NOKIA SIEMENS NETWORKS'S RESPONSE TO CONSULTATION PAPER ISSUED BY THE INFO-COMMUNICATIONS DEVELOPMENT AUTHORITY OF SINGAPORE

SPECTRUM FRAMEWORK FOR FOURTH GENERATION (4G) MOBILE COMMUNICATION SYSTEMS IN SINGAPORE

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PART I: INTRODUCTION

PART II: SPECTRUM ALLOCATIONS FOR 4G MOBILE SERVICES IN SINGAPORE

PART III: TECHNICAL QUERIES ON THE 2.5 GHz BAND AND 2.3 GHz BAND

PART IV: ALLOCATION PROCEDURE AND TIMEFRAME FOR THE 2.5 GHz BAND AND 2.3 GHz BAND

PART V: ROLLOUT AND USE OBLIGATIONS

PART VI: INVITATION TO COMMENT

PART I: INTRODUCTION

Question 1
IDA invites views and comments on the projected spectrum requirements to meet end users' demand for mobile broadband beyond 2015. To what extent can the existing wireless and mobile networks support the anticipated increase in mobile traffic?

Singapore has had a rapid growth of Mobile broadband subscriptions and traffic, driven by both laptop and smart phone users. Mobile broadband growth is a global megatrend that has not shown any signs of slowing down (even in the recent recession), and even possibly accelerating in near future with the introduction of devices in new form factors such as tablets and ebook readers. Machine-to-machine use cases and applications will also add to the subscriber numbers and traffic carried in the Mobile broadband networks. Based on the feedback from the mobile operators in Singapore and globally, spectrum assets on 900, 1800 and 2100 MHz bands are not sufficient to sustain Mobile broadband growth without adding large number of base station sites. Adding more base station sites has adverse impact on the operators' expenditure, thus impacting the affordability of the service to the end user. In most countries, frequencies on 2600 and 700/800 MHz (also known as Digital Dividend) bands are being auctioned, e.g. Europe, USA, to facilitate the Mobile broadband growth in a sustainable way.

IDA also invites views and comments on the likely technologies for the deployment of 4G mobile communication system that will meet end users' mobile communication needs beyond 2015.

In this paper, Nokia Siemens Networks considers only Long Term Evolution (LTE) as the next generation of mobile communication technology. All references to 4G mobile communication refers to LTE. Also to note that in 3GPP context, the 2.5 GHz band is commonly know as the 2.6 GHz band, and we have used both interchangeably in our response to the questions.

LTE is an emerging technology standard that is being developed by 3GPP. The process of formalizing and establishing the standard is continuing. It was finalized by in 2009 with trials carried out during 2009 and the first commercial deployments from 2010 onwards. Significantly, LTE also represents the next step in the evolution of the GSM/WCDMA/HSPA cellular network family to support the delivery of a range of services requiring high data rates similar to those in a PC-based environment. It is the natural response to operator needs as defined in the NGMN Ltd (Next Generation Mobile Networks) white paper, an initiative of leading international operators.

Although there is a very strong drive towards LTE, with several operators making a

clear commitment to the technology, the leading players in the ecosystem as a whole are still figuring out how to accelerate its uptake and how and when it will position itself in a market that will still be deploying HSPA.

Compared with existing and competing technologies, LTE will enable significant further development and more efficient delivery of the new data-rich services. The widespread use and acceptance of these services is likely to raise the need for an evolved UMTS/HSPA, due to continued cost pressure. These were among the key factors considered in the development of the LTE (FDD and TDD versions) standard.

By LTE, we mean an evolutionary step from the existing infrastructure to the LTE radio access network and the System Architecture Evolution (SAE) core network. Taking the advantages of its radio characteristics, which are based on OFDM (Orthogonal Frequency Division Multiplexing) principles, LTE is a major breakthrough in terms of performance levels beyond what will be practical with CDMA approaches, particularly in larger channel bandwidths. It will coexist with both 3G systems and 2G systems, fitting into current operator owned spectrum, or into new spectrum to be acquired. Although LTE supports a scalable bandwidth from 1.4 up to 20 MHz, a 20 MHz bandwidth will be needed to achieve its optimum performance and cope with the expected data traffic growth.

LTE will support any compliant multimode device – in particular, seamless interworking with LTE and WCDMA/HSPA and GSM as an inherent part of the 3GPP LTE/SAE standard as well as interworking with CDMA networks.

