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MOBILE BROADBAND IN 1800MHZ SPECTRUM

MOBILE BROADBAND IN 1800MHZ SPECTRUM – SPECTRUM STRATEGIES, REFARMING AND THE GLOBAL ECOSYSTEM

The rapid growth of mobile broadband is forcing operators to add both coverage and capacity, applying a holistic spectrum strategy that covers voice-centric and mobile broadband network deployments. As the penetration of 3G-capable terminals increases, the 1800MHz spectrum used for GSM services becomes an increasingly attractive candidate for refarming to mobile broadband services based on LTE and HSPA.

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THE RIGHT BAND AT THE RIGHT TIME

It is vital that operators continue to deliver good mobile broadband user experience as growing numbers of subscribers acquire smartphones, tablets, dongles and other mobile broadband enabled devices. Ensuring that there is sufficient network capacity available to meet this growing demand for anywhere, anytime connectivity with the best possible performance is the number-one priority.

Mobile broadband subscribers and traffic are growing at an unprecedented rate. The number of mobile broadband subscriptions is estimated to hit the one billion mark in 2011 [1] and Ericsson estimates that this figure will grow exponentially to almost top five billion by 2016 [2]. Some advanced markets have seen a doubling in mobile-data-traffic volumes every six to 12 months over the past few years, primarily driven by rapid subscriber growth.

The main growth driver is the mass-market shift from voice-centric feature phones to mobile broadband-enabled smartphones. In some markets, 90 percent of new handsets sold are smartphones of this type.

This transition represents a great opportunity for operators because smartphone users generate significantly higher ARPU than users with voice-centric phones. But it also represents a challenge: as subscribers become more reliant on mobile broadband access as part of their daily lives, they are starting to cite reception quality as their primary concern – ahead of ease of use, screen size and extensive battery life.

In other words, the network is becoming the differentiator, and one significant aspect of ensuring high-performance mobile broadband for the mass market is having access to sufficient radio spectrum to deliver the required capacity and coverage.

Operators need to consider the most profitable way of utilizing their total spectrum assets today and in the future. As mobile-data traffic continues to grow, one clear candidate for delivering additional spectrum for mobile broadband is the 1800MHz band, today available for deployment of GSM services to more than 350 operators in 148 countries around the world.

By refarming this 1800MHz spectrum for use by mobile broadband radio technologies, including LTE and HSPA, operators can gain the additional capacity, higher performance, global accessibility and economies of scale that will ensure the continued success of mobile broadband services.

THE CHALLENGE OF HARMONIZATION

To provide an excellent mobile broadband service, operators need to ensure highest network quality; this means having the right coverage, capacity and latency to accommodate the continuous growth of mobile-data traffic.

There are essentially three ways operators can achieve this. The first is to improve spectral efficiency by introducing radio technologies such as LTE and evolved HSPA. The second is to expand the amount of radio spectrum available to mobile broadband through the deployment of new carriers or new bands. The third is to densify the network with more cells and layered architecture. For most operators around the world, meeting demand for mobile broadband will mean engaging in a combination of these activities.

When expanding into new bands, it is important for operators to choose a frequency and technology combination that gives them the potential to create a global footprint, in order to leverage economies of scale and simplify international roaming. This becomes even more important for a new technology such as LTE, as there are a large number of deployment options. 3GPP has identified 20 paired (FDD) and 11 unpaired (TDD) bands for use by LTE around the world, as shown in Table 1. This provides a wide choice of bands for LTE deployment.

The 1800MHz band already has a global footprint, as more than 350 operators in 148 countries have spectrum assets in that band, providing great potential for global mobile broadband deployment.

In the European Union, initial licenses in the 900MHz and 1800MHz bands were dedicated to GSM technology. This situation has now changed as Commission Decision 2009/766/EC has adopted both HSPA and LTE as technologies that may be used in these bands.

Most EU countries have acknowledged this decision, but some face national competitive and legal challenges in their markets, which threaten to delay deployment of new technologies. Some member states, including the Netherlands and Switzerland, have decided to hold off deployment of non-GSM technologies until current 3G licenses expire.

