Qualcomm Europe Inc.

RTR public consultation on future frequency assignments and on the liberalisation of the 900 MHz and 1800 MHz frequency bands.

Qualcomm Response

March 2011

Executive summary

Qualcomm welcomes the opportunity to provide a response to the Rundfunk und Telekom Regulierungs-GmbH (RTR) consultation paper on future frequency assignments and on the liberalisation of the 900 MHz and 1800 MHz frequency bands.

Qualcomm applauds RTR for its intention to secure the future of mobile broadband in Austria with the refarming of the 900 MHz as well as the award of the 800 MHz band.

First and foremost, Qualcomm believes that a spectrum policy framework based on technology neutrality through standards competition, application neutrality and pan-European implementation of harmonized technical spectrum usage rights enables an efficient use of spectrum, innovation, competition and the successful commercial development of wireless technologies in Austria and in Europe.

Qualcomm invites the RTR to focus on two key objectives:

- Ensure the fast availability of a mobile broadband to all citizens (nationwide coverage of quality service) by allowing as soon as possible a flexible usage of the 900MHz band and clarifying the frequency allocation of the band beyond 2016 in order to allow timely investment in 900MHz networks.

- Support for the long term evolution of mobile broadband, especially when considering the very large traffic forecast on the mobile platform, by enabling the optimum use of the 800 MHz band for the future evolution of networks.

Qualcomm argues that these two goals ultimately also lead to the optimal spectrum usage on the long term.

Introduction

Mobile broadband is both a large opportunity for operators and a life changing experience for users. The digital divide, i.e. the inability for a significant percentage of the population to benefit from digital services such as Internet access, is rightfully identified as a key challenge for both society and the economy. Mobile broadband is the key to bridging the digital divide as it allows cost-efficient Internet connectivity over a wide coverage of sparsely populated areas.

Mobile broadband does not only provide internet access to rural areas but also provides *mobile internet access*, which in itself is becoming more and more important to citizens and companies. Services such as e-health or automotive services inherently require mobility and are expected to play a major role, particularly to cater for the need of an aging society, but also as a general infrastructure for the society. Already today, advanced users expect to have a high quality mobile internet access anywhere and everywhere, with a serious impact on the competitiveness of a region when it is not the case.

From a business perspective, mobile broadband has a growing importance in operator's business models, with a clear trend of data revenues increasing among operators. Fast connection and ubiquitous coverage are two key components to drive the usage of data services.

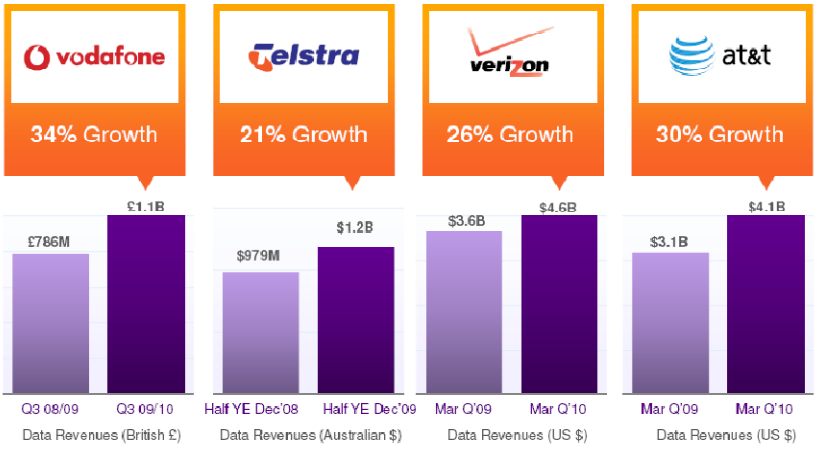

Figure 1: Operators' data revenues are growing worldwide.

Any delay in the availability of mobile broadband is likely to have vast consequences on the economic performance of a country like Austria. In particular, innovation in terms of services will remain limited as long as an ubiquituous infrastructure is not in place. In parallel, delaying the availability of the mobile broadband platform would hurt operators which rely increasingly on data revenues. At the same time, the current explosion of data traffic indicates that it is important to ensure the optimal spectrum efficiency in the long term.

HSPA900 can bridge the digital divide today

A successful mobile broadband deployment relies on both the availability of cost-efficient equipment and the availability of low frequency spectrum in order to achieve ubiquitous coverage. HSPA900 fulfils both of these key requirements. HSPA900 allows significant coverage at reasonable cost by reusing the current 2G network topology. France, a sparsely populated country by European standards, will achieve 98 percent mobile broadband coverage in 2011 with HSPA900, and 99.3 percent of the population will be covered by the end of 2013. Furthermore, users can benefit from HSPA900 immediately following deployment as a significant share of existing terminals already supports HSPA900.

HSPA900:

- Delivers a true mobile broadband user experience
- Allows cost-effective ubiquitous coverage
- Enables fast service availability to users
- Is future-proof

HSPA900 is commercially deployed in 27 networks (including in France, UK, Germany, Poland, Sweden, Belgium, Finland, Romania, Croatia, Latvia, Estonia and Iceland). At least 34 countries across the world currently permit UMTS/HSPA900. Spain, for instance, has recently adopted a royal decree to enable the deployment of UMTS900 as early as possible. 526 HSPA900 devices have been launched by 81

suppliers[1], including the Iphone4. In fact, a vast majority of 3G handsets sold today already support HSPA900 (see Figure 2 below). In addition, HSPA+ has also now been made available to the 900 MHz frequencies allowing peak rates of more than 21 Mbps on HSPA+900 dongles, and first commercial network rollouts have been completed on HSPA+ 900 in Poland and Romania.

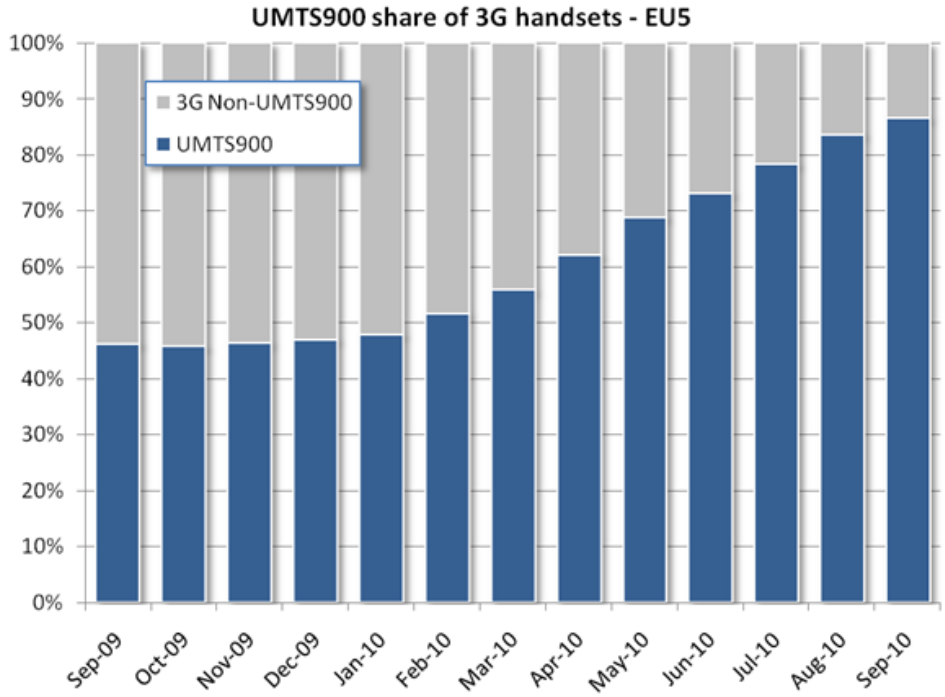

Figure 2: close to 90% of 3G handsets sold in EU5 support UMTS/HSPA900[2]

Finally, if HSPA900 is often contemplated as the optimum mobile broadband solution for suburban and rural 3G coverage, initial rollouts in urban areas have also demonstrated a superior indoor coverage and thus 3G quality of service experienced by customers with HSPA900 compatible terminals, both on voice (less incoming call failures and dropped calls) and data.

