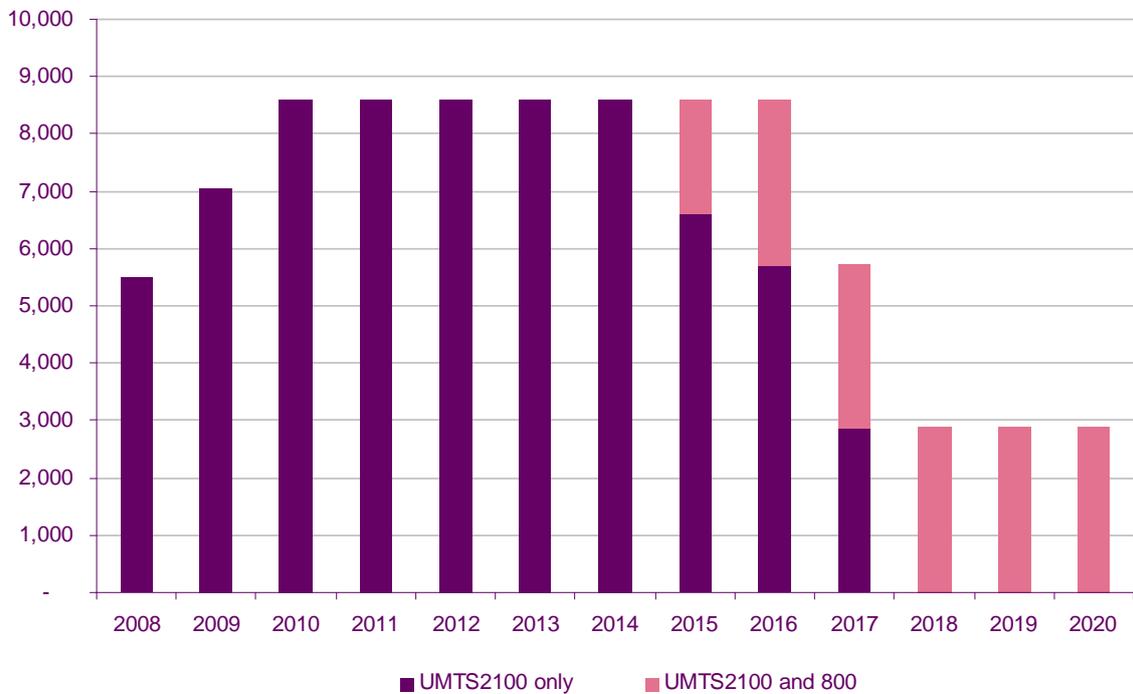


Pair 23 – Lower demand - Late 800 MHz

Operator with 900 MHz

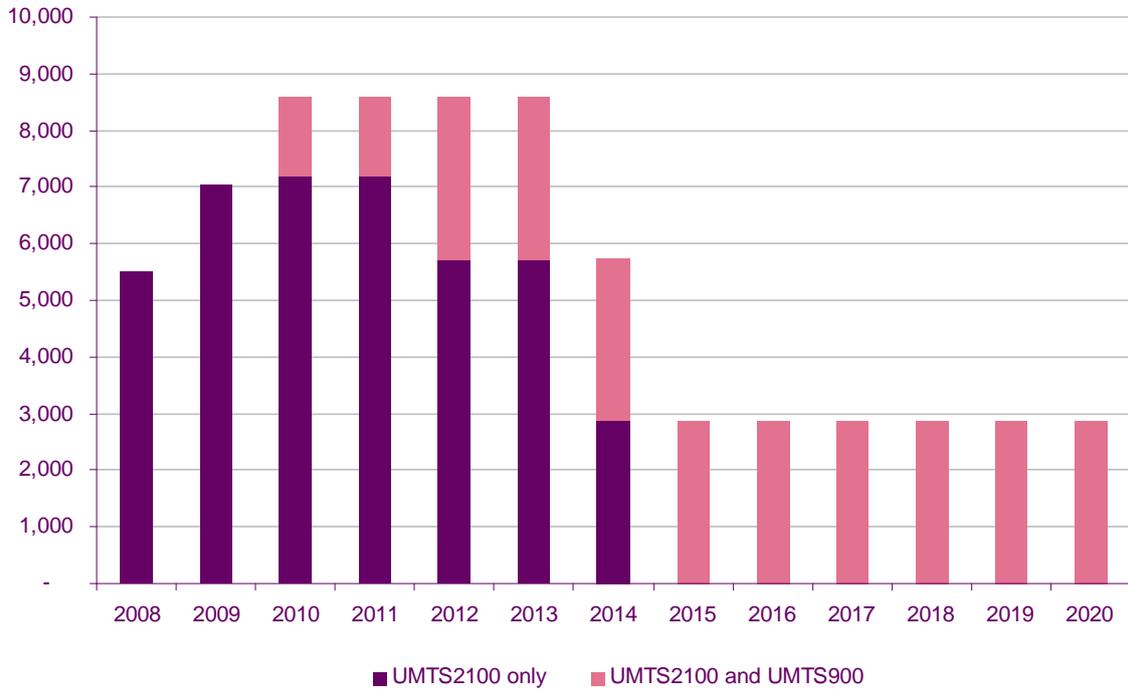


Operator without 900 MHz

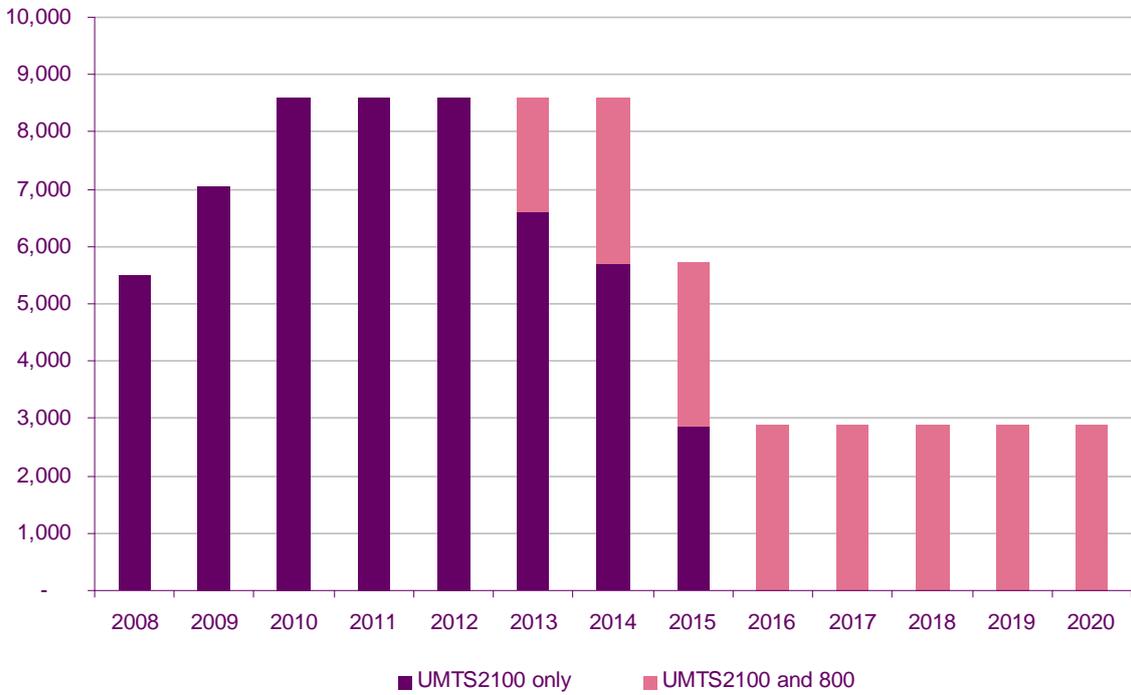