In several EU member states, the competitive situation changes if

Table 1: Frequency bands assigned for use by LTE. (Source: 3GPP)

E UTRA Operating Band	Uplink (UL) operating band BS receive UE transmit			Downlink (DL) operating band BS transmit UE receive			Duplex Mode
	FUL_low – FUL_high			FDL_low – FDL_high			
1	1920MHz	–	1980MHz	2110MHz	–	2170MHz	FDD
2	1850MHz	–	1910MHz	1930MHz	–	1990MHz	FDD
3	1710MHz	–	1785MHz	1805MHz	–	1880MHz	FDD
4	1710MHz	–	1755MHz	2110MHz	–	2155MHz	FDD
5	824MHz	–	849MHz	869MHz	–	894MHz	FDD
6	830MHz	–	840MHz	875MHz	–	885MHz	FDD
7	2500MHz	–	2570MHz	2620MHz	–	2690MHz	FDD
8	880MHz	–	915MHz	925MHz	–	960MHz	FDD
9	1749.9MHz	–	1784.9MHz	1844.9MHz	–	1879.9MHz	FDD
10	1710MHz	–	1770MHz	2110MHz	–	2170MHz	FDD
11	1427.9MHz	–	1447.9MHz	1475.9MHz	–	1495.9MHz	FDD
12	699MHz	–	716MHz	729MHz	–	746MHz	FDD
13	777MHz	–	787MHz	746MHz	–	756MHz	FDD
14	788MHz	–	798MHz	758MHz	–	768MHz	FDD
15	Reserved			Reserved			FDD
16	Reserved			Reserved			FDD
17	704MHz	–	716MHz	734MHz	–	746MHz	FDD
18	815MHz	–	830MHz	860MHz	–	875MHz	FDD
19	830MHz	–	845MHz	875MHz	–	890MHz	FDD
20	832MHz	–	862MHz	791MHz	–	821MHz	FDD
21	1447.9MHz	–	1462.9MHz	1495.9MHz	–	1510.9MHz	FDD
24	1626.5MHz	–	1660.5MHz	1525MHz	–	1559MHz	FDD
...							
33	1900MHz	–	1920MHz	1900MHz	–	1920MHz	TDD
34	2010MHz	–	2025MHz	2010MHz	–	2025MHz	TDD
35	1850MHz	–	1910MHz	1850MHz	–	1910MHz	TDD
36	1930MHz	–	1990MHz	1930MHz	–	1990MHz	TDD
37	1910MHz	–	1930MHz	1910MHz	–	1930MHz	TDD
38	2570MHz	–	2620MHz	2570MHz	–	2620MHz	TDD
39	1880MHz	–	1920MHz	1880MHz	–	1920MHz	TDD
40	2300MHz	–	2400MHz	2300MHz	–	2400MHz	TDD
41	2496MHz	–	2690MHz	2496MHz	–	2690MHz	TDD
42	3400MHz	–	3600MHz	3400MHz	–	3600MHz	TDD
43	3600MHz	–	3800MHz	3600MHz	–	3800MHz	TDD

operators with spectrum in 900MHz and 1800MHz are allowed to use WCDMA or other IMT technologies in addition to GSM. In some countries, including Denmark, Italy and Sweden, this has been resolved by reallocating spectrum in the 900MHz band to incorporate operators that only had spectrum in 2100MHz. In other markets, including Germany and the UK, regulators do not enforce reallocation in the 900MHz band, but instead are applying restrictions to existing 900MHz license holders in their upcoming auctions of 800MHz Digital Dividend spectrum.

The regulatory situation for countries outside Europe varies. Many countries allow the 900MHz and 1800MHz bands to be used for any technology, while in others they are earmarked for GSM only.

MAXIMIZING SPECTRUM UTILIZATION

The question for operators with access to 1800MHz spectrum is: how can they make best use of this resource as part of a holistic spectrum strategy for mobile broadband growth?

1800MHZ: THE ADVANTAGES

Today, the 1800MHz band is almost entirely used for GSM traffic, often as a higher band complement to GSM in the 900MHz band. Typically, the higher band is used for delivering capacity and the lower band for coverage.

