



900 MHz and 1800 MHz band refarming case study

Denmark

24 November 2011

1. Introduction
2. Executive summary
3. NITA discussing with licensees and other interested parties 2007-2010
4. NITA proposals on public consultation 30 October 2009
5. NITA Decisions 23 December 2009
6. NITA auction preparations 2010

1 Introduction

The purpose of this paper is to present a case study on the Danish process of refarming the 900 MHz and 1800 MHz bands for documenting and sharing experience on what has happened in an actual refarming case.

This paper will not contain any assessments on whether the process carried out or the outcome of it is optimal or whether improvement potential can be identified. Furthermore, this paper does not intend to and it does not express any views or positions of the GSMA and/or the mobile industry.

It seems like the information on and documentation of the different stages of the process taking place between 2007 and 2010 is published by the regulator NITA. And NITA did make summary of meetings and the information notes used in preparing for the meetings available on their website. NITA have also published the consultation documents and the consultation responses. Finally NITA published its final decisions on adjusting and amending the existing licenses and to free up 2X5 MHz of 900 MHz band spectrum and 2X10 MHz of 1800 MHz band spectrum for the purpose of auctioning the bandwidth off to new entrants into the bands. But sources are basically available in Danish and unofficial translations to English do not exist. The references included in footnotes of this case study therefore refer to documents published in Danish and we have chosen to include them even if the sources will not be accessible if you do not read Danish. Using the case study to understand the Danish 900 MHz and 1800 MHz band process does not depend upon the reader understanding Danish.

The case study has been developed by Kristin Due Hauge of the GSMA and Danish operators who are GSMA members have been involved in reading and commenting on the draft. The GSMA would like to thank members TDC, Hutchison, Telenor and TeliaSonera for their cooperation, for being very positive and supportive throughout the process and for their approval of the case study prior to GSMA releasing it.

2 Executive summary

NITA carried out the Danish 900 MHz and 1800 MHz band refarming in the same process and by using the open and transparent approach of public meetings, publicly available information notes, public consultation and making its final decision documents public. Between 2007 and 2010 the 900 MHz and 1800 MHz band refarming was on the agenda for four meetings in 'Frekvensforum' and meeting agendas, papers and summaries were published by NITA. The 2009 consultation were a public consultation and documents including responses were published by NITA. NITA published its final decisions by December 2009.

The legal frameworks the NITA decisions were based upon were Danish law and European Union law (no references were made to CEPT or ITU based instruments). And the analysis of effects on the competitive level playing field of lifting technology restrictions were the central basis for NITA when deciding to redistribute and reshuffle bandwidth and make room for new entry into both bands.

The Danish 900 MHz and 1800 MHz band refarming process consisted of redistribution of spectrum to accommodate new entry licensees in both bands, reshuffling of existing licensees meaning all operators had to spectrally move their current operations, lifting technology restrictions and adjusting to a more technology neutral approach to license design and adjusting expiry dates of existing licenses.

In the 900 MHz band NITA basically made no changes to the total bandwidth of the operators TDC and Telenor while Telia's bandwidth was reduced leaving the three existing licensees with 2X9 MHz contiguous bandwidth, 2X9 MHz contiguous bandwidth and 2X11.8 MHz contiguous bandwidth respectively. All existing licensees were spectrally moved. Existing licenses were expiring in 2011 or 2012 prior to the refarming decision but NITA did prolong and synchronize the duration so that all existing licenses now expire by end of 2019 and NITA made it clear that it will be no renewals and only new awards when prolonged licenses expire by end 2019. NITA also decided to remove existing guard bands between licensees (but not guard bands at the edges of the 900 MHz band) and ended up with freeing up 2X5 MHz contiguous bandwidth for a new license to be auctioned off.

In the 1800 MHz band NITA made no change to bandwidth of operator Telenor while operators Telia and TDC's bandwidth was reduced leaving the three existing licensees with 2X19.4 MHz contiguous bandwidth, 2X23.6 MHz contiguous bandwidth and 2X21.8 MHz contiguous bandwidth respectively. All existing licensees were spectrally moved. Existing expiry date was basically not changed; licenses will expire by June 2017 and NITA made it clear that it will be no renewals and only new awards when licenses expire by 2017. NITA ended up with freeing up 2X10 MHz contiguous bandwidth for a new license to be auctioned off.

Existing licensees were given approximately one year to carry out their re-planning and accomplishing the process of spectrally moving transmitters. The GSM only technology restrictions were lifted and replaced with conditions on deployment of GSM and technologies that can coexist with GSM, e.g. UMTS/HSPA and LTE can be deployed. NITA implemented rules on timing of the lifting of the technology restrictions aiming at creating a competitive playing level field for all licensees, existing licensees and the new entry licensees into the bands, regarding when new technologies can be deployed.

3 NITA discussing with licensees and other interested parties 2007-2010

In June 2007 NITA established 'Frekvensforum' which is an arena for regular meetings between NITA, other relevant government agencies and various market players using radio frequencies:

- The meeting frequency is two annual meetings.¹
- 'Frekvensforum' is an arena where the international and national regulatory frameworks and policy frameworks of spectrum management can be discussed and the "mandate" for 'Frekvensforum' is published by NITA.²
- The list of members of 'Frekvensforum' is published and continuously updated by NITA.³
- NITA is acting as the 'Frekvensforum' secretariat.

'Frekvensforum' was used as an arena for open and transparent discussions of refarming of the 900 MHz and 1800 MHz bands in Denmark involving the regulator and all interested parties.

June 2007

Refarming of the 900 MHz and 1800 MHz bands was on the agenda for the first meeting in 'Frekvensforum' in June 2007. NITA did put forward a note⁴ describing the EU regulatory and policy processes on refarming of the 900 MHz and 1800 MHz bands to 'Frekvensforum' in June 2007 and the summary of the meeting have references to the discussion that took place⁵.

December 2007

Refarming of the 900 MHz and 1800 MHz bands was on the agenda for the second meeting in 'Frekvensforum' in December 2007.

¹ First meeting was 21 June 2007, second meeting 11 December 2007, third meeting 11 June 2008, fourth meeting 27 November 2008, fifth meeting 7 October 2009 and sixth meeting 24 March 2010.

² <http://www.itst.dk/frekvenser-og-udstyr/frekvensforum/frekvensforum-filmappe/kommissorium-for-frekvensforum-efter-1-mode-den-21-juni-2007/Kommissorium%20-%20Frekvensforum%20Revideret.pdf>

³ <http://www.itst.dk/frekvenser-og-udstyr/frekvensforum/etableringen-af-frekvensforum-1/medlemmer-af-frekvensforum>

⁴ <http://www.itst.dk/frekvenser-og-udstyr/frekvensforum/frekvensforum-filmappe/1-mode-i-frekvensforum-den-21-juni-2007/Notat%20om%20GSM-frekvensbandene.pdf>

⁵ <http://www.itst.dk/frekvenser-og-udstyr/frekvensforum/frekvensforum-filmappe/1-mode-i-frekvensforum-den-21-juni-2007/Hovedpunktnotat%20-%201.%20mode%20i%20Frekvensforum.pdf>

Once again NITA did put forward a note⁶ updating the current situation on the European Union processes and the meeting report summarised the discussions⁷ including expression of support to start analysing the liberalization of the 900 MHz and 1800 MHz bands potential impact on competition in relevant markets and the question of redistribution of frequencies between operators was a discussion launched for public debate in this meeting.