[1] Source: GSA
[2] Source: GFK

Due to the maturity of the technology, the large existing market seeding and the capacity to address both fixed and mobile markets, HSPA900:

- Addresses both fixed and mobile markets.
- Provides the right platform for services such as smart grids, ITS (transport and logistics solutions, pay as you drive insurance solutions, automotive maintenance and multimedia services, e-call based enhanced services) and m-health for the next decade.
- Is economically attractive to customers and operators.
- Immediately improves Austria citizen internet access.

LTE800 will provide coverage for the evolution of mobile broadband

Optimal deployment of LTE will require leveraging larger channel bandwidth (10MHz, 15MHz and 20MHz) and low and high frequency bands for coverage and capacity purposes in order not to recreate a new digital divide and maintain ubiquitous access to all citizens.

Throughout Europe, the 900 MHz band is used very intensively, supporting both GSM and UMTS/HSPA services. The 900 MHz seldomly offers the possibility to vacate 10 MHz of spectrum to introduce LTE. In the meantime, the 800MHz band is becoming available throughout Europe and, as a new frequency band, easily accomodates systems with 10 MHz bandwidth.

Qualcomm recommends adopting a frequency allocation process that would allow the allocation to result in the award of three licences of 2x10MHz each, as represented in the Figure below:

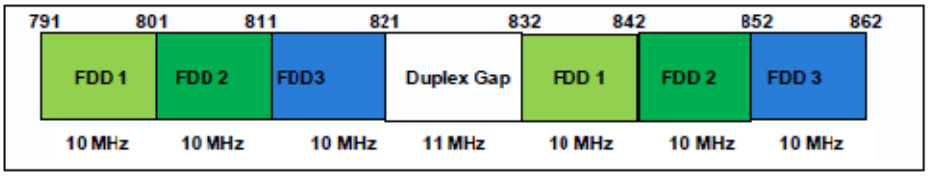

Figure 3: Optimal allocation outcome in the 800MHz band

This option was indeed the outcome reached in Germany and Sweden during the recent auctions of the 800MHz band, providing further support for its optimality. Qualcomm expects a very significant eco-system to develop around LTE800 terminals with 10MHz bandwidth.

Conclusion

When assessing:

- the maturity of technologies,
- the market availability and existing eco-systems,
- the developement and other European countries,

Qualcomm observes that the 900 MHz and 800 MHz bands align with two complementary time schedules. While the 900 MHz band allows the availability of mobile broadband in the very short term, the 800 MHz band will support the evolution towards higher bandwidth in the future.

The combination of spectrum in both the 800 MHz and 900 MHz band is necessary for an operator in order to be in the position to:

- Offer ubiquituous mobile broadband services in the near future.
- Secure the long term evolution of its network towards larger bandwidth.

Qualcomm recommends RTR to align with the technological and ecosystem trends throughout Europe by:

- Supporting the rapid deployment of mobile broadband in the 900 MHz band.
- Ensuring the optimum use of the 800 MHz band for the future evolution of networks.

Qualcomm argues that this ultimately also corresponds to the optimal spectrum usage on the long term.

2.2 Market development

Question 2.1.: How do you predict that this market will develop in the longer term? Please estimate the number of mobile subscribers who will be using mobile broadband services (smart phones, USB modems) three years from now. What average monthly data volume per customer would you predict?

Qualcomm notes that the Study Group 5 (SG5), Working Party 5D (WP5D) of the International Telecommunication Union (ITU) is currently drafting an ITU-R Report on the analysis and assessment of global broadband wireless services and marketplace for IMT (IMT.UPDATE report).
Qualcomm recommends RTR to refer to this report for comprehensive collection of views and synthesis of the evolution of the mobile broadband market.

Question 2.2.: What coverage level do you plan to attain or expect in the coming years?

Qualcomm gathered information provided by regulators and operators in three large European countries (France, Germany, UK) in the Table below. The results highlights that the population coverage with mobile telephony is nearly completed, but also that the population coverage is very significant.
Most importantly, France decision to allow mobile operators to deploy HSPA900 ensured significant coverage benefits over countries that have yet to fully allow deployment of HSPA900. France, a sparsely populated country by European standards, will achieve 98 percent mobile broadband coverage in 2011 with HSPA900, and 99.3 percent of the population will be covered by the end of 2013.

Coverage with	**Current**	**2013**	**2015**
Voice [Pop]	D: >99%		

	FR: 100% UK: 97%		
Voice [Area]	FR: >97,7%		
Broadband UMTS/LTE/WiMAX [Pop]	D: >80% FR: >92% UK: >87%	FR: >99%	FR: >99%
Broadband UMTS/LTE/WiMAX [Area]	FR: >52%		

Question 2.3.: What will a typical mobile communications network (or your network) look like in 3 to 5 years, and what technologies will be deployed?

In 3 years, Qualcomm expects a typical mobile communication network to provide:

- support of GSM for legacy,
- nationwide coverage with HSPA,
- LTE service in densely populated areas.

In 5 years, Qualcomm expects a typical mobile communication network to provide:

- nationwide coverage with HSPA+, including carrier aggregation and supplemental downlink.
- nationwide coverage with LTE service,
- LTE-advanced service in densely populated areas.

Question 2.4.: When do you expect UMTS (HSPA), LTE and WiMAX technologies to be ready for the mass market in the 800 MHz, 900 MHz and 1800 MHz frequency bands?

The selection of a technology for the network infrastructure (base stations) is no longer a critical factor as most operators deploy Single RAN Base Stations, i.e. Base Stations which can support various air interfaces (GSM, HSPA, LTE). As a result, the

operator can select at any given moment the appropriate technology for a specific band, depending on a single critical parameter: the availability and the price of terminals, i.e. the terminal eco-system in the band. Such a choice can be reverted when the terminal eco-system has evolved.
As a result, a successful mobile broadband deployment relies mostly on the availability of cost-efficient terminal equipment.

Qualcomm currently delivers HSPA+ chipsets for both mobile phones and data cards up the the release 8 of the standard (HSPA+ R8). Qualcomm also launched the industry first HSPA/LTE multimode chipset (supporting HSP, LTE FDD and LTE TDD) in Q4 2010. Qualcomm chipsets support all 3GPP bands specified to this date in the 450MHz to 2600MHz range in the most recent RFICs in production.
However, the development of terminals or data cards supporting specific frequency bands for specific technologies remain the sole choice of Original Equipment Manufacturer (OEMs). The availability and price of terminals and data cards are usually strongly correlated to the size of the corresponding market.

The expectation of the worldwide number of subscribers by technology is provided in the Figure below.