In many markets, subscribers are migrating to 3G-enabled smartphones, and offloading GSM traffic from the 1800MHz spectrum. Combined with good 3G coverage, this migration simplifies the process of refarming this spectrum for use by mobile broadband radio technologies such as LTE and HSPA.

There are a number of advantages offered by the 1800MHz band when used by mobile broadband radio technologies. In most markets, it offers 2 x 75MHz spectrum bands – often in slots of 10MHz or wider – that are typically not fragmented and often only partially utilized.

LTE supports flexible carrier bandwidths, from 1.4MHz up to 20MHz. It also supports both FDD and TDD modes. This makes the technology extremely efficient at utilizing spectrum even in narrow, fragmented bands.

For existing GSM1800 operators, this opens up the opportunity to refarm some, or all, of their 1800MHz spectrum for LTE use in a very efficient way. As LTE and GSM do not interfere with each other, they can be deployed together in adjacent frequencies without the need for guard bands. This gives GSM operators the option of gradually shifting the amount of 1800MHz bandwidth assigned to LTE in line with demand.

For operators with sufficient HSPA capacity to meet projected mobile broadband growth from smartphones, rolling out LTE in the 1800MHz band is an obvious choice. However, if the HSPA spectrum assets are not sufficient to meet this need, using the 1800MHz band for HSPA should also be considered as an option.

As part of their spectrum strategy, operators also need to consider refarming lower-band GSM spectrum (such as 900MHz) to HSPA, in order to improve HSPA coverage for the smartphone mass market. When carrying out this low-band HSPA refarming, there may be implications for the GSM load in 1800MHz, as GSM traffic is shifted from the 900MHz to the 1800MHz network. These potential effects also need to be considered as part of a 1800MHz refarming decision.

Overall, operators need to strike a balance between driving innovative, market-leading LTE services, serving the profitable and growing HSPA mass market, and continuing to manage voice-centric GSM traffic well.

A COMMERCIAL DECISION

The choice of which technology route to take – LTE1800 or HSPA1800 – will depend on a range of factors. These include: the operator's current market situation; the penetration of smartphones and other mobile broadband devices; the availability of other spectrum (especially that offering the capacity, and coverage, to cater for mobile broadband growth); the geography of the operator's service area; and local regulatory conditions.

From a technical perspective, either route is perfectly feasible. Spectrum refarming is a tried and trusted approach, and the deployment of multi-standard equipment can leave the decision open, even if the operator decides to modernize its network. Several GSM operators around the world have conducted major refarming projects to implement WCDMA/HSPA in the 900MHz band. Experience of running both GSM and WCDMA/HSPA networks has already shown how both technologies can continue to evolve in parallel, and how spectrum can be refarmed from GSM to WCDMA/HSPA in line with commercial needs.

Through its support of both FDD and TDD modes, LTE helps drive the global convergence of radio access for paired and unpaired spectrum into a single globally-adopted technology. LTE and HSPA are both highly capable radio-access technologies for mobile broadband. While LTE and its evolution will ultimately offer superior throughput and spectral efficiency, evolved HSPA performs as well as LTE in most areas and for most applications. Decisions on how fast to evolve HSPA networks and how soon to deploy LTE will be based on individual operators' circumstances. There are well-defined evolution paths for both technologies.

The decision to refarm the 1800MHz spectrum for HSPA or LTE is therefore mainly a commercial one, rather than a technical one: there are tried and trusted approaches for refarming the spectrum in either direction.

SHAPING THE ECOSYSTEM

To encourage the transition of mobile broadband subscribers to higher-speed, higher-capacity radio technologies like HSPA and LTE, operators need to manage the evolution of their networks and terminal fleets in tandem. For existing GSM1800 operators, this means rolling out network features and terminals that reduce the load from GSM services in the 1800MHz spectrum.

Operators can accelerate the process of freeing up 1800MHz bands through frequency replanning and the deployment of GSM modernization technologies that enhance voice spectral efficiency – essentially squeezing the spectrum needed by GSM traffic. As the number of global GSM subscriptions continues to rise, further investments are being made into serving these subscribers more efficiently.