Pair 24 – Lower demand - Late UMTS 900

Operator with 900 MHz

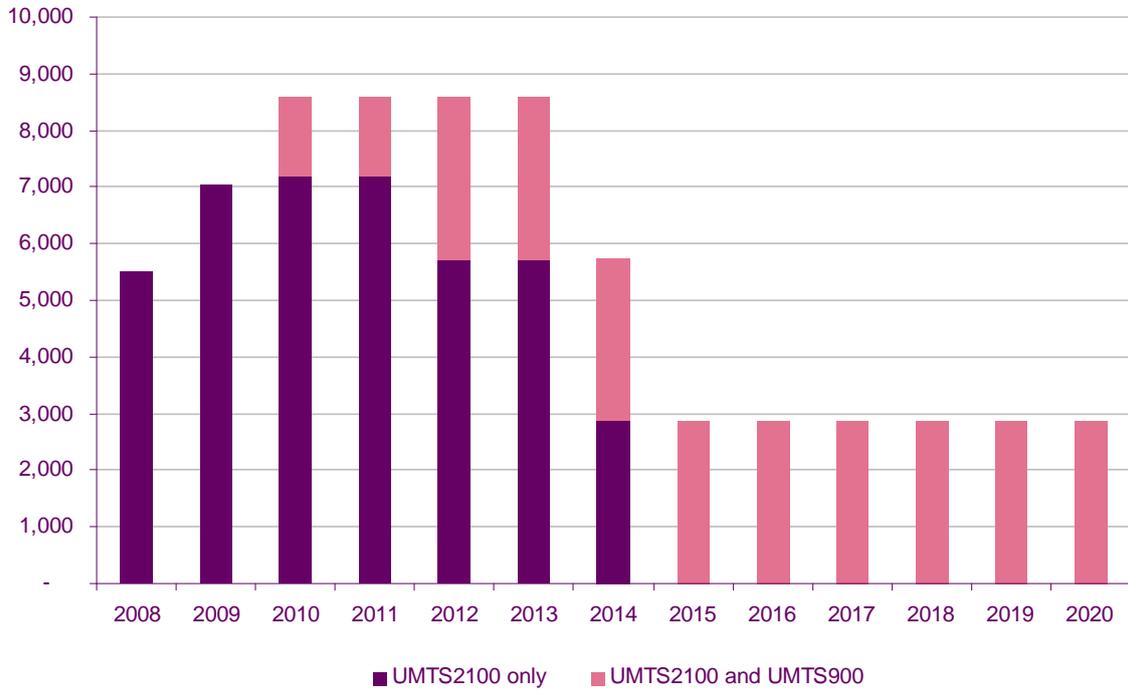


Operator without 900 MHz

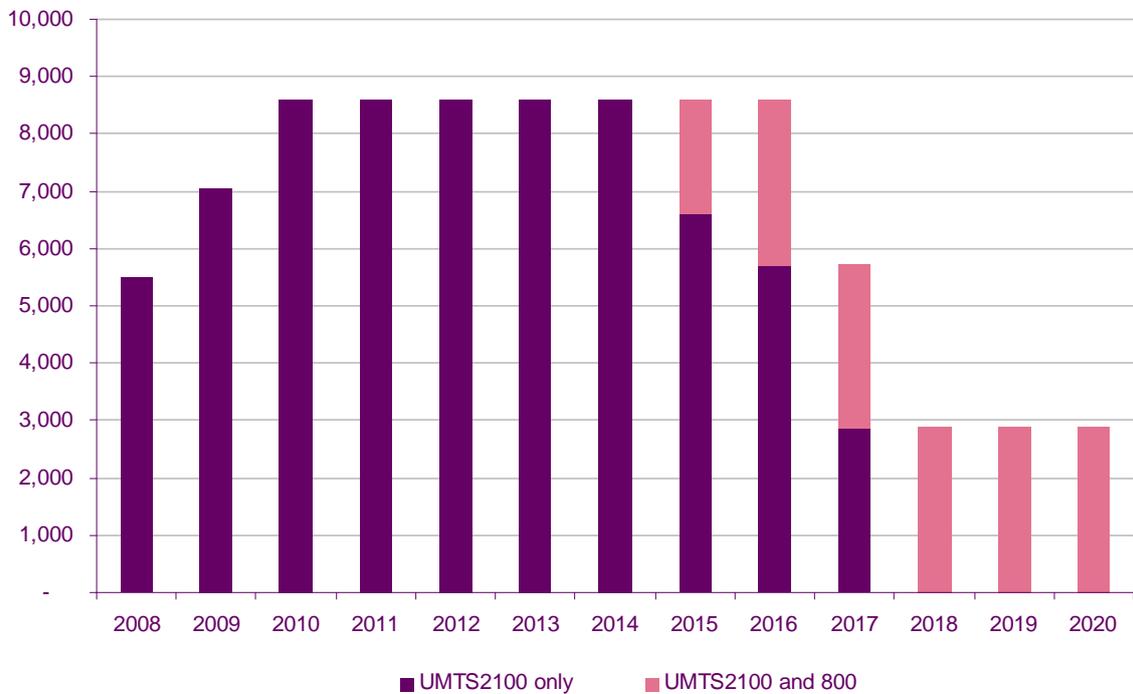