In the meeting report NITA did outline views on regulatory frameworks and policy frameworks including making references to amending use of the so-called “CT1 frequencies” and NITA stating that a potential award of 900 MHz and/or 1800 MHz frequencies to new licensees must be done by using competitive procedures (an auction – payment in kind or cash auction is basically the options under the Danish legal framework and the Danish spectrum policy).

June 2008

The third meeting in ‘Frekvensforum’ in June 2008 discussed 900 MHz and 1800 MHz refarming again.

NITA did put forward a note⁸ on update on the European Union processes and over views of current status of the 900 MHz and 1800 MHz band licensees⁹. The meeting report reflects the European Union process where the Parliament of the European Union changed their position from withdrawing the so-called “GSM Directive” and replace it with a new technical harmonisation instrument to wanting to amend the Directive¹⁰ and NITA did put forward their message on current licensees should prepare for a situation of slight reductions of bandwidth to make it possible for NITA to introduce a new license in the 900 MHz band and a new license in the 1800 MHz band.

Existing mobile operators announced that they wanted to engage in negotiations to solve the refarming challenges between them and consequently they announced that formal notices to the competition authorities on engagement in such discussions were filed.

⁶ <http://www.itst.dk/frekvenser-og-udstyr/frekvensforum/frekvensforum-filmappe/2-mode-i-frekvensforum-den-11-december-2007/2007-12-11%20Notat%20om%20900-1800%20MHz%20Frekvensbeslutningen.pdf>

⁷ <http://www.itst.dk/frekvenser-og-udstyr/frekvensforum/frekvensforum-filmappe/2-mode-i-frekvensforum-den-11-december-2007/Hovedpunktnotat%20-%20%20mode%20i%20Frekvensforum.pdf>

⁸ <http://www.itst.dk/frekvenser-og-udstyr/frekvensforum/frekvensforum-filmappe/3-mode-i-frekvensforum-den-11-juni-2008/2008-06-11%20900-1800%20MHz%20frekvensbeslutningen.pdf>

⁹ <http://www.itst.dk/frekvenser-og-udstyr/frekvensforum/frekvensforum-filmappe/3-mode-i-frekvensforum-den-11-juni-2008/2008-06-11%20900-1800%20MHz%20frekvensbeslutningen%2C%20Bilag%20%20GSM-900%20frekvensopdeling.pdf> and <http://www.itst.dk/frekvenser-og-udstyr/frekvensforum/frekvensforum-filmappe/3-mode-i-frekvensforum-den-11-juni-2008/2008-06-11%20900-1800%20MHz%20frekvensbeslutningen%2C%20Bilag%20%20GSM-1800%20frekvensopdeling.pdf>

¹⁰ <http://www.itst.dk/frekvenser-og-udstyr/frekvensforum/frekvensforum-filmappe/3-mode-i-frekvensforum-den-11-juni-2008/Hovedpunktnotat%20-%20%20mode%20i%20Frekvensforum.pdf>

Finally, NITA reminded the operators that also planned future awards of usage rights to the 2600 MHz band and the 800 MHz band was relevant in the 900 MHz and 1800 MHz band refarming context.

March 2010

For the sixth 'Frekvensforum' meeting NITA put forward a note¹¹ on update on the 900 MHz and 1800 MHz band refarming situation.

In December 2009 NITA had made their decision on amending existing 900 and 1800 licenses and redistribution of frequencies to make 2X5 MHz of 900 MHz band bandwidth and 2X10 MHz of 1800 MHz band bandwidth available for a new entry into the bands. NITA informed 'Frekvensforum' that it had been decided that the new 900 and 1800 licenses should be awarded by two (money) auctions, that a cap should be implemented so that existing licensees in the 900 MHz and 1800 MHz bands could not buy spectrum in the two auctions, that no coverage and roll-out obligations should be implemented and that reservation price for the 2X5 MHz 900 MHz band license was to be set at 8 million Danish kroner while reservation price for the 2X10 MHz 1800 MHz band license was to be set at 4 million Danish kroner.¹² Such decisions are made by the Ministry of Science after having discussed with 'Teleforligskretsen' in Denmark (this is a political decision making process based on proposals developed by government expertise and sometimes involving use of external expertise such as academics and consultants).

Finally NITA outlined the timing of the 900 MHz and 1800 MHz band awards as follows in the 'Frekvensforum' meeting: public consultation on auction rules by May 2010, adopted auction rules published by September 2010 and auctions to be executed by October and November 2010 and licenses to be assigned by end 2010.

¹¹ <http://www.itst.dk/frekvenser-og-udstyr/frekvensforum/frekvensforum-filmappe/6-mode-i-frekvensforum-den-24-marts-2010/2010-03-24%20Punkt%204c%2C%20Refarming.pdf>

¹² <http://www.itst.dk/frekvenser-og-udstyr/frekvensforum/frekvensforum-filmappe/6-mode-i-frekvensforum-den-24-marts-2010/2010-03-24%20Punkt%204c%2C%20Refarming.pdf>

4 NITA proposals on public consultation 30 October 2009

NITA published consultation documents on redistribution of usage rights to 900 MHz and 1800 MHz frequency bands on 30 October 2009 and asked all interested parties including existing licensees to respond by 27 November 2009.

NITA's approach as it was outlined for the public consultation:

- Adjusting the usage rights to 900 MHz and 1800 MHz bands radio frequencies following the amendment of the European Union 'GSM Directive' leading to the GSM only restrictions being lifted and use of the 900 MHz and 1800 MHz bands being more flexible based on a more technology neutral approach to mobile deployments.
- Ensuring the amendments of the existing licenses would promote competition in the Danish mobile market was put forward as a main policy objective by the NITA and redistribution of spectrum was discussed in this context.
- Revocation of the existing 900 MHz and 1800 MHz licenses by 12 June 2017 proposed.

The 900 MHz band (880-915 / 925-960 MHz)

The 900 MHz band licensee status when starting the refarming process:

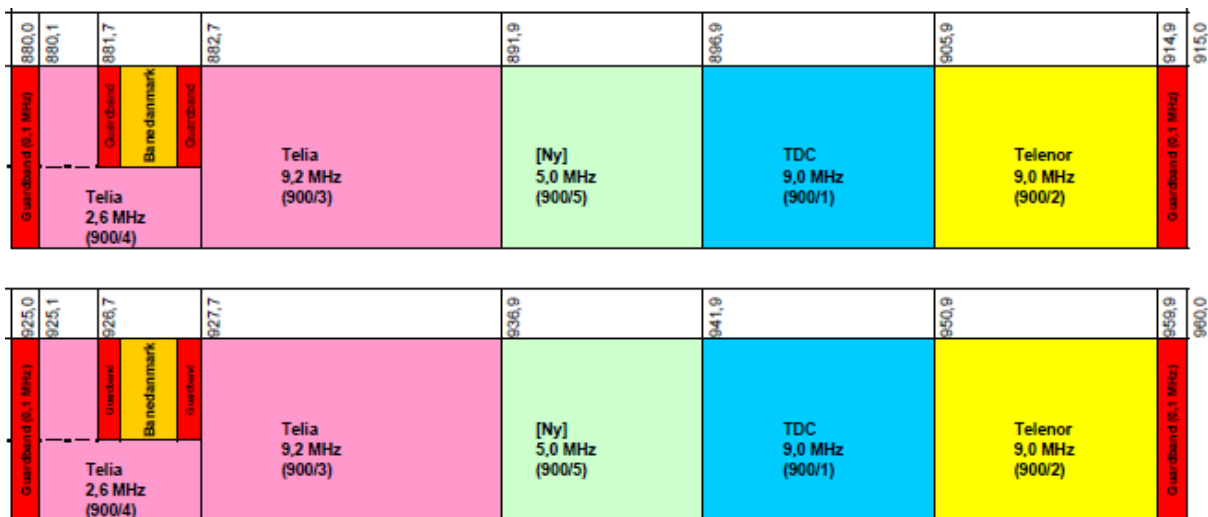
880,0	880,1	881,7	882,7	885,5	892,9	895,9	896,1	904,9	905,1	913,9	915,0
Guardband (0,1 MHz)	Telia (GSM4) 1,6 MHz	Banedanmark og guardbands	Telia (GSM4) 2,8 MHz	Telia (GSM3) 7,4 MHz	Telia (GSM4) 3,0 MHz	Guardband (0,2 MHz)	TDC (GSM1) 8,8 MHz	Guardband (0,2 MHz)	Telenor (GSM2) 8,8 MHz	CT1 og guardbands	
925,0	925,1	926,7	927,7	930,5	937,9	940,9	941,1	949,9	950,1	958,9	960,0
Guardband (0,1 MHz)	Telia (GSM4) 1,6 MHz	Banedanmark og guardbands	Telia (GSM4) 2,8 MHz	Telia (GSM3) 7,4 MHz	Telia (GSM4) 3,0 MHz	Guardband (0,2 MHz)	TDC (GSM1) 8,8 MHz	Guardband (0,2 MHz)	Telenor (GSM2) 8,8 MHz	CT1 og guardbands	

Source: NITA

Existing 900 MHz band licensing when starting the refarming process were basically about seven licenses but four licensees where three of them were mobile operators and one licensee was a "governmental agency like operator" of a communication system for operations of railways (Banedanmark), a general authorisation to use of frequencies for CT1

cordless phones (some refer to this as license exemption or class license) and external guardbands between licensees (0.4 MHz of guardbands between mobile operators and guardbands to protect CT1 and Banedanmark).

The NITA proposal on amending the 900 MHz band licensee status:



Source: NITA

NITA proposed to structure the band in four mobile licenses (of various bandwidths), abolish external guardbands between the mobile operators (guardbands to be included in bandwidth of licenses), change the use of frequencies from CT1 to mobile (general authorisation to use of frequencies to CT1 to be revoked) and current use of frequencies to communication system for operations of railways in the geographical area of Copenhagen to expire within a few years (NITA have awarded radio frequencies to GSM-R systems and Denmark have GSM-R in operation so a digital alternative to the existing old railway system operating in the 900 MHz mobile band exist).

The 1800 MHz band (1710-1785 / 1805-1880 MHz)

The 1800 band licensee status when starting the refarming process:

1710,0	1710,1	1717,3	1729,5	1731,7	1746,1	1760,5	1774,9	1784,9	1785,0
Guardband (0,1 MHz)	Telenor (DCS2) 7,2 MHz	Telenor (DCS5) 12,2 MHz	TDC (DCS6) 2,2 MHz	TDC (DCS1) 14,4 MHz	Telia (DCS3) 14,4 MHz	Telia (DCS4) 14,4 MHz	TDC (DCS6) 10,0 MHz	Guardband (0,1 MHz)	

1805,0	1805,1	1812,3	1824,5	1826,7	1841,1	1855,5	1869,9	1879,9	1880,0
Guardband (0,1 MHz)	Telenor (DCS2) 7,2 MHz	Telenor (DCS5) 12,2 MHz	TDC (DCS6) 2,2 MHz	TDC (DCS1) 14,4 MHz	Telia (DCS3) 14,4 MHz	Telia (DCS4) 14,4 MHz	TDC (DCS6) 10,0 MHz	Guardband (0,1 MHz)	

Source: NITA

When starting the refarming process there was six licenses and three licensees in the 1800 MHz band. All licensees were mobile operators. There were no guardbands between the mobile operators but 0.1 MHz of guardbands between the 1800 MHz mobile band and other users of spectrum below and above the 1800 MHz mobile band.

The NITA proposal on amending the 1800 MHz band licensee status:

1710,0	1710,1	1720,1	1731,9	1741,9	1749,1	1761,3	1773,1	1784,9	1785,0
Guardband (0,1 MHz)	[Ny] 10,0 MHz (1800/7)	TDC 11,8 MHz (1800/1)	TDC 10,0 MHz (1800/6)	Telenor 7,2 MHz (1800/2)	Telenor 12,2 MHz (1800/5)	Telia 11,8 MHz (1800/3)	Telia 11,8 MHz (1800/4)	Guardband (0,1 MHz)	

1805,0	1805,1	1815,1	1826,9	1836,9	1844,1	1856,3	1868,1	1879,9	1880,0
Guardband (0,1 MHz)	[Ny] 10,0 MHz (1800/7)	TDC 11,8 MHz (1800/1)	TDC 10,0 MHz (1800/6)	Telenor 7,2 MHz (1800/2)	Telenor 12,2 MHz (1800/5)	Telia 11,8 MHz (1800/3)	Telia 11,8 MHz (1800/4)	Guardband (0,1 MHz)	

Source: NITA

NITA proposes to expand the licensees in the 1800 band from three to four and to make that happen some adjustments of bandwidth of the licenses of existing operators.

Existing mobile market structure and competition aspects of distribution of 900 MHz and 1800 MHz bands frequencies between operators

Based on the European Union law, as amended by the amendment of the “GSM Directive”, the new European Union Commission harmonisation instruments on the 900 MHz and 1800 MHz bands and the revised sector specific European Union Directives on electronic communication services including the Framework Directive and the Authorisation Directive, NITA concluded that liberalisation of the 900 MHz and the 1800 MHz band should happen and that the main responsibility of the NITA in this process was to ensure competitive playing field in the relevant mobile markets when the use of the bands were liberalised.

NITA did put forward the following criteria for liberalisation of the 900 MHz and the 1800 MHz band and for the redistribution of spectrum between mobile operators in those two bands:

- Liberalisation of the 900 MHz and the 1800 MHz bands will have impact on competition in the Danish mobile market and NITA must find solutions for redistribution of spectrum between players using an approach which is proportional, non-discriminatory and objective.
- NITA must ensure licensees will have realistic choices of implementing relevant technologies such as GSM, UMTS/HSPA and LTE and at the same time promote efficient use of the frequencies.
- NITA must ensure existing GSM operations may continue (should existing licensees choose to continue their GSM operations).
- NITA were aiming at minimal reductions of bandwidth for existing licensees and NITA stated that ensuring contiguous bandwidth for all licensees was considered essential.