As refarming means less spectrum is available for GSM, operators need to be sure they put in place a process for maintaining performance, and minimize the effects of interference in the narrower spectrum used, as shown in Figure 1. The old cell plan is unlikely to be optimal, meaning the process will need to include some replanning and retuning of the network.

The second step in this process is to identify which features are to be implemented in the GSM network to prepare it for refarming. There are many techniques available to do this, including 1/1 reuse, Adaptive Multi-Rate (AMR) techniques and Voice services over Adaptive Multi-user channels on One Slot (VAMOS), to name a few.

Not all of these features need to be implemented at the same time, and will differ for each network case. Here, the vendor's experience of real-life refarming projects becomes very important in maintaining network performance, especially in areas such as radio optimization, tuning, replanning and monitoring.

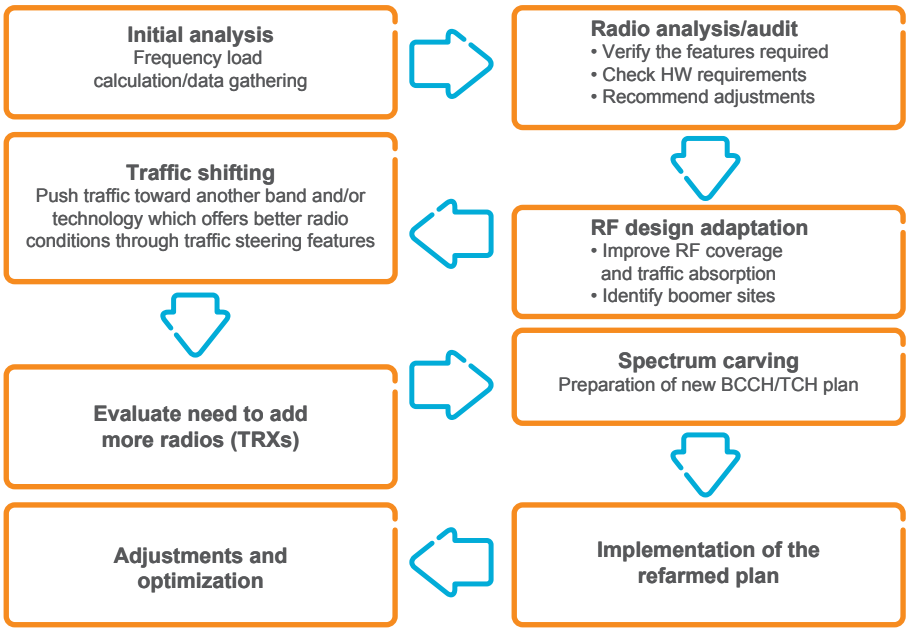

Figure 1: Service-led refarming process

As GSM operators modernize their networks to become more energy- and spectrum-efficient, they are increasingly deploying multi-frequency, multi-standard radio base stations that can handle all 3GPP radio technologies in one system. This enables smooth evolution to new mobile broadband radio technologies without significant additional capital investment, while allowing operators to serve the significant GSM subscriber base efficiently in line with market needs.

GSM1800 operators that also have HSPA implemented in the 2100MHz band will be able to reuse their existing 2100MHz radio sites for LTE1800 (and LTE2600), as they offer roughly the same levels of coverage. In addition, GSM antennas typically designed for x-polarization (Rx diversity), as well as other site assets, can be reused for 2x2 multiple-input, multiple-output (MIMO) operation in LTE and HSPA.

Another way in which operators can encourage load reduction on the GSM network is by actively steering new terminal sales towards 3G-capable devices that make less use of GSM. Some operators have proactively made the decision to offer only HSPA-enabled devices to their subscribers. In this way, the vast majority of devices will eventually be using the HSPA network, with its higher spectral efficiency for voice and data.

Of course, as part of this strategy, it is important to ensure 3G coverage is sufficient to enable HSPA devices to continue with the 3G access, without the need to use GSM for voice or data calls.