In order to realize the full benefit of LTE, the System Architecture Evolution (SAE) is required in the core network architecture (defined by 3GPP). SAE provides a flat, fully IP based network architecture, consisting of only one node in the user plane of the Core network and thus guaranteeing optimal scalability and therefore reduced cost per bit. As a circuit switched network is not available anymore voice service will be supported as VoIP.

Many of the attributes of LTE make it a favorable choice for incumbent GSM operators:

- Operators' decisions are entirely driven by business cases and on a higher level, by the stock market. By creating long-term economic sustainability for mobile broadband, LTE will improve Total Cost of Ownership (TCO) compared with HSPA.
- LTE networks will interconnect seamlessly with 3GPP and 3GPP2 legacy networks, providing the convenience of keeping the existing global roaming agreements and giving the ability to seamlessly hand-over to the GSM/WCDMA or CDMA networks when LTE coverage is not available. This allows for a smooth upgrade path from an existing 3GPP/3GPP2 network,

where LTE can be deployed in phases and still provide ubiquitous connectivity.

- LTE can be deployed in existing FDD spectrum alongside GSM or UMTS and "grow" in that spectrum in several steps as more subscribers are converted to LTE.
- With the TDD LTE version, the operators who own TDD spectrum will have the possibility to deploy TD-LTE, the TDD version of the LTE standard. Hence, they will have the flexibility required to offer mixed services to meet their customers' needs.
- 3GPP technology can use the economies of scale from GSM/WCDMA, which account for more than 85% by market share of today's mobile connections. This will have a significant impact on future LTE infrastructure and handset costs.
- LTE not only improves the throughput in the air interface and reduces the latency; it also introduces an architecture designed for IP backhaul. The backhauling will need to handle capacities of 100 Mbps and more. Therefore, the expectation is that traditional E1/T1 connections will not be scalable cost-effectively and more cost-efficient Ethernet connections will be used.
- It can operate in different frequency bands with various channel bandwidths. This enables Multi-access Base Stations in the long term to also support GSM and/or WCDMA.
- LTE supports a self-organizing network feature, which brings major OPEX savings. For all the above reasons, LTE is likely to be more attractive to incumbent operators.

PART II: SPECTRUM ALLOCATIONS FOR 4G MOBILE SERVICES IN SINGAPORE

Question 2

IDA invites views and comments on the possible radio-frequency spectrum bands, besides the 700/800 MHz, 2.3 GHz and 2.5 GHz bands, that would be suitable for 4G mobile communication systems and the likely timeframe for deployment. To what extent are the 900 MHz, 1800 MHz and 2.1 GHz alternative bands for 4G deployment? Are there other frequency bands that are currently not allocated but could be potential candidates for 4G system deployment?

LTE offers a clear advantage with its scalable bandwidth capability. It is most likely that operators will deploy LTE services in frequency bands like the newly licensed UHF band in the United States of America. Discussions are continuing Europe and the rest of the world, where the digital dividend could use some of the spectrum for LTE. Whereas some operators plan to deploy LTE in the 700 MHz or AWS (1.7–2.1 GHz) spectrum, others plan to deploy LTE in their existing 1800 MHz spectrum. In addition, some countries in Europe and other regions have already started planning for the 2.6 GHz band where it has been auctioned in many countries in Europe, the

most recent being in Germany. TeliaSonera has launched commercial LTE service on 2.6 GHz in Sweden and Norway in 2010.

In a later phase, it is most likely that operators will refarm the spectrum currently used for GSM and WCDMA and deploy LTE in their existing spectrum (850 MHz, 1900 MHz, 2.1 GHz) when LTE becomes a mass market technology. From an economical point of view, a deployment in lower frequency bands is favoured.

In terms of the channel bandwidths over which LTE will be distributed, most operators expect 20 MHz to be allocated to maximize and deliver the full benefits of LTE (higher average and peak data rates, better throughput, lower latency.

Please see attached spectrum allocation under 3GPP for FDD & TDD LTE.

It could be beneficial to the existing operators in Singapore to deploy FDD LTE in the 1800 MHz band as it can reuse the existing site locations as well as the extensive inbuilding infrastructure in buildings, tunnels and MRT lines. This will certainly help to reduce the cost of the network rollout and also allows the operators to provide services under LTE more quickly.

Secondly, FDD-LTE in 1800 MHz band would require fewer sites than it would be required for 2.6 GHz band. This would mean a better business case for the operators as well.