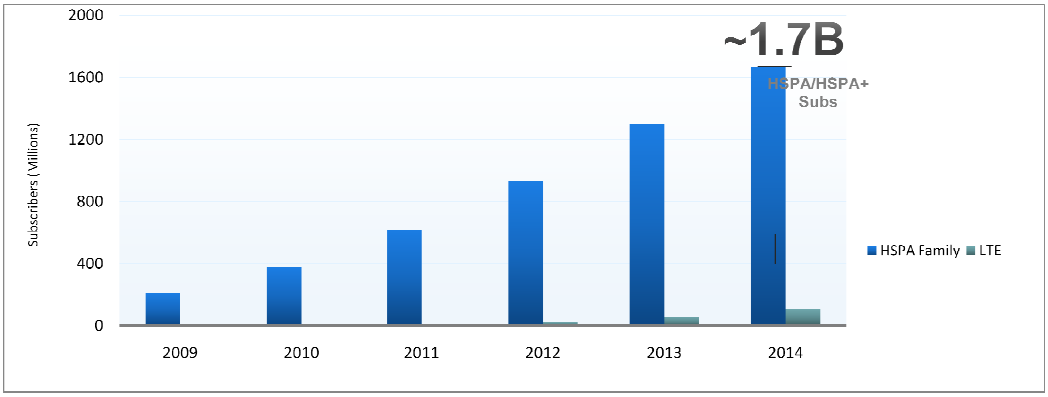

Figure 4: HSPA Family and LTE mobile broadband subscribers

Qualcomm considers a technology to be mass market once it reaches the 50 million worldwide subscriber mark. As a result, Qualcomm expectation for the mass market

availability of specific technologies in specific frequency bands is provided in the Table below.

Coverage with	Network	Modems	(Smart) Phones
UMTS in the 800 MHz band	Not expected	Not expected	Not expected
UMTS in the 900 MHz band	Already mass market	Already mass market	Already mass market
UMTS in the 1800 MHz band	Market demand just initiated. Mass Market date will depend on market development	Market demand just initiated. Mass Market date will depend on market development	Market demand just initiated. Mass Market date will depend on market development
LTE in the 800 MHz band	Market demand just initiated. Mass Market date will depend on market development. 2015 is considered by the industry as a reasonable date.	Market demand just initiated. Mass Market date will depend on market development. 2015 is considered by the industry as a reasonable date.	Market demand just initiated. Mass Market date will depend on market development. 2015 is considered by the industry as a reasonable date.
LTE in the 900 MHz band	Limited market demand as of today. Mass Market date will depend on market development.	Market demand just initiated. Mass Market date will depend on market development.	Market demand just initiated. Mass Market date will depend on market development.

LTE in the 1800 MHz band	Market demand just initiated. Mass Market date will depend on market development.	Market demand just initiated. Mass Market date will depend on market development.	Market demand just initiated. Mass Market date will depend on market development.

Question 2.5.: When do you expect that LTE will support voice telephony?

Voice over IP protocol is already supported over LTE, as a standard IP service.
With regards to an integrated voice service, Qualcomm is taking an active role and a leadership position in the VoLTE initiative, an industry wide effort to deliver the availability of Voice-over-LTE (VoLTE) in 2013.

Question 2.6.: What are the long-term spectrum needs of your organisation / of a typical mobile operator?

The long term spectrum needs of a typical mobile operator depend on a number of factors including the predicted rise of the mobile broadband traffic and the customer density of the specific operator. The ITU has conducted a number of studies on the long-term spectrum needs for IMT systems, including the ITU-R Report M.2078, 'Estimated spectrum bandwidth requirements for the future development of IMT-2000 and IMT-Advanced'.
Qualcomm recommends RTR to refer to this report for a comprehensive collection of views and synthesis of the spectrum requirements for mobile broadband.

With regards to one operator's spectrum requirement in 2015, Qualcomm argues that an operator would require 2x5MHz @ 900MHz for the deployment of HSPA900 and 2x10MHz @ 800MHz for the deployment of LTE800. Additionally, depending on his

will to innovate and on its customer base, such an operator could also require some 900MHz spectrum for legacy GSM devices, leading to a total of 2x20MHz FDD spectrum below 1GHz. It should be noted that not all operators would have the exact same requirements.

The spectrum above 1GHz available to mobile operators in 2015 is expected to represent a total of 2x205MHz of FDD spectrum (1800, 2100, 2600MHz bands) and 175MHz (1.9, 2 and 2.6GHz) of TDD spectrum. Finally, 40MHz of supplementalmobile downLink (SDL) spectrum could be available in 2013 – 2015 in the 1452-1492 MHz band, depending on the outcome of the on-going CEPT process. This spectrum would be of very high importance to mobile broadband network, as it would provide the ability to FDD networks to handle assymetric traffic, over significant coverage. SDL spectrum is actually likely to become a very desirable spectrum, given its limited projected availability. Another 100 MHz at 2.3 GHz can also be made available in the future (c.f. ongoing RSPP discussions at the European Parliament). Supposing that the projected spectrum above 1GHz (other than SDL) is sufficient to handle the mobile traffic growth and is divided among 4 operators, this would lead to the requirements in the Table below.

	FDD spectrum requirement	**TDD spectrum requirement**	**SDL spectrum requirement**
Frequencies below 1 GHz	**2x20MHz**	**N/A**	**N/A**
Frequencies above 1 GHz	**2x50MHz**	**45MHz**	**>10 MHz**

Question 2.7.: Do you consider it necessary for an operator to operate in all bands designated for mobile communications, or do you consider it more sensible in the long term to focus on "core bands" (e.g., 900 MHz only as opposed to 800 and 900 MHz)?

When assessing:

- the maturity of technologies and their limitations,
- the market availability and existing eco-systems,
- the developements in other European countries,

Qualcomm observes that the 900 MHz and 800 MHz bands align with two very distinct time schedules. While the 900 MHz band allows the availability of mobile broadband in the very short term and the legacy support of GSM, the 800 MHz band will support the evolution towards higher bandwidth in the future.

As a results, Qualcomm believes that an operators needs to operate in both the 800MHz and the 900MHz bands. Both the 900MHz and the 800MHz bands should be considered as "core bands" for the deployment of mobile broadband networks.

Similarly, the 1800MHz, 2.1GHz and FDD 2.6 GHz bands cannot be considered in the short or medium term as equivalent as they present individual characteristics:

- the 1800MHz band is the single sub-1GHz band which will support GSM,
- the 2.1GHz band will remain the band of choice (with the 900MHz) for HSPA terminals,
- the 2.6GHz band will be the preferred band for LTE terminals supporting a 20MHz bandwidth and therefore will be required to provide mobile services with data rate significantly higher than HSPA+.

Question 2.8.: How important is the assignment of frequencies below 1 GHz to your organisation / to mobile network operators? What advantages do you see in these assignments?

Spectrum bands below 1GHz are critical to any country as they are required in order to deploy ubiquituous mobile broadband network and bridge the digital divide.

Spectrum bands below 1GHz are also critical in order to deliver Quality of Service in urban areas, in deep indoor coverage situations.

Question 2.9.: What other obstacles to the future expansion of mobile broadband can you identify (e.g., connection of base stations, etc.)?

The deployment of innovative air interface will significantly increase the data rate between the User Equipment (UE) and the Base Station (BS). However, in order for this increase in the air interface data rate to result in improved Quality of Service for the user, the BS will need to rely on very fast and reliable backhauling. The connection of BS to the mobile operator core network may quickly represent the bottleneck of the network, unless advanced backhauling network are deployed. The wide availability of access to fibre optic networks would provide a suitable option for BS backhauling. The deployment of such a fiber optic backhauling network could be supported by the Austrian governement through incentives and regulatory support.

Additionally, the deployment of very high capacity network in urban areas as well as innovative network in rural area may required the deployment of new sites for BSs. Mobile operators have been facing increasing amount of difficulties in order to acquire BS sites. Regulatory support towards site acquisition and operation and better information of the citizen may be required in order to enable the deployment of mobile broadband networks.

Question 2.10.: Do you expect mobile technologies (UMTS, LTE, WiMAX) to be available to the mass market in the 3600 – 3800 MHz frequency band in the foreseeable future? If yes, when do you expect them to be available, and when could that frequency band be used?

