NOKIA

Consultation on Digital Broadcasting: Mobile Television and Related Issues

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Contents

1 Executive Summary

Making TV mobile is the natural next step in the evolution of digital world. We have witnessed the era when voice has been made mobile and some key leanings are worth to remember and take along when taking this next step.

Nokia recommendations for Mobile TV deployment in Hong Kong are based on our experiences from our deep involvement in mobile voice revolution to recent experiences on mobile TV trials and commercial deployments across the world.

The success of the mobile telephone and recently success of mobile TV have been building on following tree aspects:

- Efficient usage and allocation of spectrum
- Creation of customer demand for mobile TV: Offering of new valued services to consumers
- Enabling of sustainable business ecosystem creation by competitive supply products and services on open market approach

Spectrum usage & allocation: UHF is clearly the most suitable and efficient technology to be used for mobile TV. Alternatives such as VHF or L/S-band have fundamental problems. VHF will require cumbersome antenna solutions in handhelds and L/S band will require substantial high CAPEX and OPEX to build mobile TV coverage.

Nokia has closed observed both beauty contest and action based spectrum allocation processes. Both methods have their benefits, but beauty contest based spectrum allocation method leads to faster business ramp-up and better managed business environment, leading to benefits to society. Government is benefiting financially with increased tax income and spectrum license fees. Consumer get faster new services and service levels can be protected via license obligations. Broadcast operators can better manage their respective business.

Creation of consumer demand: Business environment should encourage rich channel supply, high quality services with good network coverage. Rich channel supply means that consumer are expecting to get approximately the same number of channels transmitted to their mobiles as they are receiving to home TV sets. The service level for Mobile TV has to be guaranteed. Consumers expects from the mobile TV service the same reliability and availability as they have with their home TV services. When the consumers are on the move, they expect to receive the TV signal coverage roughly the same as cellular network coverage.

Open mobile TV ecosystem development for Hong Kong: The cost efficient way to build infrastructure for Mobile TV is to promote the use of efficient distribution network with obligation to rent capacity. This model has been implemented in Finland and Germany is planning to use the same principle.

Adopting of global, open technology standard is the key to provide affordable devices and services to consumers. DVB-H is winning market share. DVB-H mobile TV technology has been adopted across European countries; all big Asian countries are also relying on DVB-H as mobile TV technology. North America is splitting market between MediaFlo and DVB-H. Both technologies are standardized in US by TA. MediaFlo is seen as 1st implementation in the market but WiHire and Modeo and looking work option to bring DVB-H based Mobile TV to the market. Latin America development is at very early stage, but DVB-H testing is also undergoing in Latin America as well. The wide adoption gives all parties confident that DVB-H will be the most use global standard for mobile TV. Cost efficient product and service supply ecosystem has been created based on DVB-H due to the economies of scales. This gives possibility to have state of art, competitive supplies of DVB-H products to consumer and trade customers.

These highlighted aspects are discussed more in detail in this submission. Nokia remains available for further consultations or discussions with the government on any of these issues.

2 Broadcast Technology Overview

2.1 DVB-H

The DVB-H standard (ETSI EN 302 304) is based on the DVB-T specification for terrestrial digital television, adding to it a number of features designed to take account of the limited battery life of small handheld devices, and the particular environments in which such receivers must operate. The use of a technique called time-slicing, where bursts of data are received periodically, allows the receiver to power off when it is inactive leading to significant power savings. DVB-H also employs additional forward error correction to further improve the already excellent mobile performance of DVB-T.

DVB-H incorporates a related set of specifications for IP datacast (DVB-IPDC). The specifications for IP Datacast are essential to the convergence of broadcast networks and mobile telecommunications networks that will almost certainly be central to the majority of commercial launches of DVB-H services. The specifications cover the overall system architecture, electronic service guide (ESG), content delivery protocols, and the PSI/SI that will make the establishment of convergent networks possible.