FDD-LTE in 1800 is currently under consideration by a number of countries in Europe and Asia Pacific. Network equipment and device manufacturers will support FDD-LTE in the 1800 MHz band as well. It is envisioned that multimode multiband devices would be available to support the various bands where LTE is commercially deployed.

In LTE-Advanced (LTE-A), among other developments, the maximum carrier bandwidth is planned to be increased to 100 MHz in order to achieve the maximum peak bit rate of 1 Gbps for downlink. For backwards compatibility to LTE that typically has 20 MHz bandwidth, Carrier Aggregation (CA) is being introduced. Both contiguous and non-contiguous CA will be supported, offering improved spectrum flexibility (e.g. for refarming). For example, In practice this means 20 MHz at 1800 MHz band and 20 MHz at 2.6 GHz band could be aggregated to give a total of 40 MHz bandwidth for LTE-A. Please refer to following table for the proposed band combinations for the aggregation. Please refer to the attached table for the 3GPP standardized band numbers.

Region	Transmission bandwidth		Number of LTE-A component carriers	Duplex mode	Priority
	UL	DL			
1	20 MHz	20 MHz	10 MHz CC (Band 1) + 10 MHz CC (Band 3)	FDD	TBD
	30 MHz	30 MHz	10 MHz CC (Band 1) + 20 MHz CC (Band 7)	FDD	TBD
	30 MHz	30 MHz	10 MHz CC (Band 3) + 20 MHz CC (Band 7)	FDD	TBD
	40 MHz	40 MHz	20 MHz CC (Band 7) + 20 MHz CC (Band 22)	FDD	TBD
	40 MHz	40 MHz	20 MHz CC (Band 7) + 20 MHz CC (Band 3)	FDD	TBD
2	10 MHz	10 MHz	(Beyond R10) 5 MHz CC (Band 4) + 5 MHz CC (Band 2)	FDD	5
	20 MHz	20 MHz	10 MHz CC (Band 2) + 10 MHz CC (Band 4)	FDD	2
3	20 MHz	20 MHz	10 MHz CC (Band 11) + 10 MHz CC (Band 1)	FDD	TBD
	40MHz	40MHz	20 MHz CC (Band 38) + 20 MHz CC (Band 40)	TDD	1

Please note that LTE-A is currently being standardized in 3GPP and the first version of the LTE-A specification is expected to be ready in 2011. Any references to LTE-A here are subjected to change in the 3GPP standardization.

Nokia Siemens Networks has previously presented a business case study of LTE deployment in lower frequency band such as 800MHz compared with that in higher frequency band such as 2.6 GHz. IDA could refer to that case study to get an understanding of the possible cost impact to network rollout.

PART III: TECHNICAL QUERIES ON THE 2.5 GHz BAND AND 2.3 GHz BAND

TECHNICAL QUERIES ON THE 2.5 GHz BAND

Technologies for the 2.5 GHz band

Question 3
IDA invites views and comments on the demand for the 2.5 GHz band after 2015 in Singapore, and the technologies that are currently being developed for use in the 2.5 GHz band. Are these likely to complement or substitute existing networks? Please also comment on the availability of the network equipment.

The demand for 2.5 GHz will depend on the a number of variables, including the demand of mobile data (from consumers to possibly machines to machines), users' expectation of data rates and coverage, and the resulting business case of rolling out mobile broadband in 2.5GHz versus other spectrum bands in the lower frequency and/or refarming existing allocated spectrum. Operators will choose a technology that

is compatible with their existing mobile networks and where there is a ready supply of multimode multiband devices that support the choice of technology and spectrum bands. Today, LTE will be able to interconnect seamlessly with 3GPP and 3GPP2 legacy networks, providing the convenience of keeping the existing global roaming agreements and giving the ability to seamlessly hand-over to the GSM/WCDMA networks when LTE coverage is not available.

It is expected that all leading mobile network infrastructure and device/UE manufacturers will support LTE in the 2.5GHz band and possibly even before year 2015.

Spectrum Channelling Plan in the 2.5 GHz band after 2015

Question 4
IDA invites views and comments on the paired and unpaired spectrum arrangements in the 2.5 GHz band after 2015.

Please refer to the attached table of the 3GPP standardized bands for LTE for the standard allocation of the paired and unpaired spectrum. At least 20 MHz paired spectrum per operator is needed to deliver the full benefits of LTE, e.g. the high peak data rates and spectral efficiency.