Pair 25 – Lower demand - Late 900 and 800 MHz

Operator with 900 MHz

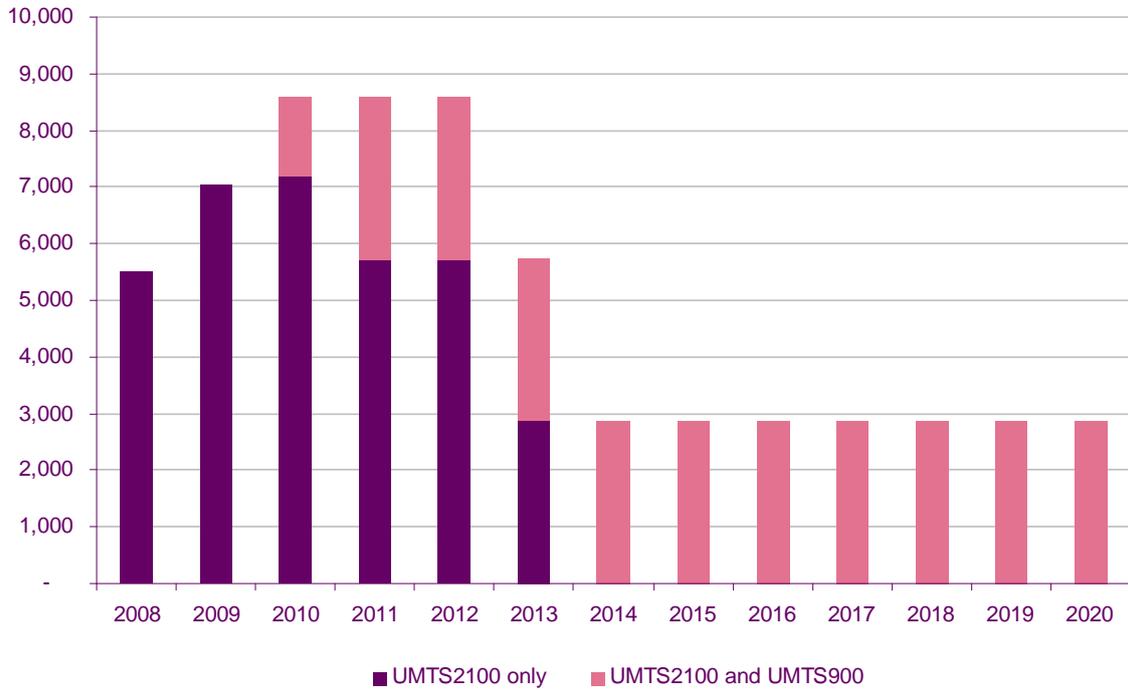


Operator without 900 MHz



Pair 26 - Lower demand - no 800 MHz

Operator with 900 MHz