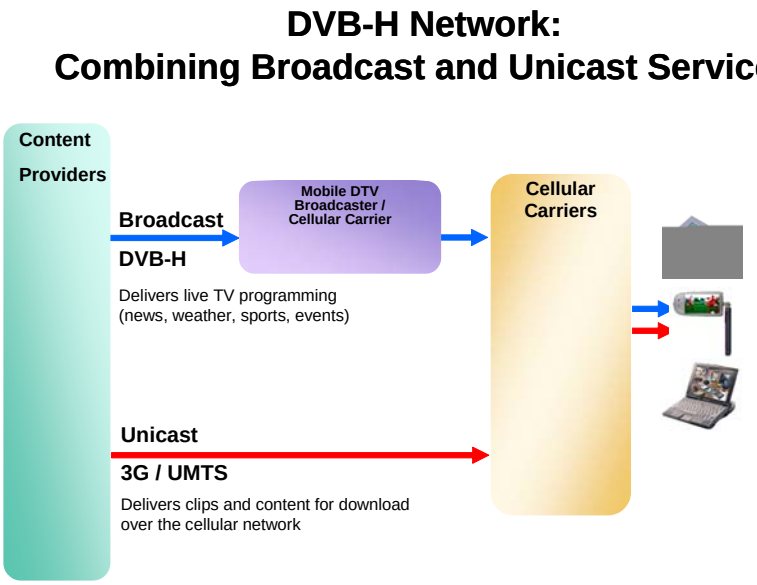

Figure 1. DVB-H Mobile DTV System[1]

DVB-H is based on proven technology that has enhanced to take into consideration mobility needs such as device power efficiency, mobility and interactivity. That combination is optimal for platform for mobile TV application as we know today, but thanks to it's openness and it has potential to grow with the demand. DVB.org and OMA are systematically driving forward of DVB-H development, keeping is competitive also in future. The open, global approach that is driving DVB-H forward is resulted in that DVB-H:

- is the most mature mobile broadcasting technology
- provides scale of economics,
- provides competitions
- supports several business models, combining broadcaster's and communication
- is future proof
- is the global standard making global use of devices possible (roaming)

2.2 DMB

DMB (Digital Multimedia Broadcasting) is a mobile DTV system that can operate via satellite (S-DMB) or terrestrial (T-DMB) transmission. DMB was developed in Korea; is based on the Eureka 147 DAB standard; and operates in frequency bands III (VHF) and L (SHF). The T-DMB standard (ETSI TS 102 427; TS 102 428) uses MPEG-4 Part 10 (H.264) for video and MPEG-4 Part 3 BSAC or HE-AAC V2 for audio. It also uses OFDM-4DPSK modulation to diminish channel effects (e.g. fading and shadowing).

2.3 MediaFlo

Forward Link Only (FLO™) is a mobile multicast technology developed by QUALCOMM. It is the underlying technology for QUALCOMM's MediaFLO mobile DTV system and wholesale service, which will be provided by MediaFLO USA, a QUALCOMM subsidiary. Given that FLO is based on a proprietary core IP, QUALCOMM is trying to standardize and "open" their solution for content providers and other elements of their ecosystem (i.e. The FLO Forum), but it is unclear if they will open the silicon opportunities or remain a sole source provider.

FLO mimics many features of the DVB-H standard, and offers good power efficiency and channel switching times. Layered modulation is offered by FLO, which benefits the QoS of video and audio streams when SNR is good. With layered modulation, the perceived QoS is more gradual than with traditional modulation methods. Philips and others are offering Frame Rate Doubling techniques as an alternative to Layered Modulation.

FLO's power efficiency good, however this needs to put this in perspective. Multiple silicon providers (including TI and Siano) have claimed 25mW time sliced power consumption for a single chip solution. This power is substantially less than the display power, so any incremental savings in receiver power will result in minimal improvement in TV play time. This reduces the benefit of smart encoding.