The successful use of 1800MHz spectrum for mobile broadband will require mobile broadband-enabled devices that can use the band. Furthermore, these devices must offer multiple standards (multi-mode) and bands (multi-band) within each mode. As it resides roughly in between the other bands allocated for use by LTE, the 1800MHz band provides a good complement to either "low" bands, such as the 800MHz band, or "high" bands, such as the 2600MHz band used for LTE in Europe.

In recent years, great advancements have been made in areas such as filter technology, which means chipset makers have been able to produce multi-band, multi-mode devices more cost-effectively than before. Several device-chipset makers have introduced or announced multi-band LTE/HSPA products, and these are starting to be shipped in commercial volumes. Ericsson has conducted extensive interoperability tests

with ST-Ericsson and other suppliers.

In June 2011, the Global mobile Suppliers Association (GSA) estimated that about 10 percent of LTE devices already support the 1800MHz band [3]. Some operators have taken the step of pre-populating their terminal fleets with such multi-mode, multi-band devices that will be ready to make use of new radio-network technologies as soon as the network is enabled.

EVOLUTION SCENARIOS

The ultimate shape that operators' mobile broadband networks will take – and the route and timing of the journey taken to get there – will vary from case to case. As an illustration of the possible alternative routes that could be taken by three different operators, Figures 2 and 3 show the start points and end points of the evolution to a high-performance mobile broadband network using different radio-access technologies. Typical European frequencies are used to illustrate the strategies for this evolution.

Scenario 1: This operator has no early access to either 2600MHz or 800MHz spectrum for LTE. Here, the first step is to refarm the 900MHz spectrum to HSPA in order to boost 3G coverage and capacity, especially in rural areas. As GSM traffic diminishes as a result of the greater HSPA capacity, the operator can refarm the 1800MHz spectrum either for LTE or HSPA to provide high-performance mobile broadband in urban and suburban areas. The technology choice will depend on the operator's market position, the current and projected device fleet, the ability to serve mass-market volumes of HSPA smartphones in existing 3GPP bands, and the availability of other bands for LTE. In this scenario, the operator is able to roll out LTE in other bands as it becomes available.

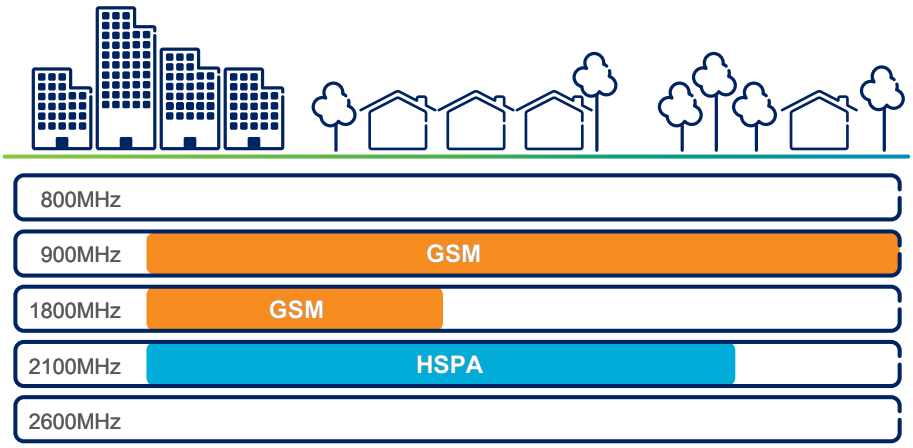

Figure 2: Starting frequency band allocation and technology deployment for the operator

Scenario 2: This operator has already deployed WCDMA/HSPA in the 900MHz, as well as in the 2100MHz band. The total spectrum in these deployments is sufficient to cater for mass HSPA smartphone uptake. By driving the uptake of 3G-capable devices that use 3G access for voice and data, and rolling out GSM efficiency improvements, GSM traffic can be served within the 900MHz spectrum. This frees up the 1800MHz spectrum for LTE deployment.