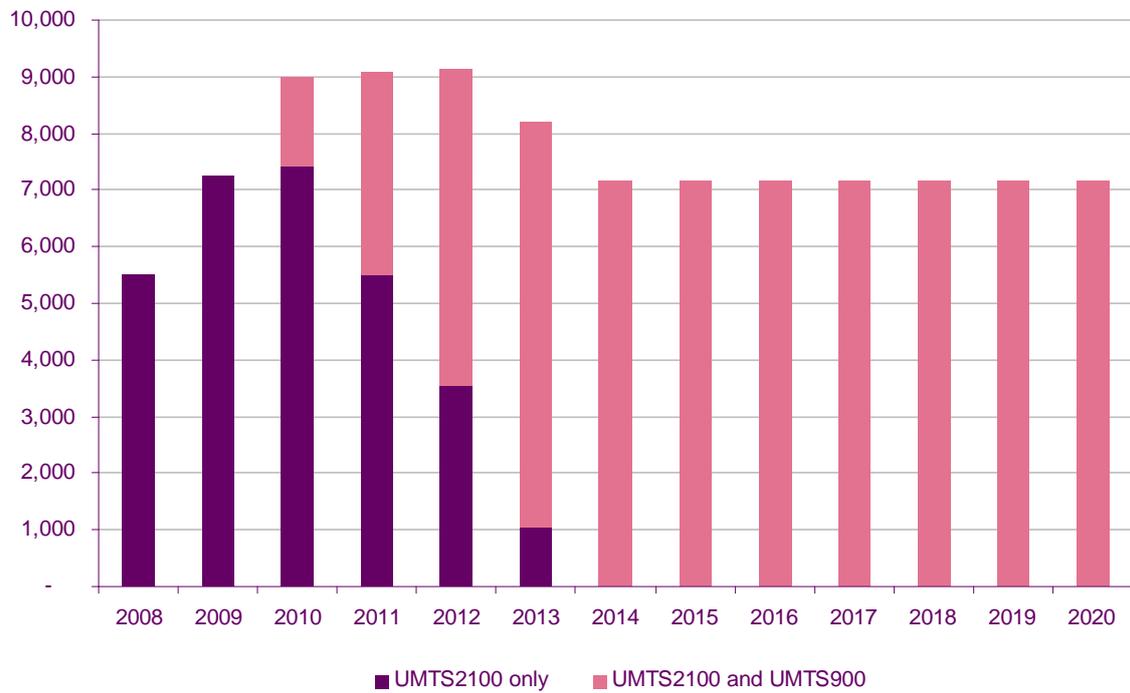


Operator without 900 MHz



Pair 27 - Higher demand - no 800 MHz

Operator with 900 MHz

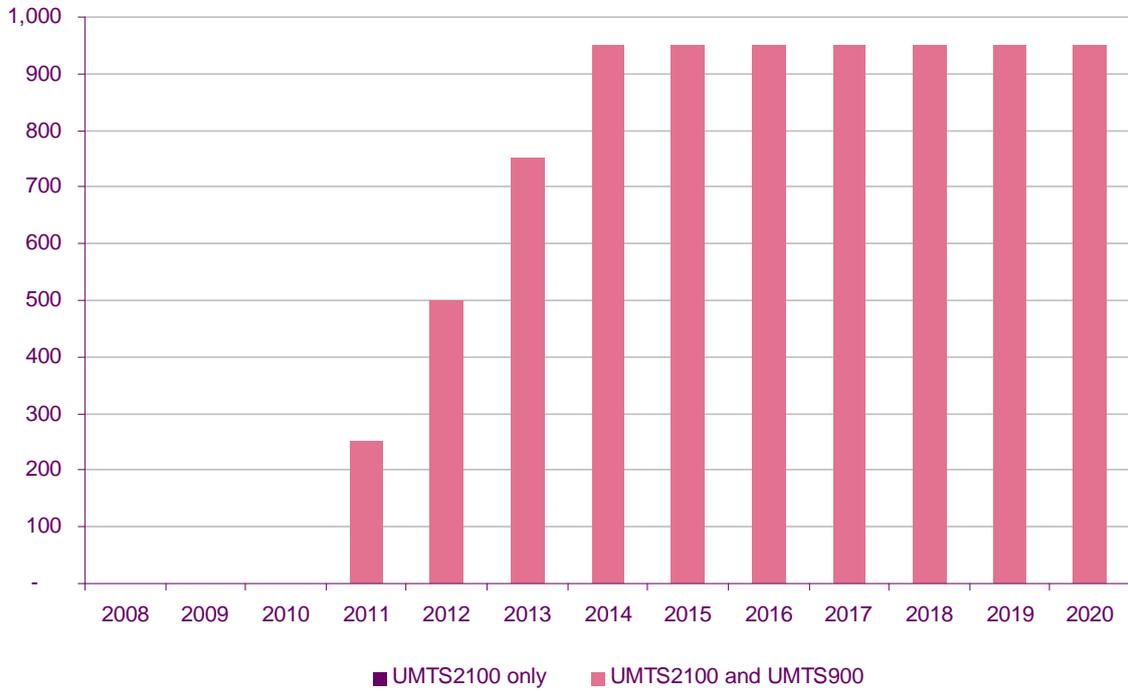


Operator without 900 MHz