2.4 CMMB/S-TIMI

CMMB(China Mobile Multimedia Broadcasting) is MobileTV technologies set being developed in P.R.China, S-Timi (Satelite-Terrestrial Interactive Multiservice Infrastructure) is modulation technology in CMMB and it's developed by ABS(Academy of Broadcasting Science) of SARFT. CMMB has published S-Timi modulation and the relevant Multiplexing specification in end of 2006 and other specifications are under development. CMMB targets to use S-Band satellite and gap filer in terrestrial to provide MobileTV service to handheld

terminals. S-Timi supports 2MHz and 8MHz bandwidth and uses OFDM modulation (4K in 8MHz and 1K in 2MHz), RS for Outer coding, LDPC(1/2, 3/4) for Inner coding, its multiplexing is based on own mechanism.

2.5 ISDB-T

Integrated Services Digital Broadcasting (ISDB-T) is a mobile DTV technology standard (ARIB STD-B31) that is primarily deployed in Japan. ISDB-T can transmit mobile multimedia broadcast programming to fixed and mobile terminals. It specifies OFDM transmission with digital modulation schemes (i.e. QPSK, DQPSK, 16QAM and 64QAM). It is applicable to all 6, 7 and 8 MHz bandwidth systems and utilizes MPEG-2 for signal multiplexing.

2.6 Comparison of main broadcasting technologies

The major mobile DTV technologies are described below and a comparison is provided in Figure 2.

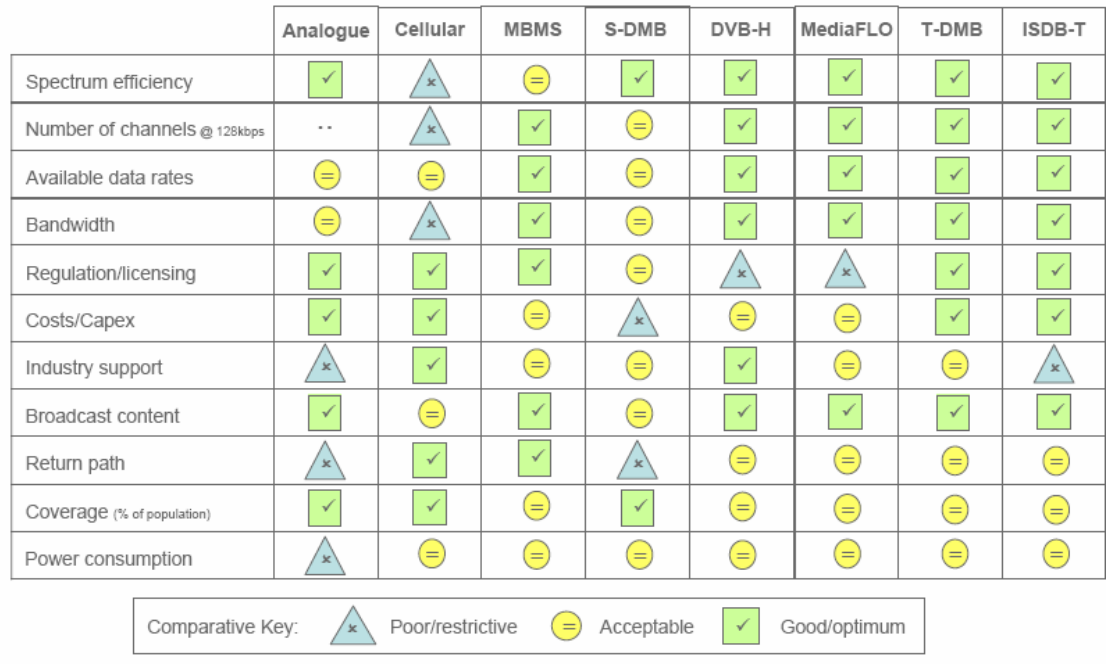

Figure 2. Major Mobile DTV Technologies

BMCO has published comprehensive report comparing main broadcast technologies. More details can be found from annexed report. (Annex 1:bmcoforum Mobile Broadcast Bearer Technologies)

3 Market update on Mobile TV deployments

3.1 Mobile TV market development

Nokia is following closely the global development of mobile TV market. Current only few markets are providing Mobile TV services on commercial basis. Korean and Japan have offered Mobile TV services to consumers already for some year's time. Some European countries (Italy, Finland) have opened services recently. In Asia Vietnam is offering mobile TV service on commercial basis.