The frequency band 3400-3800MHz is expected to become the key band for the future deployment of LTE-Advanced systems, which will require bandwidth between 20MHz and up to 100MHz.
However, it is challenging to have a clear view on the timetable for the deployment of such systems as the standardisation of such system is currently not complete and as

the regulatory framework for mobile broadband systems in the 3400-3800 MHz band still needs to be defined.

The regulatory framework for the band needs first to be properly defined by the CEPT, the standards need to be completed by the 3GPP and the band needs to be harmonised for the deployment of mobile broadband (including LTE-Advanced) systems throughout Europe before market estimation can be derived.

Question 2.11.: Would you consider it useful to assign frequencies in the 450 MHz band in the near future? If yes, when? How would this band be used?

It would be useful for the 450MHz to be assigned immediately, as it could potentially support a number of Machine-to-Machine (M2M) communication services through wireless technological solutions.

3 Refarming

3.1 Background

Question 3.1.: In your opinion, how much longer will GSM remain in use? What share of the 900 MHz / 1800 MHz band will still be used for GSM in the year 2015 and in the year 2020? In what sub-ranges of these frequency bands should GSM be deployed in the longer term?

GSM-only terminal penetration decline

GSM devices support mainly voice services, with very limited data capability. Customers have been upgrading their current devices to 3G capable devices for some time, due to the focus on mobile broadband services and the demand for smartphones and other advanced devices. Such a market evolution leads to the natural decline of the penetration of GSM-only terminals

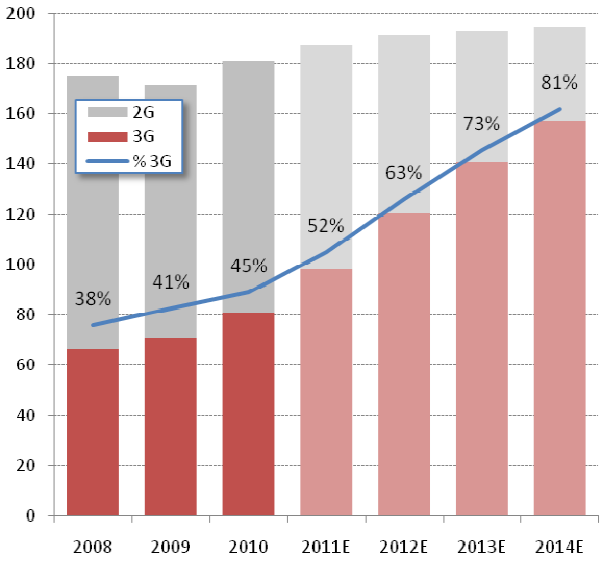

Figure 5: Western Europe handsets sales (m)[3]

[3] Source: Consolidated analyst view

This trend will accelerate as mobile broadband becomes the dominant differentiating factor for operators.

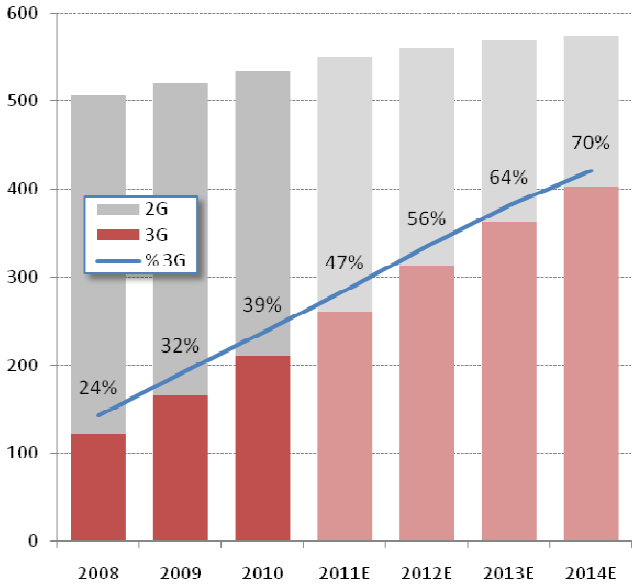

Figure 6: Western Europe subscribers (m)[4]

GSM service is adequately supported in the 1800MHz band

Though the penetration of GSM devices is declining, the GSM service is expected to still be required for a number of years, until the penetration of mobile broadband devices reaches 100%. However, GSM service is not only linked to the 900MHz band. In fact, the GSM1800 networks also provide a significant contribution in coverage and capacity to the maintenance of GSM services for years to come. It is very important to highlight that:

- GSM1800 coverage is ubiquitous in dense population areas, where the demand for mobile voice and mobile broadband, including in deep indoor situations, is the highest.
- GSM1800 coverage is especially significant and widely deployed for operators with limited 900MHz frequency allocations.

[4] Source: Wireless Intelligence

Therefore, though the GSM service is required for years to come, the support of such a service does not limit the deployment of mobile broadband technologies in the 900MHz band. GSM services can be supported on the 1800MHz for a very large percentage of the population coverage, with GSM900 continuous support only required in the few areas where GSM1800 is not available, until mobile broadband terminals achieve near-100% market penetration.

HSPA terminals will soon compete with GSM from a price perspective

In parallel, the entry price of 3G devices has been considerably reduced and now is close to challenging the price of GSM technology, while providing a significant upgrade in terms of functionalities.

In Europe, while 3G smartphones are now entering the 100-150€ retail price range with a solid uplift in Q2 2010, 3G has been stepping up promisingly in the 50-100€ retail price range over the same period. Finally, first entry phones are now existing at a less that 50€ retail price.

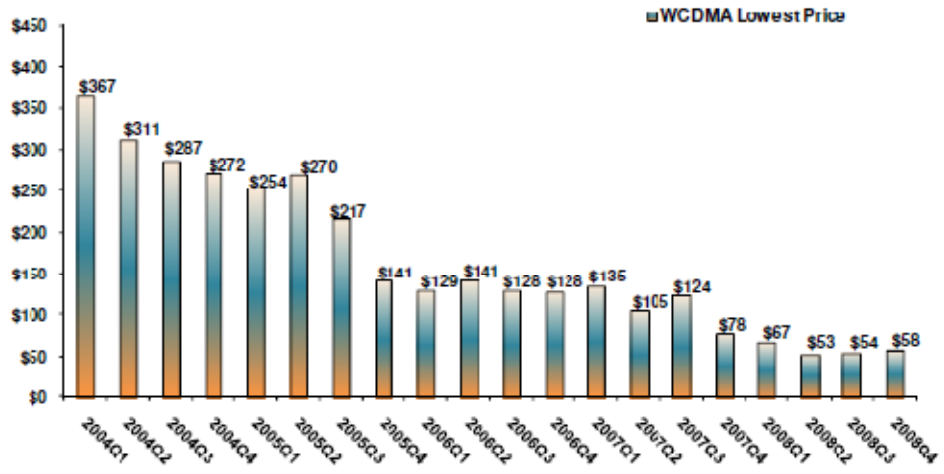

Figure 7: The entry price of 3G handsets (WCDMA handset lowest price) has decreased dramatically since the introduction of technology, and now challenges market entry prices.

Conclusion

The authorisation to deploy new technologies in the 900 MHz will completely modify the technology roadmap in the 900 and 1800 MHz bands.

Qualcomm argues that most of the GSM traffic can be handled on the 1800MHz frequency band as early as 2015, with GSM 900 still required in rural areas for coverage reasons. This is due to the fact that most voice traffic will be able to be carried over a HSPA network as both the penetration of 3G devices and the proportion of 3G subscribers will be very high in 2015. This trend (3G replacing GSM) is likely to evolve faster and faster as GSM will loose its price advantage compared to mobile broadband while offering very limited services.
Qualcomm does not expect a significant portion of either the 900 or the 1800 MHz band to be used for GSM in 2020.