Pair 28 - Less densely populated areas, slower deployment

Operator with 900 MHz

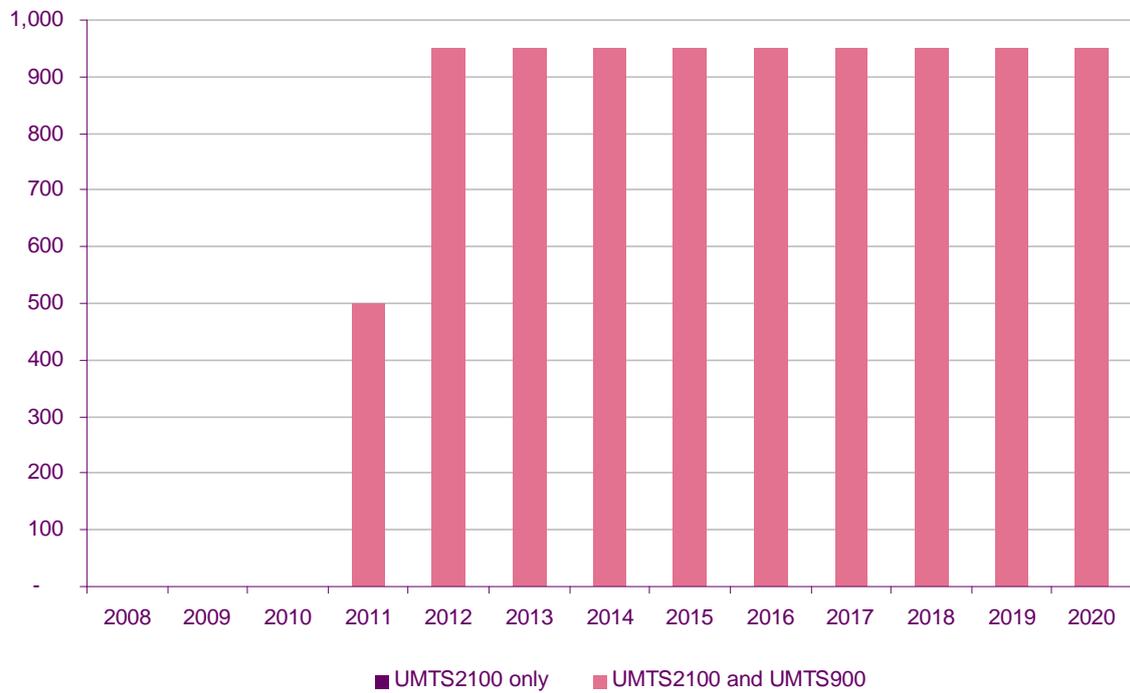


Operator without 900 MHz

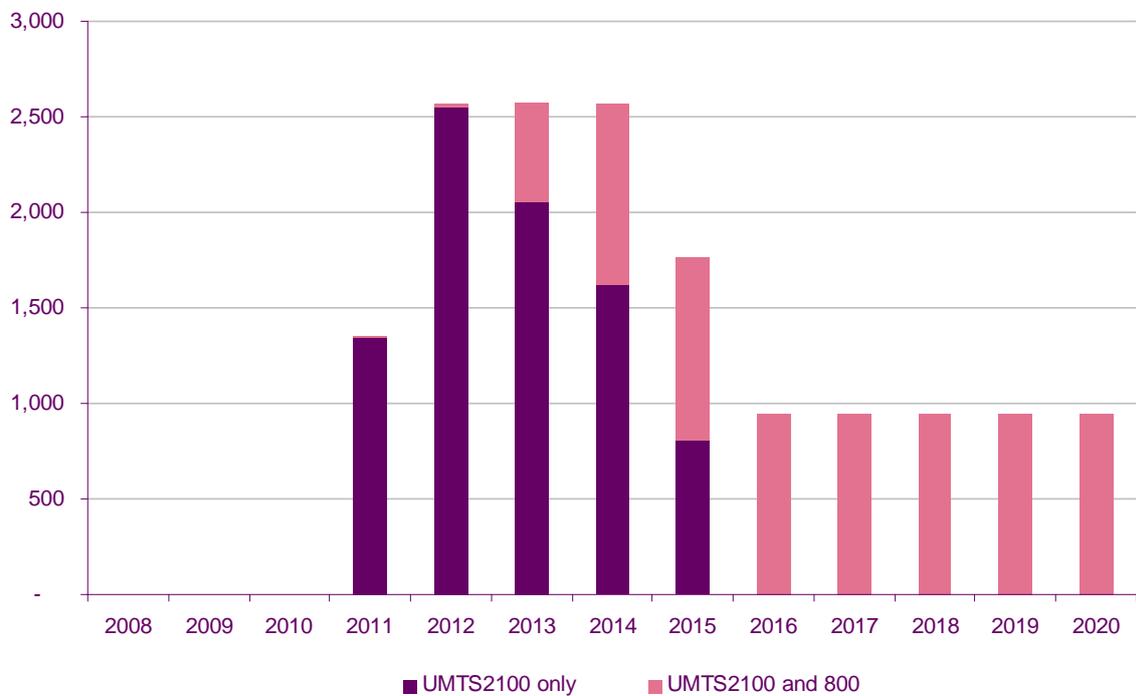