Year 2006 can be recognized as a year, when technology reached maturity for commercial deployments. Year 2007 can be characterised as a year of commercial market ramp-up. **We'll see several new markets going commercial mode in 2007. The global mass market level will be reached 2008.** Nokia sees mobile TV subscriber growth developing as follows:

BROADCAST MOBILE TV - ALL TECHNOLOGIES

Active users	2006	2007	2008	2009	2010
Year end					
APAC	4.1	10.3	25.3	48.8	81.3
China			*3.3*	*9.0*	*15.5*
EMEA	0.3	2.8	6.3	16.0	46.7
LTA	0.0	0.0	0.1	0.8	2.2
NA	0.0	0.2	1.8	6.5	15.5
Total (millions)	**4.4**	**13.4**	**33.5**	**72.1**	**145.7**

Besides of the number of mobile TV subscribers all-in-all, the technology selection is an essential aspect. Table below shows Nokia estimates on development of Mobile TV subscribers per technology.

Share by technology	2006	2007	2008	2009	2010
Year end					
DVB-H	7%	23%	27%	38%	49%
MediaFLO	0%	2%	6%	9%	11%
Other (includes DMB, ISDB-T, S-TIMI)	93%	76%	68%	53%	40%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Nokia, April 2007

DMB has most subscribers today, but all the forecasts show consistently that DVB-H will have the highest market share in future and will be globally adopted dominant Mobile TV standard. Availability of interoperable devices from main vendors will bring needed choices to consumers and will guarantee affordable device priced through competition and scale of economics.

Global Mobile TV **interoperability** has been the goal within the companies supporting DVB-H. Four major mobile phone manufactures Nokia, SE, Motorola and Samsung have publicly committed into development of interoperable mobile TV devices based on DVB-H.

"To achieve interoperability among their digital video broadcast handheld (DVB-H) enabled mobile devices and the open standards-based Nokia network services system Samsung and Nokia said today they will work together in a move they said is aimed at boosting greater adoption of broadcast mobile TV services and accelerating service deployment. Samsung and Nokia said they will work together to support solutions based on the open OMA BCAST standard available for operator partners interested in deploying multi-vendor mobile TV services and trials this year and onward"; Nokia-Samsung press release April 2007.

3.2 Mobile TV business models

Mobile TV is can be deployed with different business models. Europe and Asian market seems to be approaching this new business opportunity from different angle. In Europe, mobile operators are actively involved and thus also planned business model and promoted user profiles reflect that. In Europe tighter integration between mobile broadcaster and mobile operator is favoured. In Asia the broadcaster are very active and as a consequence business models are then mainly broadcaster driven. Currently used business models are described more in detail in annex 2: bmcoforum: Business Model Study: November 2006

3.3 Europe

The European Union Commissioner for Telecommunications, Viviane Reding, expressed strong support for mobile TV and DVB-H in her speech at the CeBIT fair held in Hanover, Germany earlier this month. According to Reding, mobile TV is an exciting new platform for the distribution of audiovisual content that could generate new business opportunities for content creators and service providers, bring new value-added services to citizens, and create jobs in Europe.

Reding urged European countries and industry to agree on an interoperable mobile broadcast standard to ensure the rapid development of mobile TV. She also referred to the success of GSM for mobile telecommunications and DVB for digital television. "I am very confident that on the basis of DVB-H, mobile TV services can develop the economies of scale they need for take-up across Europe and around the world", said Reding.

In addition to policy-making, the Commission has invested some €40 million in mobile TV related research.

Spectrum needs to be secured now, says industry

The European Commission also initiated the setting up of the European Mobile Broadcasting Council (EMBC) last year. EMBC, with its members from the hardware, software, broadcasting, and content industries, is providing the Commission with industry opinions on developing mobile TV regulation and standardization. This month EMBC released a report that stresses the importance of allocating an adequate amount of spectrum for mobile TV services.