Question 3.2.: In the longer term, would you consider the current frequency assignments in the GSM bands to be compatible with an efficient use of those frequencies for 3G/4G technologies? Please provide reasons for your response.

Mobile broadband technologies (either HSPA or LTE) require 5MHz frequency blocks or multiple of 5MHz frequency blocks for deployment. Though LTE also supports lower bandwidth, the efficiency of the technology on bandwidth lower than 5MHz is very low. Therefore, Qualcomm does not expect a significant eco-system to develop for LTE on channel bandwidth lower than 5MHz.
Maintaining the current spectrum assignement would limit the mobile broadband deployment in the 900MHz band to a maximum a 4 carriers, when a total of 7 carriers can be deployed in the 900MHz, provided spectrum assignements based on multiple of 5MHz blocks are adopted.
Therefore, Qualcomm urges RTR to favour a divison of the band on 5MHz frequency blocks as fast as possible in order to ensure an efficient long term use of the 900 and 1800 MHz bands and a rapid refarming of the bands for new technologies.

Question 3.3.: If the 900 MHz and/or 1800 MHz band is liberalised, do you see any risk that distortions of competition will arise? If yes, please provide precise indications of the form in which such distortions would arise.

Qualcomm would like to limit its current response to mobile broadband market, technology and spectrum policy considerations.

Question 3.4.: Do you believe that the time remaining between refarming and the expiration of current GSM licences will be sufficient to justify investments in 3G/4G technologies in those bands? Please provide reasons for your response.

The 900MHz band is probably today the most important frequency band for the mobile industry both nationally and internationally:

- The 900MHz band provides coverage in remote areas to GSM users in Austria.
- The 900MHz band provides coverage for both voice and data services internationally.
- The 900MHz band is very well harmonised internationally supporting roaming on an extended scale.

Given the importance of the 900MHz band, it is critical to provide visibility to network operators in order to:

- Allow timely investment in the 900MHz networks. Without visibility on spectrum allocations beyond 2016, there will be no further investment or adequate maintenance of 900MHz network. This would lead to a situation on the horizon 2016 where the most important mobile frequency band (900MHz) is also the one where the worst mobile infrastructure is deployed.
- Secure continuity of service for users beyond 2016. Should the 900MHz spectrum allocation of an operator be reduced beyond 2016, it is critical to inform the operator as soon as possible in order to allow him to take the

appropriate measures to ensure the continuity of service to all its customers beyond 2016.

RTR should clarify the future allocation of the 900 and 1800MHz bands as early as possible in order to enable timely investment in networks. Switzerland recognised this requirement when OFCOM decided to conduct the allocation of frequency band for mobile broadband beyond 2015 as early as possible (allocation scheduled for 2011). Comreg (Ireland regulator) is also working to provide visibility on the future 900MHz allocation as early as possible in order to secure the continuity of service to all mobile customers.

The competition situation would also be clarified by such allocation and would therefore very likely significantly ease the task of the RTR in order to enable a flexible use of the 900MHz band.

Finally, Qualcomm supports that the flexible use of the 900MHz band should be allowed as soon as the digital dividend frequency are available for deployment.

Question 3.5.: In the long term, the frequency bands in question will be used in a technology-neutral manner with various technologies, especially near national borders. What effects do you believe this will have?

The introduction of HSPA/LTE in the 900/1800MHz band will facilitate the situation at the border since these technology operates with a frequency reuse equal to 1, i.e. allowing adjacent cells to use the same frequency.

Furthermore, the introduction of new technology in these bands will offer significant opportunities to provide roaming services, both for data and voice.

Question 3.6.: Can you identify any other problems in connection with refarming? If yes, please explain.

The main issue identified by Qualcomm w.r.t. the refarming of the 900 and 1800 MHz band is the risk of competition issues leading to a delay of the refarming of the band.

Should the introduction of new technology in the 900MHz be unduly prevented, Austria would run the risk of seriously falling behind in terms of mobile broadband service availability in the short and middle term (until reallocation of the band in 2016). **Keeping GSM as the sole technology allowed in the 900MHz until 2016 due to competition issues would be in contradiction with the requirement for RTR to ensure an efficient use of radio frequencies, a rare public resource.**

3.3 Refarming in the 900 MHz band

Question 3.7.: Do you agree with this analysis? If not, please provide precise reasons why you disagree.

Qualcomm mostly agrees with RTR's analysis.
Qualcomm argues that refarming and early auction of the 900MHz band should not be conducted after, but jointly with the assignement of the digital dividend due to two main reasons:

- The joint allocation would provide the maximum flexibility and certainty for an operator to acquire the appropriate combination of sub-1GHz spectrum for its target business plan.
- The joint allocation would prevent operators having acquired Digital Dividend spectrum to prevent the refarming of the 900MHz band in order to prevent competition to their future services.

Question 3.8.: Can you identify any other options? How would you assess those options in terms of the objectives discussed above?

Qualcomm argues that refarming and early auction of the 900MHz band should not be conducted after, but jointly with the assignement of the digital dividend due to two main reasons:

- The joint allocation would provide the maximum flexibility and certainty for an operator to acquire the appropriate combination of sub-1GHz spectrum for its target business plan.
- The joint allocation would prevent operators having acquired Digital Dividend spectrum to prevent the refarming of the 900MHz band in order to prevent competition to their future services.

As a result, Qualcomm believes that a joint allocation better ensures:

- The efficient use of spectrum both in short and long term.
- A sustainable competition.
- Legal certainty, as all operators would have an interest to support the refarming process, as part of a larger opportunity (providing ubiquituous mobile broadband services).

3.4 Refarming in the 1800 MHz band

Question 3.9.: Do you agree with this assessment? Please provide reasons for your response.

Qualcomm fully agrees with the RTR's assessment as all operators possess spectrum above 1GHz for mobile broadband services.

4 Upcoming frequency assignments

4.2 450 MHz band

Question 4.1.: For what purpose(s) could this frequency band be used? What general conditions would be important for the use of this frequency band?

The 450MHz band could potentially support a number of Machine-to-Machine (M2M) communication services through wireless technological solutions.

Question 4.1.: Do you intend to acquire frequencies in this band? If no, why not? If yes, when would you plan to start using the frequencies?

Qualcomm is a technology provider and does not intend to acquire spectrum in this band, as it is not interested in becoming a mobile network operator in Austria.

Question 4.2.: In your view, which services/applications would be especially well supported by this frequency band? What technologies will be deployed / would you deploy?

The 450MHz band could potentially support a number of Machine-to-Machine (M2M) communication services through wireless technological solutions.

4.3 Assignment of the 800 MHz band

Question 4.4.: Do you intend to acquire frequencies in this band? If no, why not? If yes, when would you plan to start using the frequencies?

Qualcomm is a technology provider and does not intend to acquire spectrum in this band, as it is not interested in becoming a mobile network operator in Austria.

Question 4.5.: In your view, which services/applications would be especially well supported by this frequency band? What technologies will be deployed / would you deploy?

Qualcomm believes that the 800MHz band is the perfect complement to the 2.6GHz band for the deployment of mobile broadband networks based on LTE.

Optimal deployment of LTE will require leveraging larger channel bandwidth (10MHz, 15MHz and 20MHz) and low and high frequency bands for coverage and capacity purposes in order not to recreate a new digital divide and maintain ubiquitous access to all citizens.