As of October 2009 the Danish market were served by four mobile operators:

TDC	providing 900 MHz band and 1800 MHz band based GSM and 2100 MHz band based UMTS/HSPA
Telenor Denmark	providing 900 MHz band and 1800 MHz band based GSM and 2100 MHz band based UMTS/HSPA
TeliaSonera	providing 900 MHz band and 1800 MHz band based GSM and 2100 MHz band based UMTS/HSPA
“3”	providing 2100 MHz band based UMTS/HSPA

Based on the fact that the four players have been assigned same amount of radio frequencies (bandwidth) in the 2100 MHz band and that their license conditions were the same NITA

concluded that the four players had equal conditions to provide UMTS/HSPA services prior to liberalisation of the 900 MHz and the 1800 MHz bands. Based on the player “3”¹³ not having access to any 900 MHz and 1800 MHz bands spectrum NITA concluded removing GSM only restrictions from the current 900 MHz and 1800 MHz bands licenses would be in breach of the European Union law based obligation on government/regulators on promoting competition unless “3” and other interested parties were given an opportunity to compete for being assigned 900 MHz and 1800 MHz bands spectrum.

As of October 2009 usage rights for the 800 MHz and the 2600 MHz bands were not awarded in Denmark, the bands would be awarded using auctions where all existing mobile operators and other interested parties would be allowed to compete for usage rights and LTE services were not provided in Denmark. Consequently NITA concluded assessing the impact of the 900 MHz band or the 1800 MHz bands being suitable for offering LTE services when preparing for liberalisation of the 900 MHz and 1800 MHz bands towards end of 2009 was not relevant for the time when the decisions on the 900 MHz and 1800 MHz bands situation were made.

Coverage requirements and technology restrictions

NITA put forward a view on the European Union law requiring them to ensure that existing GSM operations were given the opportunity to continue.

Existing 900 MHz and 1800 MHz bands licenses were awarded using payment in kind style auctions (“beauty contests”) and the bids on coverage and roll-out were transformed into conditions in the licenses of winning bidders and NITA concluded this did mean they had to ensure existing operators had sufficient spectrum to comply with the existing coverage obligations.

NITA did put forward a proposal of reducing coverage obligations under one of Telia’s licenses because the bandwidth of that license were proposed to be significantly reduced for NITA to be able to free up spectrum for a new fourth license in the 900 MHz band (proposed reduction of bandwidth for Telia in the 900 band was 2X3 MHz altogether). In addition Telia had to accept that 2X1 MHz of 900 MHz band spectrum would continue to be used by Banedanmark for railway related purposes in a geographical area in and around the Danish capital Copenhagen until this license will expire by end 2012. No other reductions of coverage requirements in the 900 MHz band were proposed by NITA. And NITA added that their view is that current coverage requirements of the 900 MHz band licenses were extensive. Existing coverage requirements include both population coverage and geographic coverage requirements. Existing coverage requirements are individual and differs between the licenses because the requirements were imposed as a result on individual payment in

¹³ Hi3G Access AB is a joint venture between Hutchison Whampoa Limited and Sweden's Investor AB.

kind style bidding in the “beauty contest” award of existing licenses. Finally, NITA did put forward the view of reduction of coverage requirements under one of Telia’s 900 MHz band licenses would have limited, if any, impact on the provision of services to consumers because the extensive coverage requirements under the other Telia 900 MHz band license were upheld and would ensure 900 MHz band based coverage for Telia subscribers.

NITA proposed to amend the coverage requirements so that it is no longer required to comply by using GSM technology but licensees wanting to comply by using e.g. UMTS or LTE would be given the opportunity to do so.

To ensure the new entry into the 900 MHz and 1800 MHz bands would be given reasonable time to prepare for launching services that could compete with existing licensees if they changed current GSM deployment to deployment of new technologies in the 900 MHz and 1800 MHz bands NITA proposed that lifting the technology restriction of existing licenses should come into force nine months after the award of the new license was completed.

New 900 MHz band license

NITA proposed to establish a new 900 MHz band license of 2X5 MHz of bandwidth.

NITA did put forward the assumption of a new entry not being interested in using the 900 MHz band frequencies to establish a GSM network but would be looking at deploying UMTS/HSPA or other technologies such as LTE. Consequently, NITA concluded it was not relevant to ensure the new entry sufficient bandwidth to run GSM and a new technology in parallel in the 900 MHz band. Furthermore, NITA argued that establishing a UMTS/HSPA and/or a LTE based network would also rely upon use of the 2100 MHz band (full band – 2X60 MHz – is awarded to four mobile operators in Denmark), the refarmed 1800 MHz band, the 2600 MHz band which were about to be awarded a few months after the refarming consultation and the 800 MHz band which were allocated to mobile but still to be awarded (by 2011 or 2012 was the assumption at the time where 900 MHz and 1800 MHz bands refarming decisions were prepared and made). Finally, NITA concluded that implementation of the new Danish Frequency Act by January 2010 would open up for a secondary market for radio frequencies in Denmark and operators could engage in buying, selling and hiring of spectrum for establishing mobile broadband networks.

NITA proposed no coverage or roll-out requirements should be imposed on new licensee in the 900 MHz band. NITA would propose a cap that would not allow existing licensees to bid for the 2X5 MHz block in the 2010 auction but Ministry would make the decision.

New 1800 MHz band license

NITA proposed to establish a new 1800 MHz band license of 2X10 MHz of bandwidth.

NITA did put forward the assumption of a new entry not being interested in using the 1800 MHz band frequencies to establish a GSM network but looking at implementing UMTS/HSPA or other technologies such as LTE. Consequently NITA concluded it was not relevant to ensure the new entry sufficient bandwidth to run GSM and a new technology in parallel in the 1800 MHz band. Furthermore, NITA argued that establishing a UMTS/HSPA and/or a LTE based network would also rely upon use of the 2100 MHz band (full band – 2X60 MHz – is awarded to four mobile operators in Denmark), the 2600 MHz band which were about to be awarded a few months after the refarming consultation and the 800 MHz band which were allocated to mobile but still to be awarded (by 2011 or 2012 was the assumption at the time where 900 MHz and 1800 MHz bands refarming decisions were prepared and made). Finally, NITA concluded that implementation of the new Danish Frequency Act by January 2010 would open a secondary market for radio frequencies in Denmark and operators could engage in buying, selling and hiring of spectrum for establishing mobile broadband networks.

NITA proposed no coverage or roll-out requirements should be imposed on new licensee. NITA would propose a cap that would not allow existing licensees to bid for the 2X10 MHz block in the 2010 auction of the new 1800 MHz band license but the Ministry would make the final decision.

Expiry of 900 MHz and 1800 MHz bands licenses

When licenses were issued Denmark had a system of license expiry after 10 years with an automatic renewal of 10 years unless NITA notified licensee of reasons for why renewal would not happen (there are certain reasons explicitly listed by regulatory framework that can lead to renewal not happening).