Switching off the analog TV networks will free up spectrum for new services during the next few years. The industry organization bmcoforum notes, however, that implementation of mobile TV should not be delayed until after the digital TV switch-over. "Mobile TV should have the same access to spectrum as any other TV service", says Jouni Kämäräinen, Vice-Chairman of bmcoforum. Visit www.bmcoforum.org to download bmcoforum's new spectrum policy paper.

The European Commission is expected to disclose its more concrete approach to mobile TV spectrum and standardization issues in mid 2007.

Mobile operators are strongly involved in mobile TV market development. Strong mobile operator dominance is influencing the selected profile, favouring OMA BCAST. OMA BAST profile takes into consideration mobile operators concerns, such as interactivity, service and content protection etc.

OMA BCAST is recognized by all mobile TV standardization bodies and it is developing into main stream profile for mobile TV service protection and purchasing technology.

Italy is the first market that opened DVB-H based mobile TV networks for mass market. 3G Italy network opening was synchronized with World Cup

2006 June 2006. This global media event has boosted consumer take-up. By end of 2006 about 400 000 subscribers was mobile TV services in Italy. **Finland** mobile TV network was opened in December 2006. Due to un-resolved content rights issues, the main TV stations have not been able to offer their programs to consumers.

According to the current understanding, further commercial broadcast mobile TV services are going to be introduced in Europe as follows:

2007: **Netherlands**

2008: **Germany, Spain, France, Switzerland**

In all of these cases, the basic technology choice is DVB-H. Key mobile operators involved in these countries have all confirmed their desire to deploy services based on the OMA BCAST standard with the OMA BCAST smart card profile as their service protection and purchasing technology of choice.

3.4 North America

US market has polarized around technology issue. DVB.H and MediaFlo are two main choices to broadcasted mobile TV in US

AT&T and Sprint have selected to use MediaFlo platform to offer mobile TV services.

HiWire and Model trialling with DVB-H in US market

3.5 Latin America

Both broadcasters and mobile operators across have shown interest in trialling mobile TV services in the region. DVB-H is trialled is some Latin America countries. However both technology standardization and business models are pretty much open, thus commercial deployment will take place later.

3.6 South East Asia Pacific & China

Broadcasters in the 10 Asian countries have agreed to adopt the DVB-T standard. The decision was taken at the 4th Asean Digital Broadcasting (ADB)

meeting held in Kuala Lumpur, ahead of the conference of the Asean Ministers Responsible for Information (AMRI), scheduled to take place in May. A statement released on behalf of the 50 delegates attending the conference pointed to the benefits to the consumer of a single digital standard in bringing down costs. The countries concerned are Brunei, Darussalam, Cambodia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. The conference also discussed a timetable for digital switchover. Malaysia has already announced its commitment to the DVB standard.

In the area there is strong recent development towards commercial network rollout. In these cases, DVB-H as broadcasting technology is favoured. In most cases broadcasters are leading the development influencing the selected partnering and business models.

Taiwan has issued four mobile TV testing licences to assess technologies and to understand consumer behaviour in order to develop regulatory framework for Mobile TV in Taiwan. Out of four trial licence owners three will use DVB-H for trials and one consortium is testing MediaFlo.

Several broadcast technologies are tested in P.R China, including DVB-H, DMB and Chinese mobile TV technologies such as CMMB/S-TIMI. The broadcast technology standardization situation in P.R of China is open.

4 Spectrum Analysis

When suitability of various frequency bands for mobile-TV use is discussed then the following issues have to be considered:

- Radio propagation
- Building penetration loss
- Terminal characteristics, especially antenna gain
- Interoperability with cellular radios in the same terminal
- Limitations in mobility due to the Doppler effect
- Man made noise

Radio propagation effects can be estimated by using for example the Okumura-Hata propagation model. From the model we can see that compared to the UHF, L-band will have roughly an 8 dB loss and VHF III-band roughly an 8 dB advantage as the effect of the frequency multiplier is 7.9 dB / octave.