Throughout Europe, the 900 MHz band is used very intensively, supporting both GSM and UMTS/HSPA services. The 900 MHz seldomly offers the possibility to vacate 10 MHz of spectrum to introduce LTE. In the meantime, the 800MHz band is becoming available throughout Europe and, as a new frequency band, easily accomodates systems with 10 MHz bandwidth.

Qualcomm recommends adopting a frequency allocation process that would allow the allocation to result in the award of three licences of 2x10MHz each, as represented in the Figure below:

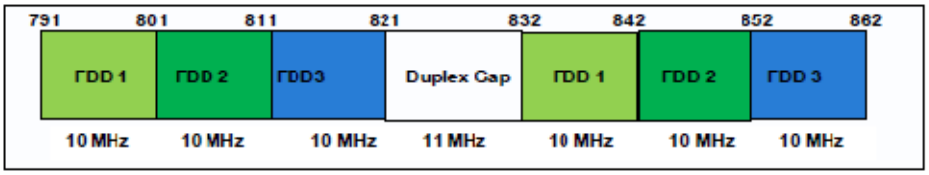

Figure 8: Optimal allocation outcome in the 800MHz band

This option was indeed the outcome reached in Germany during the recent auction of the 800MHz band, providing further support for its optimality. Qualcomm expects a very significant eco-system to develop around LTE800 terminals with 10MHz bandwidth.

Question 4.6.: Please give an estimate of your frequency requirements / a network operator's frequency requirements in this band. How many interested parties would you expect?

Optimal deployment of LTE requires leveraging larger channel bandwidth (minimum 10MHz), while the performance limits of the duplexing filters will restrict the overall performance of LTE terminals in the 800MHz band for bandwidths higher than 10MHz, as indicated 3GPP 36.101 (LTE) specifications[5]. Therefore, Qualcomm recommends adopting a frequency allocation process that would allow the allocation to result in the award of three licences of 2x10MHz each, as represented in the Figure below:

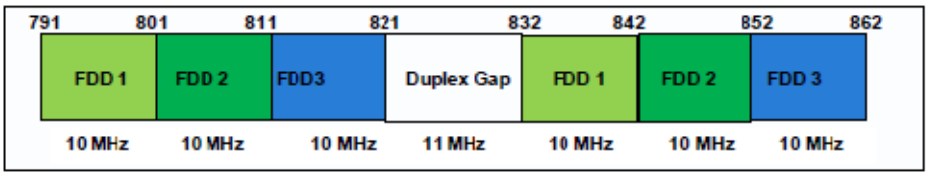

Figure 9: Optimal allocation outcome in the 800MHz band

[5] Using terminals with bandwidth larger than 10MHz in 800 MHz bands would require advances in radio-frequency components technology.

Question 4.7.: In your view, what is the smallest possible bandwidth an operator should be able to acquire in this frequency band?

A 5MHz block would enable the deployment of LTE in the band. However, Qualcomm argues that optimal deployment of LTE requires leveraging larger channel bandwidth (minimum 10MHz). As a result, Qualcomm recommends adopting a frequency allocation process that would allow the allocation to result in the award of three licences of 2x10MHz each.

Question 4.8.: In your view, what subdivision of the frequency band would be most reasonable? How many frequency packages (in what size) should be put up for assignment?

Qualcomm recommends adopting a frequency allocation process that would allow the allocation to result in the award of three licences of 2x10MHz each, as represented in the Figure below:

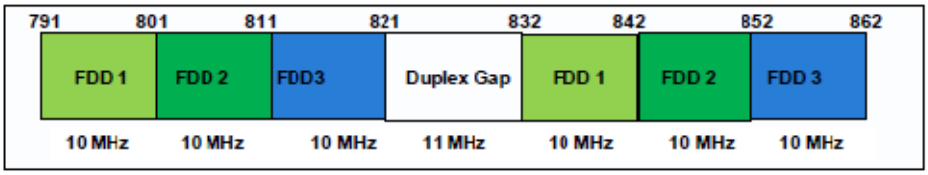

Figure 10: Optimal allocation outcome in the 800MHz band.

Question 4.9.: Would it be important to obtain adjacent frequency blocks?

The optimal deployment of LTE requires leveraging larger channel bandwidth (minimum 10MHz). As a result, Qualcomm indicates that it is critical to obtain adjacent frequency blocks.

Question 4.10.: Please describe the rollout scenario you expect or plan to implement. In what regions will these frequencies primarily be used?

Qualcomm believes that the 800MHz band is the perfect complement to the 2.6GHz band for the deployment of mobile broadband networks based on LTE. Optimal deployment of LTE will require leveraging larger channel bandwidth (10MHz, 15MHz and 20MHz) and low and high frequency bands for coverage and capacity purposes.

Qualcomm expect a roll-out scenario where a LTE 800MHz network would provide both ubiquituous coverage of rural areas in order to bridge the digital divide and indoor coverage in urban area in order to guarantee a continuous Quality-of-Service throughout the network coverage.

Question 4.11.: In your view, how homogenous/heterogeneous is this spectrum? What usage limitations can you identify? Which parts of the band would be affected by those limitations?

The BS Block Edge Mask adopted in the European Commission Decision of 6 May 2010 on 'harmonised technical conditions of use in the 790-862 MHz frequency band for terrestrial systems capable of providing electronic communications services in the European Union' (2010/267/EU) are very stringent for the BSs deployed in 791-801 MHz. Furthermore, these BSs would potentially create more interference than BSs deployed in higher frequency blocks, due to the lack of selectivity of Terrestrial TV receivers.

As a result, it is expected that the ubiquituous deployment of a network in 791-801MHz will be more complicated than in 801-811MHz and 811-821MHz.

Question 4.12.: When do you believe the frequencies should be auctioned off? Would you prefer another time, for example if it made it possible to define specific conditions of use or if it enabled simultaneous assignment with 900 MHz frequencies?

The spectrum should be auctioned as early as possible in order to allow the fast deployment of LTE networks in Austria and ubiquituous LTE coverage to Austrian citizen.

4.4 Assignment of 900 MHz frequencies

Question 4.13.: Would you acquire frequencies in this band? If no, why not?

Qualcomm is a technology provider and does not intend to acquire spectrum in this band, as it is not interested in becoming a mobile network operator in Austria.

Question 4.14.: In your view, which services/applications would be especially well supported by this frequency band? What technologies will be deployed / would you deploy?

Qualcomm expects voice and data (mobile broadband) services to be supported in this band. The 900MHz band is the key band to provide ubiquituous mobile broadband coverage to customers in the short and middle term, as HSPA900 terminals are readily available (close to 80% of 3G handsets sold in EU5 support UMTS900).
Qualcomm also expects GSM to remain deployed in this band for a number of years, until the GSM traffic has been entirely shifted to the 1800MHz band.

Question 4.15.: Please give an estimate of your frequency requirements / a network operator's frequency requirements in this band. How many interested parties would you expect?

Qualcomm indicates that an operator would require 2x5MHz @ 900MHz for the deployment of HSPA900.
Additionally, depending on his will to innovate and on its customer base, such an operator could also require some 900MHz spectrum for legacy GSM devices, leading to a total of 2x10MHz in the 900 MHz band.

Question 4.16.: In your view, what is the smallest possible bandwidth an operator should be able to acquire in this frequency band?

Maintaining the spectrum assignement on blocks smaller than 5MHz would potentially limit the mobile broadband deployment in the 900MHz band, as mobile network operator would need to win multiple blocks in order to be able to deploy HSPA/LTE900.
Qualcomm urges RTR to favour a divison of the band on 5MHz frequency blocks in order to ensure an efficient long term use of the 900MHz band and a rapid refarming of the band for new technologies.
Hence, Qualcomm believes that 5MHz is the smallest bandwidth that an operator should be able to acquire in this frequency band.