Pair 29 - Less densely populated areas, faster deployment

Operator with 900 MHz

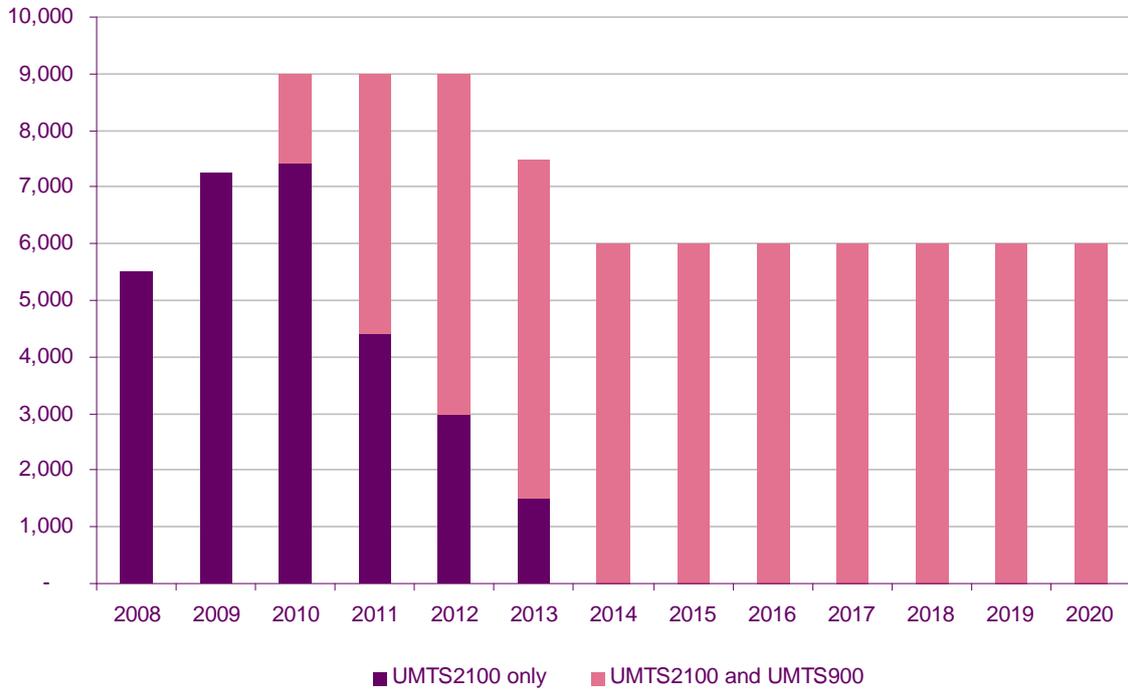


Operator without 900 MHz

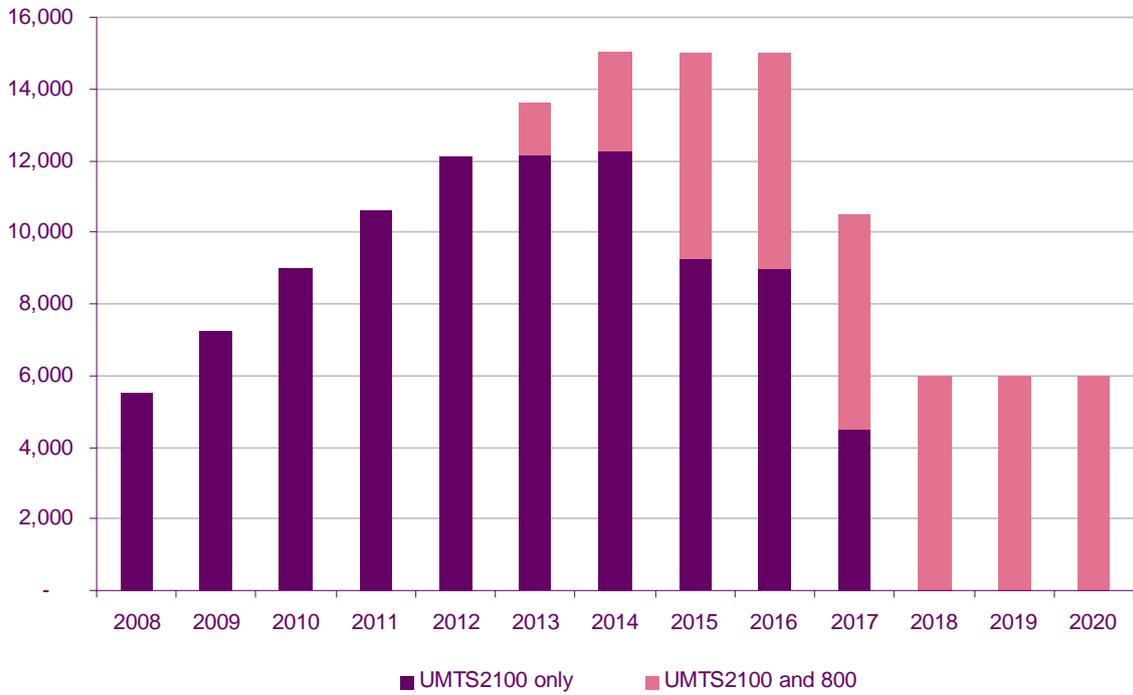


Pair 30 - Non-matching roll out, 6,000 vs. 15,000