Building penetration loss is a rather difficult subject as it will vary from case to case. In general it can be assumed that in VHF III-band the median BPL is rather similar than in UHF, but in VHF the standard deviation is smaller and thus there is an overall gain in the link budget margin perhaps by 2dBs. In the L-band the BPL median value will raise from the UHF slightly, but the STD remains about the same. Therefore it can be estimated that there is roughly a 2dB loss compared to the UHF.

In the terminal characteristics the dominant factor affecting the frequency selection is the antenna gain. The trend in terminal design and user acceptance has led in the past 5-10 years to smaller terminal with fully integrated antennas. As the antenna size is dependent on the wavelength (frequency), integrating efficient antennas in the VHF III band is almost impossible and any design would have to rely on external antennas, which would probably not receive customer acceptance on the device. If integrated antennas are used the loss in antenna gain compared to the UHF is about 15 dB. In the UHF-band the possibilities for better antenna design exist, but the limiting factor is the wide tuning range of the antenna, in general 470-750 MHz, and therefore the overall gain is still rather low. In the L-band efficient resonant antenna designs can be

applied and therefore the L-band will have an advantage of about 5dB over the UHF-band.

Interoperability with cellular radios integrated to the same terminal will restrict the usable frequency ranges in some cases. In the VHF III no further restrictions apply and the whole band can be used for mobile TV. In UHF interoperability with GSM900 will restrict the usable part of the band to 470 to 750 MHz. The L-band can have similar problems with the GSM1800 as the upper part of the UHF-band (700-750), but it should be possible to overcome these.

Often forgotten factor is the man made noise. This is decreasing with the frequency and is a severe problem in VHF III and can restrict the sensitivity of the terminal severely. In UHF it can still have some effect, but clearly lower than in VHF III. L-band is the best in this respect.

Doppler used to be a significant factor when selecting the frequency for mobile-TV applications. However the recent developments in DVB-H receiver technology have removed all practical restrictions in the UHF band even when using the 8k-mode, which from the SFN-size point of view is the wanted one. L-band can have restrictions and the possible FFT-size is limited to the 4k one.

The factors are summarised in the following table:

Parameter	VHF III	UHF	L-Band
Propagation	+8 dB	0 dB	-8 dB
Building loss	+2 dB	0dB	-2 dB
Terminal Antenna	-15 dB	0dB	+5 dB
Interoperability	No problems	750 MHz limit	GSM1800 can be a problem
Man made noise	High level	Moderate	Low
Doppler	8k OK	8k OK	4k has to be used
Terminal cost/complexity	Dual band ->higher cost	Simple	Dual band ->higher cost

Overall it can be summarised the both VHF III and L-bands will have a roughly 5 dB loss in the link budget when compared to the UHF. **Thus the UHF seems to be the optimum band for mobile-TV use from the network cost point of view**.

The conclusions of the above discussion can be used to analyze the network cost for each case. Attached is a full analysis, but this can be summarized so that a VHF III network is roughly 50% more expensive than a UHF network and L-band network is roughly 300% more expensive.

More information is available in annexes: 3) bmcoforum: Spectrum Position for Mobile TV; March 2007, 4) Finding right frequency for Mobile TV and 5) DVB-H – DMB system comparison.

4.1 UHF

The UHF-band is the optimum band for mobile broadcasting. In general it can be said that in broadcasting the network benefits from the lower frequencies higher powers and higher masts. However, there are some limitations and if we go as low as VHF III the network cost start to raise due to the antenna integration problems in terminals.

4.2 S-Band

The S-band is used by hybrid satellite/terrestrial systems like DVB-SH or S-DMB. For a limited size urban terrestrial network any benefits of the satellite segment (wide outdoor coverage) are not really used and the terrestrial repeater network will become very dense and expensive due to the high frequency.

Public sources from the Korean S-DMB deployment have given the following figures for the network:

- 250 Million USD investment in the dedicated satellite system
- Over 120 million USD in 2005 for installing 4,800 gap-fillers in 26 cities nationwide, including the major cities of Seoul, Busan, Daejeon, Daegu, Ulsan, and Gwangju
- A plan to invest a further US$700 million over the next five years (2005-2010), in order to improve its services.
- Total investment is 1070 million USD

Nokia estimates that a good UHF DVB-H network in a country like South-Korea would cost 150-200 million USD. This example shows the high cost of the high frequency hybrid satellite/terrestrial system.