Question 4.17.: In your view, what subdivision of the frequency band would be most reasonable? How many frequency packages (in what size) should be put up for assignment? Would it be important to obtain adjacent frequency blocks?

Qualcomm urges RTR to favour a divison of the band on 5MHz frequency blocks in order to ensure an efficient long term use of the 900MHz band and a rapid refarming of the band for new technologies. Therefore, Qualcomm favours the allocation of 7 blocks of 2x5MHz each.
Qualcomm believes that it would be important to obtain adjacent frequency blocks for two reasons:

- For operators whishing to have joint GSM and HSPA 900 operation in the band, adjacent blocks would enable to collocated depoyment of HSPA and GSM in adjacent bands. Collocated deployment of HSPA and GSM allows for smaller frequency separation (hence higher spectrum efficiency) between the two networks (see section below on GSM/HSPA deployment).
- For operators whishing to deploy LTE in the band, they would have the possibility to deploy LTE based on 10MHz bandwidth.

Deployment strategies for HSPA900

3GPP studied the theoretical coexistence between HSPA900 and GSM, taking into account only the 3GPP required equipment emissions limits. Qualcomm further studied the topic both theoretically and through measurements of real equipment. Real equipment always outperforms the 3GPP mandatory emission limits, sometimes by a large margin.

There are two possible scenarios: coordinated approach where GSM900 and HSPA900 are collocated and un-coordinated approach.

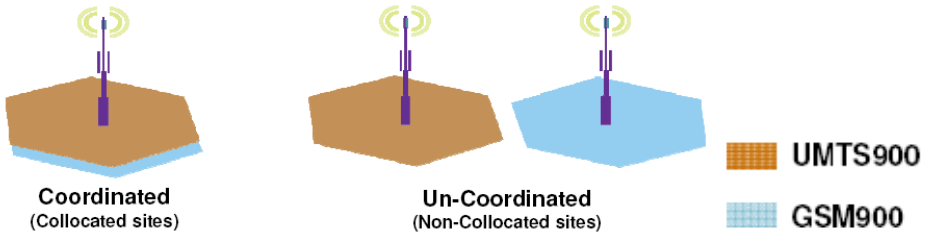

Figure 11: Coordinated and uncoordinated deployment of UMTS900

The coordinated approach requires the least amount of guard band to deploy HSPA900 in band. 3GPP recommends 2.6MHz separation, which corresponds to a purposely relaxed requirement to allow product differentiation. Qualcomm demonstrated in its studies that 2.2MHz separation is sufficient in the coordinated case.

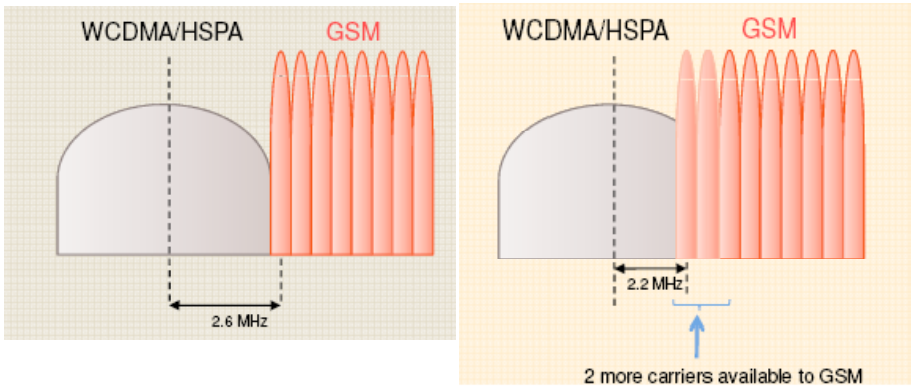

Figure 12: Two GSM/UMTS separation options for coordinated approach

A 2.2MHz carrier to carrier separation maximises the spectrum available to GSM, allowing 2 extra GSM carriers on each side of the HSPA carrier. Such a choice would result in a HSPA capacity loss of less than 5%, with no meaningful impact on the GSM network.

HSPA900 and GSM900 non-collocation is possible. This may be necessary in urban areas. For example, overlay may not be needed for GSM900 micro/pico cells and capacity sites because of HSPA900's higher capacity.
In such a case, 2.8MHz of guard band is recommended by 3GPP to avoid HSPA capacity loss in such an un-coordinated approach. Qualcomm demonstrated in its studies that 2.6MHz carrier to carrier separation is sufficient in the uncoordinated case.

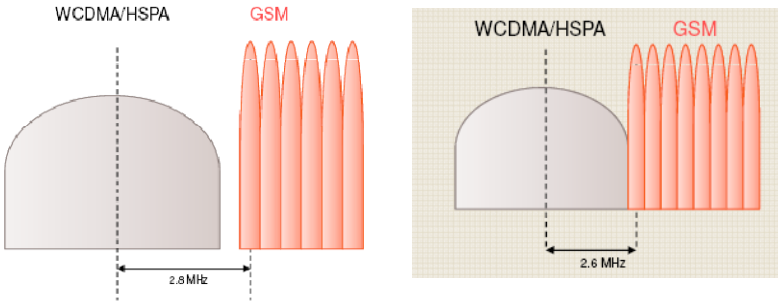

Figure 13: Two GSM/UMTS separation options for un-coordinated approach

Operators having access to more than 5MHz of consecutive 900MHz spectrum can adopt a number of intelligent frequency planning measures in order to minimize interference. For example, the so-called sandwiched spectrum approach reduces interference between operators and provides even more spectrum for GSM. Furthermore, assigning sensitive BCCH carriers away from WCDMA/HSPA spectrum reduces impact of interference.

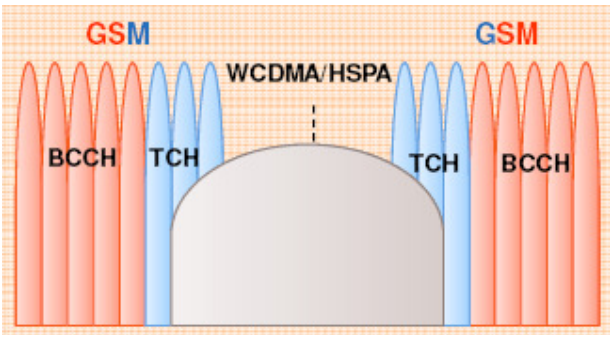

Figure 14: Some measures to minimise GSM/UMTS interference

Finally, assigning GSM micro/pico cell sub-band away from WCDMA/HSPA spectrum simulates coordinated scenario even with non-collocated micro/pico cells.

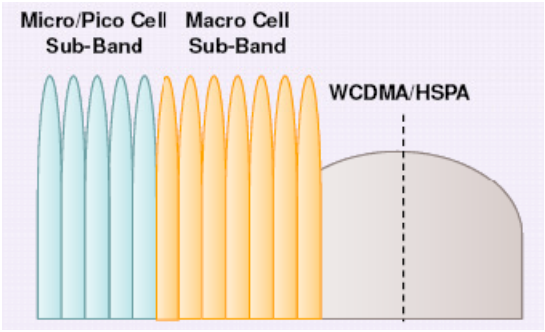

Figure 15: Selecting frequencies for micro/pico GSM base stations

The conclusions on the required separation between the HSPA carrier and the GSM carrier are summarised in the Table 1.