The table below gives an overview of the status of licenses, licensees and expiry dates before and after refarming:

Technology before refarming	Licensee and license	Date of award	Date of expiry before refarming	Proposed date of expiry after refarming	Technology after refarming
GSM900	TDC Mobil (GSM1)	1 March 1997	1 March 2012	12 June 2017	GSM and technologies that can co-exist (e.g. UMTS/HSPA and LTE)
GSM900	Telenor (GSM2)	1 March 1997	1 March 2012	12 June 2017	GSM and technologies that can co-exist (e.g. UMTS/HSPA and LTE)
GSM900	Telia (GSM3)	1 February 2001	1 February 2011	12 June 2017	GSM and technologies that can co-exist (e.g. UMTS/HSPA and LTE)

GSM900	Telia (GSM4)	1 February 2001	1 February 2011	12 June 2017	GSM and technologies that can co-exist (e.g. UMTS/HSPA and LTE)
DCS1800	TDC Mobil (DCS1)	12 June 1997	12 June 2017	12 June 2017	GSM and technologies that can co-exist (e.g. UMTS/HSPA and LTE)
DCS 1800	Telenor (DCS2)	12 June 1997	12 June 2017	12 June 2017	GSM and technologies that can co-exist (e.g. UMTS/HSPA and LTE)
DCS1800	Telia (DCS3)	12 June 1997	12 June 2017	12 June 2017	GSM and technologies that can co-exist (e.g. UMTS/HSPA and LTE)
DCS1800	Telia (DCS4)	12 June 1997	12 June 2017	12 June 2017	GSM and technologies that can co-exist (e.g. UMTS/HSPA and LTE)
DCS1800	Telenor (DCS5)	1 January 2001	1 January 2011	12 June 2017	GSM and technologies that can co-exist (e.g. UMTS/HSPA and LTE)
DCS1800	TDC Mobil (DCS6)	1 January 2001	1 January 2011	12 June 2017	GSM and technologies that can co-exist (e.g. UMTS/HSPA and LTE)

NITA was aiming at synchronising expiry dates and their proposal was to choose 12 June 2017 as the aligned expiry date and prolong licenses that expired before that date, cf. table above.

The 2X5 MHz license that NITA were planning to award to new entry bidder in the 900 MHz band in 2010 would be awarded with expiry by 12 June 2032 (12 June 2017 + 15 years). NITA proposed to spectrally move the new licensee to be awarded in 2010 from the middle of the 900 MHz band to the upper 5 MHz block in the 900 MHz band in 2017 when all the existing licenses would expire and being available to the market through a new award of 2X30 MHz of spectrum in the 900 MHz band.

NITA proposed exactly the same approach on synchronizing the license expiry dates in 2017 for the 1800 MHz band: the new entry into the band in 2010 award of a 2X10 MHz license would be given usage rights expiring 12 June 2032 (12 June 2017 + 15 years) and set up a new award for the remaining bandwidth of the 1800 MHz band when existing licenses expire in 2017.

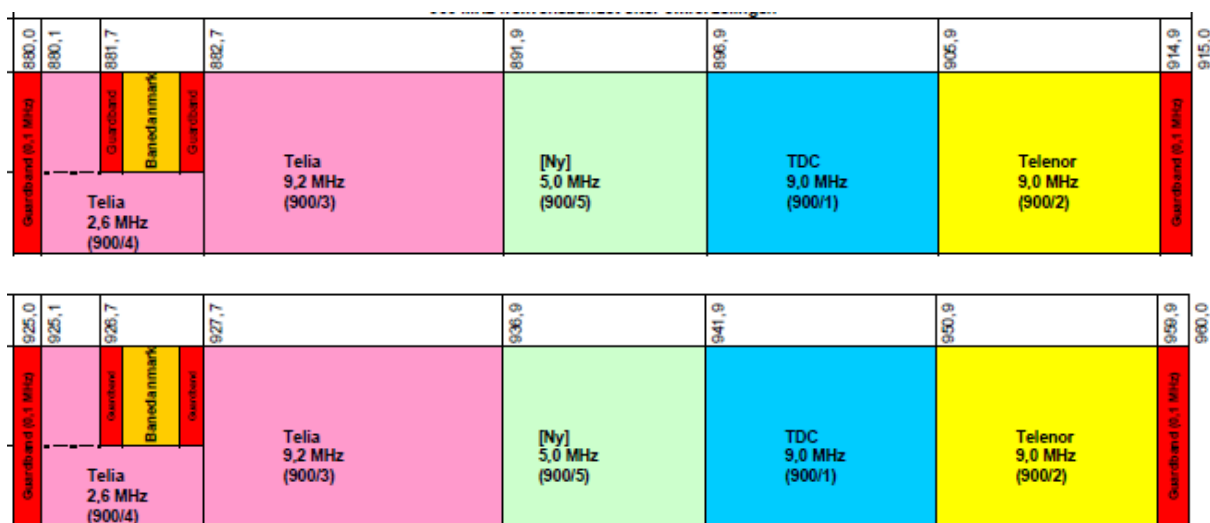
This would mean prolonging existing licenses that should have expired in 2011 and 2012 to 2017 and keeping the 2017 expiry of existing licenses with a 2017 expiry date. And it would mean awarding new licenses in 2010 and in 2017 that all would have same 2032 expiry date.

5 NITA Decisions 23 December 2009

On 23 December 2009 NITA made and published its decisions on redistribution of spectrum, spectrally moving existing licensees, freeing up spectrum for a new licensee in both the 900 MHz and the 1800 MHz band and lifting technology restrictions in existing licensees in the 900 MHz and 1800 MHz bands.

The 900 MHz band

The figure below illustrates the licensee situation in the 900 MHz band after NITA made its decision on refarming:



Source: NITA

Spectrally moving licensees and redistribution of spectrum to facilitate new entry licensee

TDC was spectrally moved and new assignment covers 896.9-905.9 / 941.9-950.9 MHz which adds up to 2X9 MHz contiguous bandwidth and consequently their bandwidth were increased by 2X0.2 MHz compared with the situation prior to the refarming decision.

Telenor was spectrally moved and new assignment covers 905.9-914.9 / 950.9-959.9 MHz which adds up to 2X9 MHz of contiguous bandwidth and consequently their bandwidth were increased by 2X0.2 MHz compared with the situation prior to the refarming decision.

Telia (or formally Telia Nättjänster Norden AB) were spectrally moved; their two licenses were merged so that new assignment covers 880.1-891.9 / 925.1-936.9 MHz, which adds up to 2X11.8 MHz of contiguous bandwidth and consequently their bandwidth were decreased by 2X3 MHz compared with the situation prior to the refarming decision. Furthermore a geographic definition of the usage rights reducing the bandwidth available for Telia in the Copenhagen area were imposed: the frequency bands 881.7-882.7 / 926.7-927.7 MHz cannot

be used in a distance that is closer to the railway related system for S-trains in the Copenhagen area (that usage right is assigned to Banedanmark and is supposed to expire by 2012 but the 23 December 2009 decision by NITA did not define any time dimension on this usage restriction imposed on Telia).

Before refarming a total of 2X2.6 MHz bandwidth was used for guardbands while the refarming re-planning of the band reduced bandwidth used for guardbands to 2X0.2 MHz bandwidth.

A block of 2X5 MHz contiguous spectrum was released for award to a new licensee by an auction.