4.3 L-Band

As shown above the L-Band is not an ideal band for mobile broadcasting due to the high cost of the network infrastructure.

The only L-band deployment so far has been the US Modeo-case, which is operating at 1.6 GHz. Probably one of the reasons for a slow business start has been the high deployment cost of the L-band network.

In Europe the L-band was discussed 1-2 years ago in many countries as a possible fast way to find frequencies for mobile-TV. However, it seems that since that in most of the countries UHF-frequencies have been found and L-band is not any more seen as a real option.

As a result of the new ITU-R Geneva-06 frequency plan most of the European countries have 6 to 7 national multiplexes available for DVB-T or DVB-H deployments in the UHF and many European administrations have reserved 1 (or even 2 in the long term) for mobile use. This is also the recommendation of the European commission although the Commission also gave a task for CEPT to find out possibilities for a more flexible use of the L-band in the future. However, the practical outcome of this study will not probably enhance the L-band use even if it increases the flexibility. For the moment the only country in Europe, which is still seriously discussing possible L-band use for mobile TV is the UK and even there digital dividend spectrum in the UHF will become available (auction) in 2008.

From a global perspective as of today, L-band implementation will be very limited and it means that it will not have a wide range of mass market terminals available in the market. Being a open market like Hong Kong, with an extreme high replacement cycle for mobile terminals, the selection of L-band will greatly limited the terminal choices for end user.

5 Spectrum allocation principles

Nokia is having a neutral opinion on this issue. All proposed approached, service neutral approach, conventional approach or pro-mobile TV approach, may lead to successful market development depending on how overall conditions for build new business are establish in the market place.

As DVB-H (IPDC) supports video, audio and data applications, thus it should be competitive technology to be used what so ever spectrum allocation principle is used.

6 Spectrum Assignment Principle

6.1 Auction

Nokia does not see auctioning as the best possible mechanism to assign frequencies in this case. Typically action process has lead either to very high licence prices or very low prices. The first scenario has lead to situation where the winner has not been able to ramp-up in fast way commercial services. The later has lead to the situation where the owner of the auction has not got high enough compensation for the frequency, resulting to incompletion of the whole process. In case of Mobile-TV business case, the business opportunity is high, but also risks are relatively high. That will make it very difficult for bidders to evaluate value of the frequency correctly.

6.2 Service utilization fee (SUF)

When it is difficult to evaluate frequency value, it is also difficult to set a fair service utilization fee for the frequency. In case of 3G, the business has been known from the 2G business and therefore the value of the spectrum has been much easier to evaluate. Mobile-TV on the other hand is a totally new business case without any prior understanding of opportunities or risks.

6.3 Nokia Proposal

Nokia proposes that frequencies will granted based on results of beauty contest and instead of using pre-determined SUF, the licensee and Hong Kong government will make “revenue-sharing” agreement, based on which licensee will pay agreed portion of revenues to government. This agreement should guarantee that the winner has interest and reliable plan to build network coverage and frequency licensing cost are inline with business. Hong Kong

government on the other side can set their conditions for frequency licence and will get constant and fair revenues from the licensee revenues. Annex (6) Government decision on an operation licence for a digital broadcasting network, Date 23 March 2006

7 Licensing Agreement

Nokia, from a solution and device manufacturing point of view, has a neutral position in regarding the legal and logistic arrangement of the licensing agreement. However, by observing the development in other place, we believe that a light-regulated environment stimulate best business results and service to end users.

8 References

1) bmcoforum: Mobile Broadcast Bearer Technologies, January 2007-04-05
2) bmcoforum: Business Model Study: November 2006
3) bmcoforum: Spectrum Position for Mobile TV; March 2007
4) Finding right frequency for Mobile TV
5) DVB-H – DMB system comparison
6) Government decision on an operation licence for a digital broadcasting network, Date 23 March 2006