	Coordinated Deployment		Uncoordinated Deployment	
	3GPP TR	Qualcomm Simulation and Test Results	3GPP TR	Qualcomm Simulation and Test Results
GSM to HSPA Centre Frequency Distance [MHz]	2.6	2.2	2.8	2.6
Allowed HSPA Bandwidth [MHz]	5.0	4.2	5.4	5.0
Number of GSM Channels to Free Up	25	21	27	25

Table 1: Spectrum Requirement for HSPA900

Question 4.18.: Please describe the rollout scenario you expect or plan to implement. In what regions will these frequencies primarily be used?

Qualcomm believes that the 900MHz band is the perfect complement to the 2.1GHz band for the deployment of mobile broadband networks based on HSPA. Optimal deployment of HSPA requires low and high frequency bands for coverage and capacity purposes.

Qualcomm expect a roll-out scenario where an HSPA 900MHz network would provide both ubiquituous coverage of rural areas in order to bridge the digital divide and indoor coverage in urban area in order to guarantee a continuous Quality-of-Service throughout the network coverage.

Qualcomm expects HSPA900 to play an ever growing role on mobile data roaming, as the 900MHz band is widely harmonised and HSPA will be by far the dominant mobile broadband air interface technology for years to come.

Question 4.19.: In your view, how homogenous/heterogeneous is this spectrum? What usage limitations can you identify? Which parts of the band would be affected by those limitations?

Qualcomm expects this spectrum to be reasonably homogenous, even if the two extreme frequency blocks should follow the recommendation of CEPT studies for co-existence with systems in adjacent bands.

Indeed, the CEPT Report 96, 'Compatibility between UMTS 900/1800 and systems operating in adjacent bands', concludes that:

- There is a priori no need of an additional guard band between UMTS900 and GSM-R, a carrier separation of 2.8 MHz or more between the UMTS900 carrier and the nearest GSM-R carrier is sufficient. For some critical cases (e.g.

with high located antenna, open and sparsely populated areas served by high power UMTS BS close to the railway tracks, blocking etc, which would lead to assumption of possible direct line of sight coupling) the MCL calculations demonstrate that coordination is needed for a certain range of distances (up to 4 km or more from railway track).

- The potential interference from UMTS900 to aeronautical DME operating at frequencies above 972 MHz does not represent any difficulty.

Question 4.20.: In your opinion, when should the auction take place if the frequencies are auctioned off early? Should the frequencies be auctioned off together with the digital dividend in a simultaneous auction? If not, please provide precise reasons.

The 900MHz band is probably today the most important frequency band for the mobile industry both nationally and internationally:

- The 900MHz band provides coverage in remote areas to GSM users in Austria.
- The 900MHz band provides coverage for both voice and data services internationally.
- The 900MHz band is very well harmonised internationally supporting roaming on an extended scale.

Given the importance of the 900MHz band, it is critical to provide visibility to network operators in order to:

- Allow timely investment in the 900MHz networks. Without visibility on spectrum allocations beyond 2016, there will be no further investment or adequate maintenance of 900MHz network. This would lead to a situation on the horizon 2016 where the most important mobile frequency band (900MHz) is also the one where the worst mobile infrastructure is deployed.
- Secure continuity of service for users beyond 2016. Should the 900MHz spectrum allocation of an operator be reduced beyond 2016, it is critical to

inform the operator as soon as possible in order to allow him to take the appropriate measures to ensure the continuity of service to all its customers beyond 2016.

RTR should clarify the future allocation of the 900 and 1800MHz bands as early as possible in order to enable timely investment in networks. Switzerland recognised this requirement when OFCOM decided to conduct the allocation of frequency band for mobile broadband beyond 2015 as early as possible (allocation scheduled for 2011). Comreg (Ireland regulator) is also working to provide visibility on the future 900MHz allocation as early as possible in order to secure the continuity of service to all mobile customers.

The competition situation would also be clarified by such allocation and would therefore very likely significantly ease the task of the RTR in order to enable a flexible use of the 900MHz band.

Qualcomm argues that refarming and early auction of the 900MHz band should be conducted jointly with the assignement of the digital dividend due to two main reasons:

- The joint allocation would provide the maximum flexibility and certainty for an operator to acquire the appropriate combination of sub-1GHz spectrum for its target business plan.
- The joint allocation would prevent operators having acquired Digital Dividend spectrum to prevent the refarming of the 900MHz band in order to prevent competition to their future services.

Qualcomm believes that a joint allocation better ensures:

- The efficient use of spectrum both in short and long term.
- A sustainable competition.
- Legal certainty, as all operators would have an interest to support the refarming process, as part of a larger opportunity (providing ubiquituous mobile broadband services).

Finally, Qualcomm supports that the flexible use of the 900MHz band should be allowed as soon as the digital dividend frequency are available for deployment.

4.5 3600 – 3800 MHz band

Question 4.22.: Do you intend to acquire frequencies in the 3600 – 3800 MHz band? If no, why not? If yes, when would you plan to start using the frequencies?

Qualcomm is a technology provider and does not intend to acquire spectrum in this band, as it is not interested in becoming a mobile network operator in Austria.

Question 4.23.: In your view, which services/applications would be especially well supported by the 3600 – 3800 MHz band? What general conditions would be important for the use of this frequency band? What technologies will be deployed / would you deploy? Are there any differences in usage possibilities compared to the 3400 – 3600 MHz frequency band? If yes, how do the bands differ?

First and foremost, Qualcomm considers that the allocation of the 3600-3800MHz is premature at this stage. The CEPT regulatory framework for mobile broadband systems in the 3400-3800 MHz band should be completed before RTR considers the allocation of the 3600-3800MHz band. The RTR should also carefully review the usage of the 3400-3600MHz band, as both band are expected to be used jointly for the deployment of LTE-Advanced systems.

The frequency band 3400-3800MHz is expected to become the key band for the future deployment of LTE-Advanced systems, which will require bandwidth between 20MHz and up to 100MHz. Therefore, Qualcomm recommends adopting a frequency allocation process of the 3600-3800MHz that would allow the allocation to result in the award of licences with bandwidths multiples of 20MHz.

Question 4.24.: Please give an estimate of your frequency requirements / a network operator's frequency requirements in the 3600 – 3800 MHz band. What minimum block size would be appropriate in your opinion?

The frequency band 3400-3800MHz is expected to become the key band for the future deployment of LTE-Advanced systems, which will require bandwidth between 20MHz and up to 100MHz. Therefore, Qualcomm recommends adopting a frequency allocation process of the 3600-3800MHz that would allow the allocation to result in the award of licences with bandwidths multiples of 20MHz.

Question 4.25.: Would you prefer to use the 3600 – 3800 MHz frequency band for TDD or FDD?

First and foremost, Qualcomm considers that the allocation of the 3600-3800MHz is premature at this stage. The CEPT regulatory framework for mobile broadband systems in the 3400-3800 MHz band should be completed before RTR considers the allocation of the 3600-3800MHz band. The RTR should also carefully review the usage of the 3400-3600MHz band, as both band are expected to be used jointly for the deployment of LTE-Advanced systems.

The selection of a duplexing mode in the 3600-3800MHz is likely to follow directly from the adoption of a preferred harmonised duplexing scheme for the 3400-3600MHz band.

Question 4.26.: How much interest in these frequencies would you expect to see?

Qualcomm expects interest in the band to begin once:

- A harmonised band plan is adopted at CEPT level.
- The LTE-Advanced standard for the band is completed.

- Refarming of the 3400-3600MHz for mobile broadband systems (LTE-Advanced) is completed.

Question 4.27.: How should the usage areas be defined? In small areas, by federal province, or throughout Austria? Or would you prefer a different usage area (e.g., by base station)? How should different usage areas be delimited?

Qualcomm considers that it is too early to provide a clear response to these questions.

5 Publication of consultation results

We are willing to allow the full publication of our individual comments.