One year from decision was made to decision of spectrally moving licensees comes into force

The decisions on spectrally moving existing licensees were made by NITA 23 December 2009 and entry into force was set to approximately one year later; 1 January 2011. According to Danish law licensees shall be given one year for preparing and implementing the required spectrally moving of their operations.

This means existing licensees were given approximately one year to re-plan their networks and adjust existing GSM transmitters to comply with the new assignments (spectrally moving their operation). In addition, the existing licensees had been aware of this happening through open and transparent discussions and formal consultations so that they could start their re-planning process and preparations at earlier point in time if they wanted to do so.

Timing of and consequences of lifting of technology restrictions (including consequences for coverage requirements)

Technologies that can technically coexist with GSM, and UMTS were particularly mentioned as an example by NITA, can be deployed in the 900 MHz band.

The coverage requirements and obligations to provide certain services were amended so that existing licensees could use other technologies than GSM to fulfil its obligations. But with the exception of slightly reducing some existing coverage obligations on Telia because their bandwidth was reduced by 2X3 MHz both the existing geographic and population coverage requirements were upheld by NITA.

The decisions were made by NITA 23 December 2009 and will come into force approximately one year later; 1 January 2011. Furthermore, existing licensees are not allowed to commercially offer other services than GSM services using the 900 MHz

frequencies before 1 May 2011. This means that after 1 May 2011 existing licensees can use the 900 MHz band for deployment of other technologies that can co-exist with GSM.

The decision taken by NITA means those current GSM coverage requirements applies until 1 May 2011 but after that day existing licensees may fulfil obligations using other technologies than GSM such as e.g. UMTS/HSPA and LTE. But coverage provided based on deployment of those technologies in other bands than the 900 MHz band cannot be used for complying with the 900 MHz based coverage obligations.

Prolonged licenses – new expiry dates by end of 2019

Existing 900 MHz band licenses expire by 2011 and 2012 but the refarming decision prolonged licenses and new expiry was set to 31 December 2019.

The NITA proposal put out for consultation before making the 23 December 2009 decisions were prolonging licenses until 12 June 2017 but as a response to inputs on investment cycles for upgrading technologies received in the consultation process NITA decided to extend the prolongation and new expiry of existing licenses were set to 31 December 2019.

NITA also decided that there would be no assessment of renewal when facing expiry by end of 2019 (this is referring to the Danish system of almost automatic renewal after ten years so that duration of licenses normally have been 2X10 years). In 2019 there will be a new award of 2X30 MHz of bandwidth in the 900 MHz band (and implicitly this probably means an award where incumbents formally are given no advantage over other interested parties).

The 1800 MHz band

The figure below illustrates the licensee situation in the 1800 MHz band after NITA made its decision on refarming:

1800 MHz-frekvensbåndet efter omfordelingen										
Frekvens i MHz	1710,0	1710,1	1720,1	1731,9	1741,9	1749,1	1761,3	1773,1	1784,9	1785,0
Tilladelse	Guaraband (0,1 MHz)	[Ny] 10,0 MHz (1800/7)	TDC 11,8 MHz (1800/1)	TDC 10,0 MHz (1800/6)	Telenor 7,2 MHz (1800/2)	Telenor 12,2 MHz (1800/5)	Telia 11,8 MHz (1800/3)	Telia 11,8 MHz (1800/4)	Guaraband (0,1 MHz)	

Frekvens i MHz	1805,0	1805,1	1815,1	1826,9	1836,9	1844,1	1856,3	1868,1	1879,9	1880,0
Tilladelse	Guaraband (0,1 MHz)	[Ny] 10,0 MHz (1800/7)	TDC 11,8 MHz (1800/1)	TDC 10,0 MHz (1800/6)	Telenor 7,2 MHz (1800/2)	Telenor 12,2 MHz (1800/5)	Telia 11,8 MHz (1800/3)	Telia 11,8 MHz (1800/4)	Guaraband (0,1 MHz)	

Source: NITA

Spectrally moving licensees and redistribution of spectrum to facilitate new entry licensee

TDC was spectrally moved and new assignment covers 1720.1-1741.9 / 1815.1-1836.9 MHz which adds up to 2X21.8 MHz contiguous bandwidth and consequently their bandwidth were decreased by 2X4.8 MHz compared with the situation prior to the refarming decision.

Telenor was spectrally moved and new assignment covers 1741.9-1761.3 / 1836.9-1856.3 MHz which adds up to 2X19.4 MHz of contiguous bandwidth and consequently no change to Telenor's bandwidth were made compared with the situation prior to the refarming decision.

Telia (or formally Telia Nättjänster Norden AB) were spectrally moved and new assignment covers 1761.3-1784.9 / 1856.3-1879.9 MHz which adds up to 2X23.6 MHz of contiguous bandwidth and consequently their bandwidth were decreased by 2X5.2 MHz compared with the situation prior to the refarming decision.

Before refarming a total of 2X0.2 MHz bandwidth was used for guardbands at band edges and the refarming decision did not change this.

A block of 2X10 MHz contiguous bandwidth was released for award to a new licensee.

One year from decision was made to decision of spectrally moving licensees comes into force

The decisions on spectrally moving existing licensees were made by NITA 23 December 2009 and entry into force was set to approximately one year later; 1 January 2011. According to Danish law licensees shall be given one year for preparing and implementing the required spectrally moving of their operations.

This means existing licensees were given approximately one year to re-plan their networks and adjust existing GSM transmitters to comply with the new assignments (spectrally moving their operation). In addition, the existing licensees had been aware of this happening through open and transparent discussions and formal consultations so that they could start their re-planning process and preparations at earlier point in time if they wanted to do so.

Timing of and consequences of lifting of technology restrictions (including consequences for coverage obligations)

Technologies that can technically coexist with GSM, and UMTS and LTE were particularly mentioned as an example by NITA, can be deployed in the 1800 MHz band.

The coverage requirements and obligations to provide certain services were amended so that existing licensees could use other technologies than GSM to fulfil its obligations. But both the existing geographic and population coverage requirements were upheld by NITA.

The decisions were made by NITA 23 December 2009 and were set to come into force approximately one year later; 1 January 2011. Furthermore, existing licensees were not allowed to commercially offer other services than GSM services using the 1800 MHz band frequencies before 1 May 2011. This means that after 1 May 2011 existing licensees can use the 1800 MHz band for deployment of other technologies than can co-exist with GSM.

The decision taken by NITA means the original GSM coverage requirements did apply until 1 May 2011 but after that day existing licensees may fulfil obligations using other technologies than GSM such as e.g. UMTS/HSPA and LTE. But coverage provided based on deployment of those technologies in other bands than the 1800 MHz band cannot be used for complying with the 1800 MHz based coverage obligations.

Expiry dates by June 2017

Existing 1800 MHz band licenses expire by 2017 with the exception of two of the six licenses that expire by 2012. The refarming decision also synchronised the expiry of all licenses to 13 June 2017.

NITA also decided that there would be no assessment of renewal when facing expiry by 2017 (this is referring to the Danish system of almost automatic renewal after ten years so that duration of licenses normally have been 2X10 years). Upon 2017 expiry there will be a new award of 2X60 MHz of bandwidth in the 1800 MHz band (and implicitly this probably means an award where incumbents formally are given no advantage over other interested parties).