Operator with 900 MHz

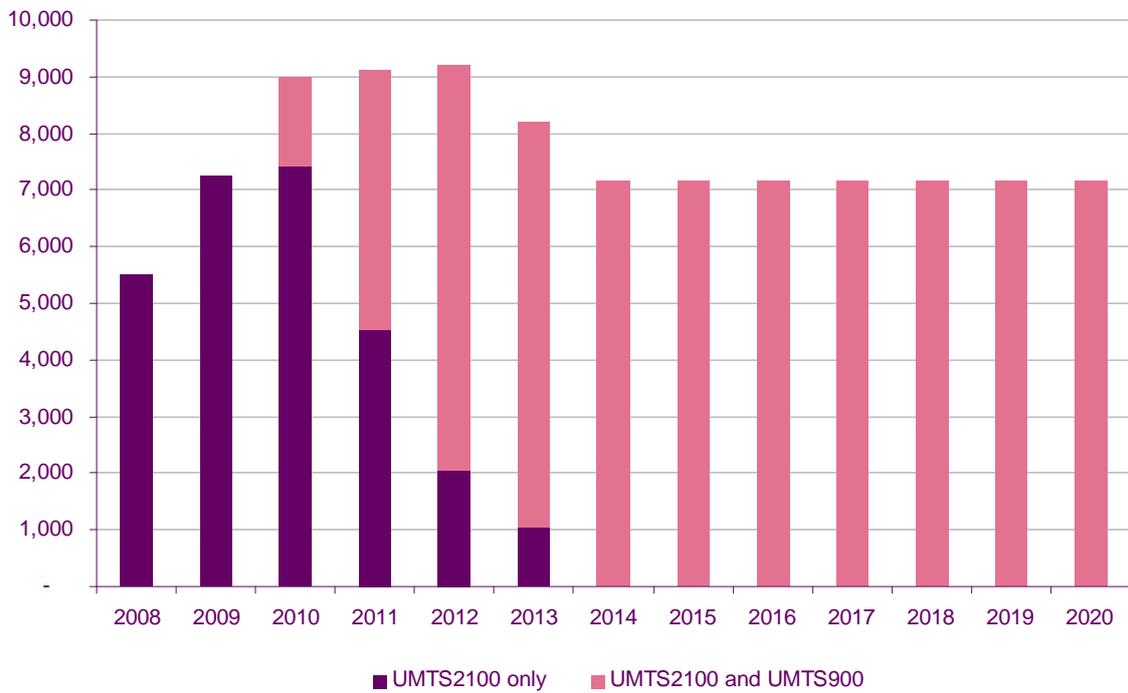


Operator without 900 MHz

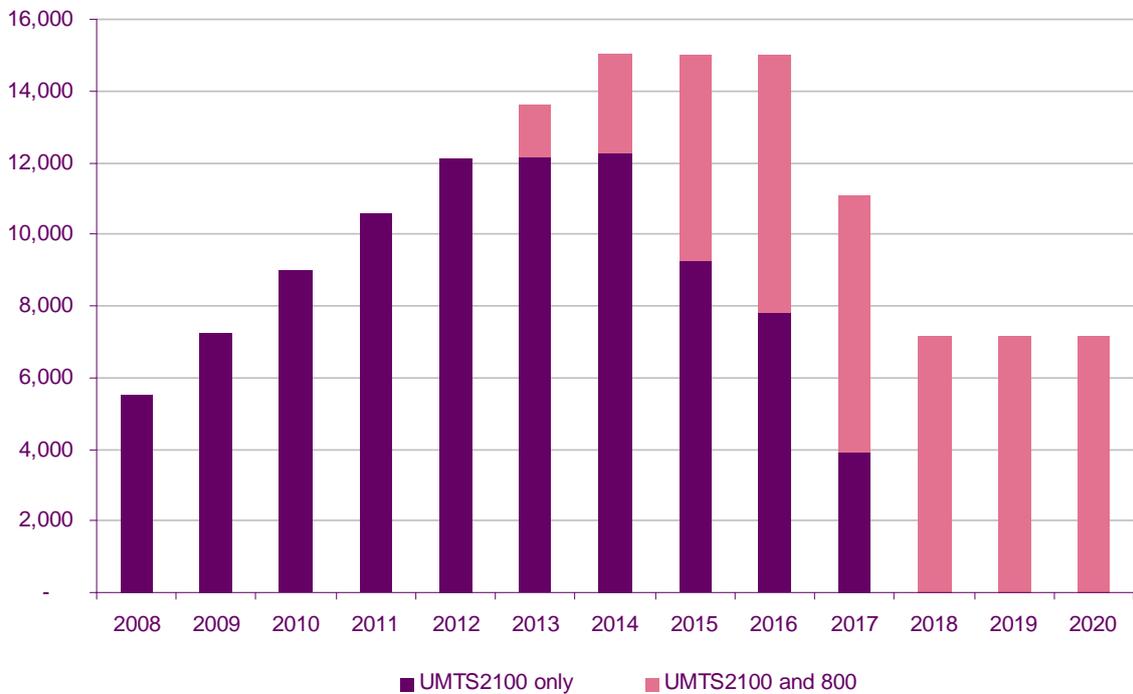


Pair 31 - Non-matching roll out, 7,300 vs. 15,000