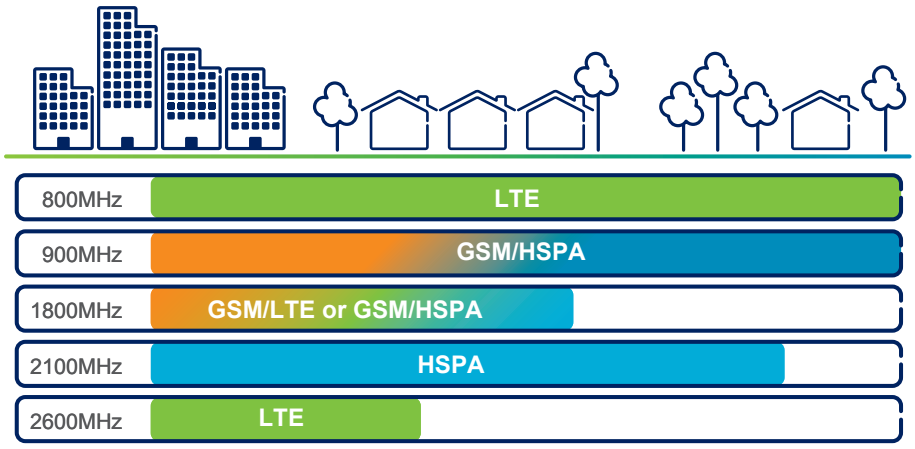

Figure 3: Evolved frequency band allocation and deployment for the operator

Scenario 3: This operator has early access to 2600MHz spectrum for LTE, as well as the option for rolling out LTE in the Digital Dividend 800MHz band (made available following the shutdown of Europe's analog TV networks). The operator's first step is to refarm 900MHz spectrum to WCDMA/HSPA to provide wider and deeper 3G coverage and capacity, especially for rural and indoor areas. Increasing use of WCDMA/HSPA in the wide area gradually reduces load on the GSM/EDGE network.

In addition, the operator deploys LTE in the 2600MHz band in urban hotspots to provide a high-speed mobile-broadband service to complement the HSPA access. After this, the operator rolls out LTE in the 800MHz band to provide high-performance broadband in the wide area, including rural areas.

Ultimately, when GSM traffic has diminished significantly, the operator can refarm the 1800MHz spectrum for LTE as well to provide a further capacity and boost coverage. Alternatively, if the need for additional HSPA capacity is more pressing at this time, the operator has the option of deploying HSPA in the 1800MHz spectrum.

CONCLUSION

The popularity and rapid growth of mobile broadband services are a result of the value people derive from having anywhere, anytime connectivity to the internet. To maintain and enhance mobile broadband user experience – especially as user devices and applications become more powerful and data-hungry – operators need to deploy ever-faster connections, along with greater network capacity and broad coverage.

As two key components of this unified mobile broadband network, LTE and HSPA are both capable of delivering the additional capacity, coverage and performance that operators need. The 1800MHz band is a strong candidate for such deployments, due to its large footprint. Whichever technology path operators choose to take, they will benefit from access to additional radio spectrum that will enhance their subscribers' mobile broadband experience in their own networks and as they roam.

Ultimately, the technology ecosystem will be shaped by the commercial decisions that operators make for their own markets. But one thing is for certain: the 1800MHz band represents a major asset for enabling mobile broadband growth in the coming years. As the first rollouts of mobile broadband in 1800MHz are already under way, the trend appears to be unstoppable.

GLOSSARY

3G	a generation of standards for mobile telecommunications services
3GPP	3rd Generation Partnership Project
AMR	Adaptive Multi-Rate
ARPU	average revenue per user
BCCH	Broadcast Control Channel
BS	base station
E UTRA	Evolved UMTS Terrestrial Radio Access
EDGE	Enhanced Data rates for Global Evolution
FDD	frequency division duplex/duplexing
GSM	Global System for Mobile Communications
HSPA	High-Speed Packet Access
IMT	International Mobile Telecommunications
LTE	Long-Term Evolution
MIMO	multiple-input, multiple-output
RF	radio frequency
TCH	traffic channel
TDD	time division duplex/duplexing
TRX	transceiver
UE	user equipment
UMTS	Universal Mobile Telecommunications System
VAMOS	Voice services over Adaptive Multi-user channels on One Slot
WCDMA	Wideband Code Division Multiple Access

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