A summary of situation after the refarming decisions

Technology	Licensee and previous licenses	Assignment after refarming decision	Date of expiry before refarming	Date of expiry after refarming
GSM and technologies than can coexist with GSM, e.g. UMTS/HSPA and LTE	TDC Mobil (GSM1)	896.9-905.9 / 941.9-950.9 MHz 2X9 MHz of contiguous bandwidth Bandwidth increased by 2X0.2 MHz	1 March 2012	31 December 2019
GSM and technologies than can coexist with GSM, e.g. UMTS/HSPA and LTE	Telenor (GSM2)	905.9-914.9 / 950.9-959.9 MHz 2X9 MHz of contiguous bandwidth Bandwidth increased by 2X0.2 MHz	1 March 2012	31 December 2019
GSM and technologies than can coexist with GSM, e.g. UMTS/HSPA and LTE	Telia (GSM3) Telia (GSM4)	880.1-891.9 / 925.1-936.9 MHz 2X11.8 MHz of contiguous bandwidth Bandwidth decreased by 2X3 MHz	1 February 2011	31 December 2019
GSM and technologies than can coexist with GSM, e.g. UMTS/HSPA and LTE	New license to be auctioned in 2010	891.9-896.9 / 936.9-941.9 MHz 2X5 MHz of contiguous bandwidth Created by a combination of removing guardbands between licenses and reducing Telia's bandwidth		
GSM and technologies than can coexist with GSM, e.g. UMTS/HSPA and LTE	TDC Mobil (DCS1) TDC Mobil (DCS6)	1720.1-1741.9 / 1815.1-1836.9 MHz 2X21.8 MHz of contiguous bandwidth Bandwidth decreased by 2X4.8 MHz	12 June 2017	12 June 2017
GSM and technologies than can coexist with GSM, e.g. UMTS/HSPA and LTE	Telenor (DCS2) Telenor (DCS5)	1741.9-1761.3 / 1836.9-1856.3 MHz 2X19.4 MHz of contiguous bandwidth No change to bandwidth	12 June 2017	12 June 2017

GSM and technologies than can coexist with GSM, e.g. UMTS/HSPA and LTE	Telia (DCS3)	1761.3-1784.9 / 1856.3-1879.9 MHz	12 June 2017	12 June 2017
	Telia (DCS4)	2X23.6 MHz of contiguous bandwidth Bandwidth decreased by 2X5.2 MHz		
GSM and technologies than can coexist with GSM, e.g. UMTS/HSPA and LTE	New license to be auctioned in 2010	1710.1-1720.1 / 1805.1-1815.1 MHz 2X10 MHz contiguous bandwidth Created by reducing Telia and TDC's bandwidth		

6 Auctions of new 900 MHz and 1800 MHz band licenses

By 8 September 2010 NITA published that the 900 MHz band auction and the 1800 MHz band auction would take place in October 2010 and put forward 20 October and 25 October respectively as the kick off date for the two auctions.¹⁴

What was up for sale:

- Contiguous bandwidth of 2X5 MHz in the 900 MHz band (the 891.9 896.9 / 936.9 941.9 MHz bands) with geographical coverage of Danish territory and expiry by 31 December 2034. Starting 1 January 2011 the licensee may use GSM technology and starting 1 May 2011 the licensee may use mobile technologies that can coexist with GSM such as e.g. UMTS/HSPA and LTE for commercial provision of electronic communication services.¹⁵
- Contiguous bandwidth of 2X10 MHz in the 1800 MHz band (the 1710.1-1720.1 / 1805.1-1815.1 MHz bands) with geographic coverage of Danish territory and with expiry by 12 June 2032. Starting 1 January 2011 the licensee may use GSM technology and starting 1 May 2011 the licensee may use mobile technologies that can coexist with GSM such as e.g. UMTS/HSPA and LTE for commercial provision of electronic communication services.¹⁶

Reservation price for the licenses were set to 8 million Danish kroner for the 900 MHz band license and 4 million Danish kroner for the 1800 band license. Both licenses would be sold to highest bid (but since it was designed as two separate auctions no combinations of bids for the two licenses etc. were allowed).

¹⁴ <http://www.itst.dk/nyheder/pressemeddelelser/nye-frekvensauktioner-i-oktober-2010>

¹⁵ Draft license is published (in Danish): <http://www.itst.dk/frekvenser-og-udstyr/auktioner-og-udbud/aktuelle-auktioner-og-udbud/900-og-1800-mhz-auktion/filarkiv-900-og-1800-auktion/Bilag%20E%20udkast%20til%20900-tilladelse.pdf>

¹⁶ Draft license is published (in Danish): <http://www.itst.dk/frekvenser-og-udstyr/auktioner-og-udbud/aktuelle-auktioner-og-udbud/900-og-1800-mhz-auktion/filarkiv-900-og-1800-auktion/Bilag%20F%20udkast%20til%201800-tilladelse.pdf>

Bidders had to register by 29 September 2010 but existing licensees in the 900 MHz and 1800 MHz bands – TDC, Telenor and Telia – were not allowed to participate in the auction (a cap was implemented). So the Danish 900 MHz and 1800 MHz bands refarming process was planned for concluding by auctioning off 2X5 MHz in the 900 MHz band and 2X10 MHz in the 1800 MHz band to new entries into the bands.¹⁷

By deadline for register as bidder 29 September 2010 Hi3G Denmark ApS was the only bidder registered for both the 900 MHz band auction and for the 1800 MHz band auction. The auction rules was designed so that a only registered bidder was allowed to buy the two licenses at the minimum price set (8 million Danish kroner for the 900 band license and 4 million Danish kroner for the 1800 band license).¹⁸

On 18 October 2010 Hi3G Denmark ApS were assigned the 900 band license comprising 2X5 MHz of bandwidth and the 1800 band license comprising 2X10 MHz of bandwidth.¹⁹

¹⁷ <http://www.itst.dk/frekvenser-og-udstyr/auktioner-og-udbud/tidligere-auktioner-og-udbud/900-og-1800-mhz-auktion>

¹⁸ <http://www.itst.dk/frekvenser-og-udstyr/auktioner-og-udbud/tidligere-auktioner-og-udbud/900-og-1800-mhz-auktion/tilmelding-til-900-mhz-og-1800-mhz-auktionerne>

¹⁹ <http://www.itst.dk/frekvenser-og-udstyr/frekvenstilladelser-mv/tilladelser-udstedt-efter-auktion-eller-udbud/900-mhz-frekvensbandet> <http://www.itst.dk/frekvenser-og-udstyr/frekvenstilladelser-mv/tilladelser-udstedt-efter-auktion-eller-udbud/1800-mhz-frekvensbandet>

7 Concluding remarks

The Danish 900 MHz and 1800 MHz bands refarming process ended up with moving from three licensees in the two bands to four licensees in the two bands. In the 2100 MHz band Denmark had four existing licensees and at the time of the 900 MHz and 1800 MHz bands refarming process the Danish market were served by the four operators TDC, Telenor, Telia and "3". With Hi3G Denmark ApS buying the new 900 MHz band license and the new 1800 MHz band license the refarming process basically ended up with the four existing mobile operators serving the Danish market have access to both 900 MHz band, 1800 MHz band and 2100 MHz band spectrum. In addition, those four mobile operators did also by spectrum in the Danish 2600 MHz band auction. When this case study was finalized the 800 MHz band auction had not happened.