Operator with 900 MHz

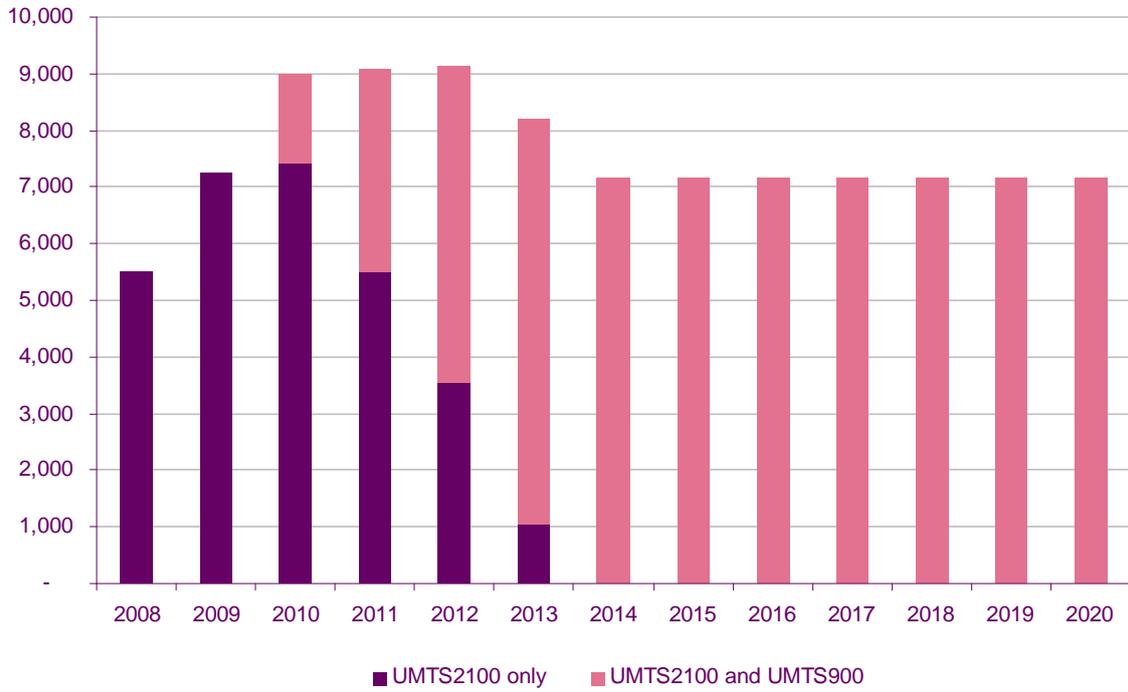


Operator without 900 MHz



Pair 32 - Non-matching roll out, 7,300 vs. 9,000

Operator with 900 MHz



Operator without 900 MHz