Guard band

Question 5
IDA invites views and comments on whether the size of 5 MHz guard block at the frequency boundaries between paired and unpaired spectrum is sufficient to safeguard the adjacent band. IDA also invites views on our proposal not to specify guard block requirement between licensees using the TDD or FDD band.

5 MHz guard band is possible. It will also requires extra attention to tight filtering while 10 MHz gives more relaxed requirements for filtering.

Spectrum Block Size

Question 6
IDA invites views and comments on whether allocating 5 MHz spectrum lot size is appropriate for the current technologies in the 2.5 GHz band. IDA also invites views on our proposal to allocate spectrum in individual blocks of 5 MHz and let operators who need a larger carrier size to combine multiple blocks together. Alternatively, should IDA allocate in larger blocks based on multiples of 5 MHz?

In order to deliver the benefits of LTE, allocation of the spectrum in the blocks of 10 MHz should give the best combination of the flexibility and efficiency to the operators. The allocation of 5 MHz blocks could lead to a fragmented spectrum assignment and the operator(s) may not be able to deploy LTE in optimally.

Alternative Band Plan after 2015

Question 7
IDA invites views and comments on our proposal for an interleaved band plan with combinations of 15 MHz and 20 MHz paired spectrum blocks as well as 25 MHz of unpaired spectrum blocks available for assignment in contiguous block of 15 MHz, 20 MHz and 25 MHz respectively by IDA and whether this would be appropriate.

This will lead to a compromised service by one or more operators, as at least 20 MHz paired spectrum per operator is needed to deliver the full benefits of LTE, e.g. the high peak data rates and spectral efficiency. It's also likely that the proposal would leave one of the operators with a TDD and 2 with a FDD spectrum.

IDA also invites views and comments on the practical measures that operators would implement to allow coexistence of BSS and mobile services in the same band in the border areas so that more spectrum blocks can be made available.

No comments

TECHNICAL QUERIES ON THE 2.3 GHz BAND

Question 8
IDA invites views and comments on the likely technologies for the 2.3 GHz band and the availability of network equipments for use in the band. IDA also invites views on our proposal to retain the existing channeling plan for the 2.3 GHz band and to allocate the spectrum in blocks of 5 MHz when the band is re-allocated after 2015. Please also comment on whether the current amount of 50 MHz spectrum available in the 2.3 GHz band is sufficient to meet industry demands after 2015.

The likely technology that can be deployed for 2.3 GHZ band would include TD-LTE. Service providers and operators in countries like China, India and Russia have indicated their intention to rollout TD-LTE in the 2.3GHz band from late 2010 onwards. It is expected that all leading LTE network manufacturers would have equipment ready in 2010 for commercial deployment.

In TD-LTE technology both downlink and uplink share an unpaired frequency channel in time divided manner. Thus at least 20 MHz paired spectrum per operator is needed

to deliver the full benefits of LTE, e.g. the high peak data rates and spectral efficiency.

PART IV: ALLOCATION PROCEDURE AND TIMEFRAME FOR THE 2.5 GHZ BAND AND 2.3 GHZ BAND

Spectrum Allocation Timeframe

Question 9:
IDA invites views and comments on what is an appropriate timeframe for IDA to allocate the 2.3 GHz and 2.5 GHz bands. Should the allocation of the 2.3 GHz band proceed separately from that of the 2.5 GHz band, given the greater uncertainty over the timeframe in which the 2.5 GHz band would be available? If so, when would be an appropriate timeframe for IDA to allocate the 2.3 GHz band?

No Comments

Spectrum Allocation Procedure

Question 10:
IDA invites views and comments on what would be a fair and efficient allocation mechanism for the 2.5 GHz band. In the case where there are existing deployments in the band, should IDA grant first rights of refusal for the current right-holders?

First rights of refusal should be given to current right holders who had already deployed their networks in the allocated spectrum bands and have made the service commercially available to consumers and enterprise customers or has submitted plans to rollout the network within a specified time frame.

No comments on spectrum allocation methodology.

PART V: ROLLOUT AND USE OBLIGATIONS

Question 11:
IDA invites views and comments on the proposal to impose both service provisioning and coverage obligations on the operators awarded the 2.3 GHz and 2.5 GHz spectrum after 2015. In particular, what would be an appropriate service provisioning obligation and the timeframe for deployment bearing in mind that the spectrum assignment is likely to take effect only from 1 July 2015? Similarly, what would be an appropriate measure for service coverage obligation and the timeframe for deployment?

No comments.