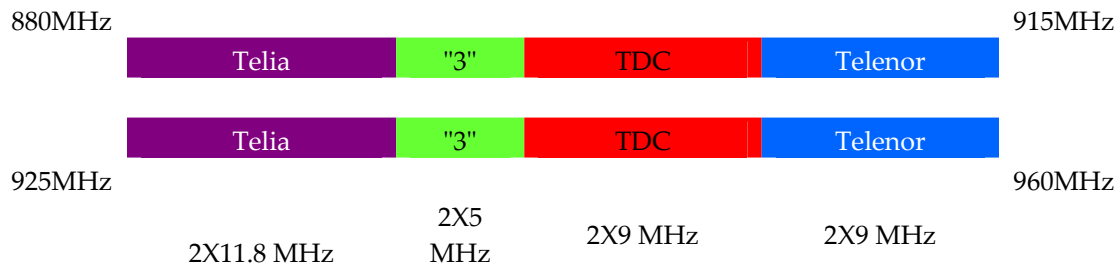
Annex

The table below gives the overview of distribution of mobile spectrum between the four operators serving the Danish market updated per 8 September 2011.

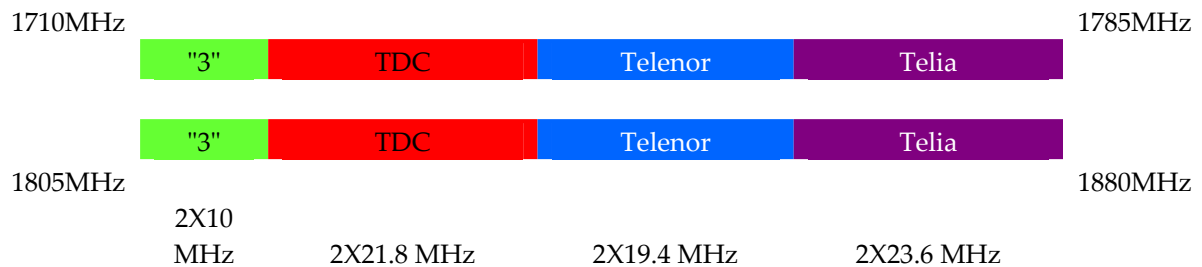
The auction of 800 MHz band spectrum is scheduled for 2012.

	900 MHz band	1800 MHz band	2100 MHz band	2600 MHz band
TDC	2X9 MHz Contiguous bandwidth 896.9-905.9 / 941.9-950.9 MHz	2X21.8 MHz contiguous bandwidth 1720.1-1741.9 / 1815.1-1836.9 MHz	2X15 MHz contiguous bandwidth 1935-1950 / 2125-2140 MHz 5 MHz unpaired 1900-1905 MHz	2X20 MHz contiguous bandwidth 2500-2520 / 2620-2640 MHz
Telenor	2X9 MHz contiguous bandwidth 905.9-914.9 / 950.9-959.9 MHz	2X19.4 MHz contiguous bandwidth 1741.9-1761.3 / 1836.9-1856.3 MHz	2X15 MHz contiguous bandwidth 1965-1980 / 2155-2170 MHz 5 MHz unpaired 1910-1915 MHz	2X20 MHz contiguous bandwidth 2550-2570 / 2670-2690 MHz 10 MHz unpaired 2595-2605 MHz
Telia	2X11.8 MHz contiguous bandwidth 880.1-891.9 / 925.1-936.9 MHz	2X23.6 MHz contiguous bandwidth 1761.3-1784.9 / 1856.3-1879.9 MHz	2X15 MHz contiguous bandwidth 1950-1965 / 2140-2155 MHz 5 MHz unpaired 1905-1910 MHz	2X20 MHz contiguous bandwidth 2530-2550 / 2650-2670 MHz 10 MHz unpaired + the C10 block 2605-2620 MHz
“3”	2X5 MHz contiguous bandwidth 891.9-896.9 / 936.9-941.9 MHz	2X10 MHz contiguous bandwidth 1710.1-1720.1 / 1805.1-1815.1 MHz	2X15 MHz contiguous bandwidth 1920-1935/ 2110-2125 MHz 5 MHz unpaired 1915 - 1920 MHz	2X10 MHz contiguous bandwidth 2520-2530 / 2640-2650 MHz 25 MHz unpaired 2570-2595 MHz

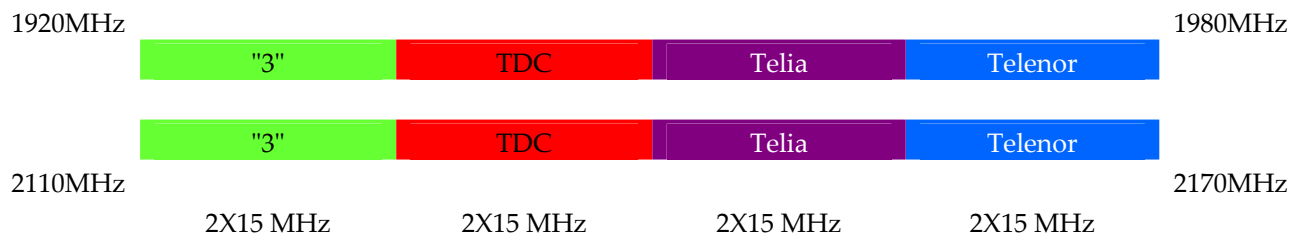
The distribution of spectrum between operators in the Danish 2X35 MHz 900 MHz band per 8 September 2011:



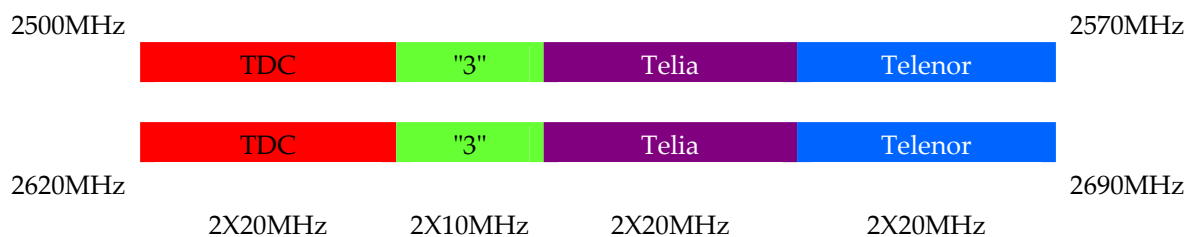
The distribution of spectrum between operators in the Danish 2X75 MHz 1800 MHz band per 8 September 2011:



The distribution of the paired spectrum between operators in the Danish 2X60 MHz 2100 MHz band per 8 September 2011:



The distribution of the paired spectrum between operators in the Danish 2600 MHz band per 8 September 2011:



The 2600 MHz band situation in unpaired mode:

