TSG-RAN Meeting #16 **RP-020354**
Marco Island, FL, USA, 4 - 7 June 2002

Presentation of Specification to TSG or WG

Presentation to:	**TSG-RAN Meeting #16**
Document for presentation:	**TR 25.889 Version 1.0.0, Feasibility Study considering the viable deployment of UTRA in additional and diverse spectrum arrangements (Release 6)**
Presented for:	**Information**

Abstract of document:

The present document summarises results from the feasibility study of Viable Deployment of UTRA in Additional and Diverse Spectrum Arrangements. The spectrum arrangements include bands defined at ITU-R WRC-2000 as well as the present bands I, II and II

The TR in its present form has been sent to ITU-R WP8F upon request.

Changes since last presentation to TSG-RAN Meeting:

First presentation to RAN.

Outstanding Issues:

How can the requirements for the 2.5 GHz band be addressed?

How can the requirements for the frequency band asymmetry be addressed?

Feasibility of UL next to DL allocations with flexible positions?

Contentious Issues:

The information in TR 25.889 is based on text from RAN WG4 meeting documents that to some parts contained information in areas outside of the RAN WG4 mandate. As this information is useful in helping understanding of the technical feasibility assessment and related conclusions in these sections, it has been kept..

3GPP TR 25.889 V1.0.0 (2002-05)

Technical Report

3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
Feasibility Study considering the viable deployment of UTRA in additional and diverse spectrum arrangements
(Release 6)

Select keywords from list provided in specs database.

Keywords

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

This clause is optional. If it exists, it is always the second unnumbered clause.

1 Scope

The present document summarises results from the feasibility study of Viable Deployment of UTRA in Additional and Diverse Spectrum Arrangements. The spectrum arrangements include bands defined at ITU-R WRC-2000 as well as the present bands I, II and II.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[<seq>] <doctype> <#>[([up to and including]{yyyy[-mm]|V<a[.b[.c]]>}[onwards])]: "<Title>".

[1] 3GPP TR 41.001: "GSM Release specifications".

[2] 3GPP TR 21 912 (V3.1.0): "Example 2, using fixed text".

[3] ITU-R 8F/623, “REPORT OF THE SEVENTH MEETING OF WORKING PARTY 8F (Queenstown, 27 February – 5 March 2002)”; ATTACHMENT 7.2, “Working document on preferred options for frequency arrangements for IMT-2000 systems in bands identified by WARC-92 and WRC-2000 (Revision to Att. 8.2 of Doc. 8F/489)”

[4] 3GPP TS 25.331 v 3.9.0 (2001-12)“Radio Resource Control (RRC); Protocol Specification (Release 1999)”

[5] R2-011087 Proposed CR 776 on Missing UARFCN uplink info, Nokia.

[6] R2-011511 Approved Report of the 21st TSG-RAN WG2 meeting, Secretary.

[7] 3GPP TS 25.101 v 3.9.0 (2001-12) “UE Radio Transmission and Reception (FDD) (Release 1999)”

[8] 3GPP TS 25.104 v 3.9.0 (2001-12) “UTRA (BS) FDD; Radio transmission and Reception (Release 1999)”

3 Definitions, symbols and abbreviations

Delete from the above heading those words which are not applicable.

Subclause numbering depends on applicability and should be renumbered accordingly.

3.1 Definitions

For the purposes of the present document, the [following] terms and definitions [given in ... and the following] apply.

Definition format

***<defined term>**: <definition>.*

example: text used to clarify abstract rules by applying them literally.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Symbol format

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

Abbreviation format

<ACRONYM> <Explanation>

4 Background and Introduction

The present 3GPP specifications cover the IMT-2000 2 GHz band (Band I and II), in accordance with ITU-R Radio Regulations Article S5 Footnote S5.388, in R99 and Rel4 and the work is continuing with the UMTS1900 Band II improvements and UMTS 1800 Band III.

ITU-R WRC-2000 identified additional extension bands for IMT-2000 that requires further studies for the subsequent future deployment of UTRA in the whole or parts of the bands as indicated below:

- 806 - 960 MHz (The whole band 806 - 960 MHz is not identified on a global basis for IMT-2000 due to variation in the primary Mobile Service allocation across the three ITU Regions)
- 1710 - 1885 MHz, where the work is progressing under UMTS1800 WI.
- 2500 - 2690 MHz (In ITU Region 1 the bands 2500 - 2520 MHz and 2670 - 2690 MHz is also allocated on a co-primary basis to the Mobile Satellite Service subject to market demand)

4.1 Scope and Objective of work

The viable deployment of UTRA in additional and diverse spectrum arrangements should be assessed, including

- Duplex spacing arrangements other than for Bands I, II and III.
- Arbitrary selectable or variable duplex spacing methods
- Use of asymmetric spectrum arrangements considering the need for additional downlink traffic capacity
- Terminal capabilities and signalling
- Possible interface impacts

Spectrum bands to study in an initial phase are

Present bands:

- 1920 - 1980 / 2110 – 2170 Band I (core band)
- 1850 - 1910 / 1930 – 1990 Band II (PCS1900 band)
- 1710 - 1785 / 1805 – 1880 Band III (GSM1800 band)

Implementations to study for new bands and combinations of bands:

1) 1710 - 1770 / 2110 - 2170 MHz

2a) 1710 - 1800 / 2110 - 2200 MHz

2b) 1920 - 2010 / 2110 - 2200 MHz

3) 1755 - [1805] / 2110 - [2160] MHz

4) 1710 - [1755] / 1805 – [1850]

5) 2500 - 2690 MHz:

(Alt A) Entire band as additional DL to other bands used for technologies within scope & objective of 3GPP.

(Alt B) DL and UL in this band.

(Alt C) DL and UL in this band, and additional DL to other bands used for technologies within scope & objective of 3GPP.

The technology study should describe a possible technical implementation of a Variable Duplex technology (VDT)solution to satisfy the addressed new spectrum arrangements but also considering the existing spectrum arrangements.

The information in this TR is partly based on text from RAN4 meeting documents that also contained information in areas outside of the RAN4 mandate. Examples are paragraphs containing information on how the split of uplink versus downlink traffic will develop with time, as well as suggestions on how to develop a specification assuming certain decisions are taken in e.g. regulatory bodies on how the new spectrum is to be used. As this information is useful in helping understanding of the technical feasibility assessment and related conclusions in these sections, this information has been kept. RAN4 has refrained from discussing the text parts outside of its mandate for this TR, and thus conclusions should not be drawn from these parts.

The part related to the technical feasibility, and especially the text in the conclusion clause, have been agreed by RAN WG4.

5 Description of the spectrum arrangements

Document 8F/623 [3] lists several band pairing options.

Table 1: Frequency Arrangements

Arrangements	UE Tx (MHz)	Duplex Centre Gap (MHz)	BS Tx (MHz)	Duplex separation (MHz)	Remarks
Band I	1920 - 1980	130	2110 - 2170	190	Current spec.
Band II	1850 – 1910	20	1930 - 1990	80	Current spec.
Band III	1710 - 1785	20	1805 - 1880	95	Current spec.
(*)	1710 – 1755	50	1805 - 1850	95	
(*)	1755 – 1805	305	2110 - 2160	355	
(*)	1710 - 1770	240	2110 - 2170	400	
(*)	1920 - 1980	520	2500 - 2690	Variable	
(*)	1850 – 1910	590	2500 - 2690	Variable	
(*)	1710 - 1785	715	2500 - 2690	Variable	
(*)	1710 -1770	730	2500 - 2690	Variable	
(**)	2500 (2520) - x	y≥20	z – (2670) 2690	Variable	x, y and z to be defined
(**)	z – (2670) 2690	y≥20	2500 (2520) - x	Variable	x, y and z to be defined. (Reversed duplex direction)

Note 1: Combination of Bands (*) and Bands (**) may be required to be considered in the future work.

Note 2: ITU-R Resolution 225 from the World Radio Communication Conference 2000 (WRC-2000) states that the bands 2500 - 2520 MHz and 2670 - 2690 MHz (as identified for IMT-2000 in the footnote S5.384A of the RR, and allocated to the mobile-satellite service (MSS)) may be used for the satellite component of IMT-2000. However, depending on market developments it may be possible in the longer term for bands 2500 - 2520 MHz and 2670 - 2690 MHz to be used by the terrestrial component of IMT-2000.

6 Enabling technologies for operation in the new bands

6.1 Solutions for implementing variable duplex separation in one terminal

Enabling terminals to operate with a variable duplex separation will facilitate roaming between different countries or regions. In addition, for operators with multiple band pairings, such terminals will be able to handoff from one band to another.

It is to be noted that, at this stage, the variable duplex separation may be understood as a variable duplex separation on a frequency block basis or a variable duplex separation on a frequency channel basis. It is thus recommended to choose between both alternatives before finalising the specifications.

6.1.1 Status in 3GPP specifications for accommodating variable duplex separation in one terminal

Several technical specifications allow the possibility of accommodating variable duplex separation in one terminal. Mainly affected are the specifications in RAN WG2 regarding the signalling and RAN WG4 regarding the Radio Transmission and Reception, but also test specifications in TSG-T1. In TSG-RAN there is also a study item " Feasibility Study considering the viable deployment of UTRA in additional and diverse spectrum arrangements " which is described in RP-010718.

6.1.1.1 Signalling and control of the UE (RAN2)

6.1.1.1.1 System Information Block type 5

Affected specifications in RAN WG2 are 3GPP TS 25.306 and 25.331. TS 25.306 specify the Tx/Rx frequency separation for FDD UEs operating in the UMTS core band as a UE Radio Access Capability.

For common channels, in the Rel'99 of UMTS 3GPP specifications there is (for “Band a”) only one assumed duplex distance of 190 MHz. This means that currently a Rel'99 UE for all frequency bands assumes an UL frequency that is 190 MHz below than the DL frequency. For dedicated channels variable duplex distance is supported. The UE is capable to support variable duplex distance according to its UE Radio Access Capability (see TS 25.306).

However, for common channels variable duplex distance is currently not supported. When a UE sends its first access to a UMTS network, the UE will after it has found a cell on a certain DL frequency, read the system information sent in that cell. This system information will give the channel parameters for the UL random access channel in system information block (SIB) number 5 (see TS 25.331 [4] section 8.1.1.6.5). SIB 5 contain all configuration for common channels, both UL and DL. It should be noted that UL frequency is not included in the random access channel parameters. The UE will then send an access attempt on an UL frequency that is 190 MHz below the DL frequency that the UE have been using to read system information.

For some regions in the world it has been discussed to use new non-Rel'99 frequency bands for UTMS, where the DL frequency is the same as in Rel'99 but the UL frequency is different from Rel'99 (option 4 and 5 in Section 5.1).

Since, a Rel'99 UE always assumes that the UL frequency is 190 MHz less than the DL frequency, there is a risk that a Rel'99 UE transmits on an UL frequency that is erroneous according to the assigned band. This can happen if this new non Rel'99 frequency allocation is introduced and the Rel'99 UE enters such a network.

First it should be noted that since this new non-Rel'99 frequency bands, as outlined in the problem above, does not exist yet, there is no solution implemented in any 3GPP specification. A solution will only be implemented when the situation with these new non-Rel'99 frequency bands exists.

Solutions were discussed at 3GPP RAN2 meeting #21 related to document R2-011087 [5]. The discussions are captured in the minutes in R2-011511 [6].

A possible solution could in short be described as; that SIB 5 will only be used in networks where the default duplex distance of 190 MHz is used. In a network where another duplex distance is used a new SIB 5 should be introduced "SIB 5 bis". This "SIB 5 bis" should be sent instead of the Rel'99 SIB 5 and may then also contain the UL frequency.

It is recommended to have RAN2 develop the details based on RAN4 recommendations for the SIB5 to indicate system duplex configuration.

According to the current specifications a Rel'99 UE that enters a network (e.g. cell) that do not send SIB 5 will be barred from access (see TS 25.331 [3] section 8.1.1.5). The UE will not be able to transmit on the UL neither for normal access nor emergency calls. This is also the desired behaviour since, the UE do not have the correct duplex distance needed.

This means that sending "SIB 5 bis" will result in that only UEs that understand this new SIB can access that network. This will then potentially be captured in a future Release of the 3GPP specifications when the non-Rel'99 frequency bands are introduced.

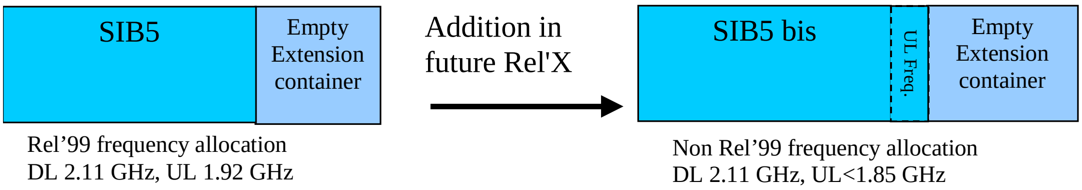

Figure 1. Possible solution in RAN2 specifications for accommodating several band pairings in one terminal.

Hence, there is no risk that old UEs transmit in on the wrong UL frequency, and there are possibilities to safely introduce new frequencies for common channels in the future.

6.1.1.2 Frequency bands and hardware issues (RAN4)

6.1.1.2.1 Frequency bands

In TS 25.101 [7] (see section 5.3) the TX-RX frequency separation is specified for fixed separation of 190 MHz and 80 MHz depending on the frequency band. Further it states that UTRA/FDD can support both fixed and variable transmit to receive frequency separation. And it also states that the use of other transmit to receive frequency separations in existing or other frequency bands shall not be precluded. Similar text can be found in TS 25.104 [8] regarding the Base Station.

When other frequency arrangements are introduced in 3GPP this section would be updated to list the TX-RX frequency separation for those frequency arrangements. Depending on the frequency arrangements there would also be other additions to RAN WG4 specifications, including that section 5.2 in 3GPP TS 25.101 [7] would be expanded by the relevant frequency bands.

The number of bands implemented in the UE is left to the manufacturers in agreement with operator partners.

6.1.1.2.2 RF performance

The impact to RF performance, firstly sensitivity, transmitter power and current drain, and secondly additional interference requirements, may require a change in the specifications. The variety of band combinations and the need for non-compressed as well as compressed mode terminals leads to a high number of possibilities that must be taken into account. It must be considered that RF performance specifications may be negatively affected, especially as the complexity in modes/bands increases.

It is therefore recommended to further study Rx and Tx RF performance before specifications can be finalised for UEs supporting multiple duplex spacings.

6.1.2 Examples of Implementation of variable duplex separation in one terminal

The UMTS core band is according to option 1 with 190 MHz fixed duplex separation as specified in 3GPP. Since not all options will be available in every region there will be a need to support more than one option in one terminal. Based on the assumption that the UMTS core band will be used in several regions and will be available first on the market. One scenario is to combine option 1 with one or several other options. The following scenarios have been chosen for further evaluation:

- Options 1 + 5 (+4)
- Options 1 + 2

The combination Options 1 + 3 has similar design impacts as Options 1 + 2.

Any of the proposed additional bands to the existing UMTS core band (Option 1) will require variable duplex separation. The simplest configuration to consider is Option 1 + Option 5 configured in a compressed mode with DCS1800 or PCS1900.

- Options 1+5 (+4):

Adding Option 5 leaves the core RX band untouched, so the complete receiver can be reused. The added TX band is at a larger duplex gap making it potentially relatively straightforward to implement. An example of a compressed mode implementation is shown in Figure 2. The duplex filter in Figure 2 is a new component, but it is assumed it can be based on existing technology.

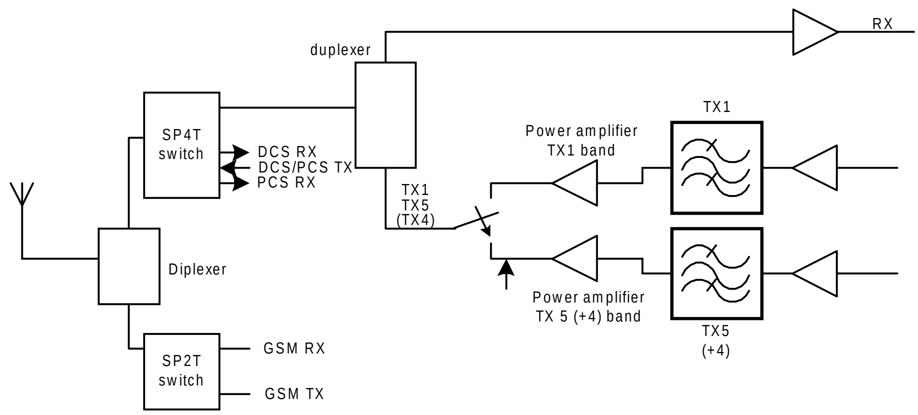

Figure 2. Example of compressed mode implementation for Option 1+5.

In Figure 3, another example of a compressed mode implementation is shown, which is more readily realizable, as multiple RF filters are used instead of one single duplexer.

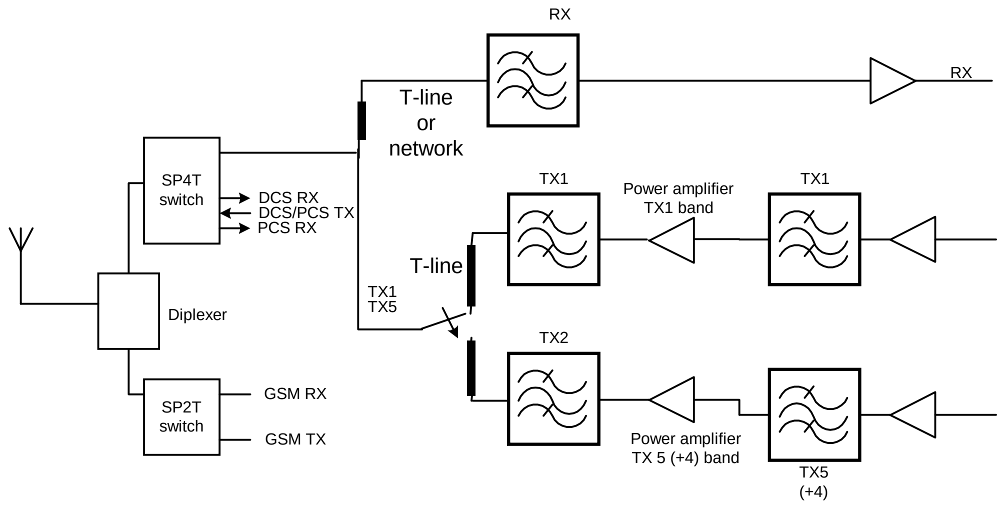

Figure 3. Example of compressed mode implementation for Option 1+5.

Having an additional duplex mode results in additional losses to both the Tx and Rx sides of the WCDMA system. As the number of bands increases, the losses can be expected to increase even more. Furthermore if a non-compressed mode implementation is chosen for associating DCS1800 or PCS1900 to WCDMA, then the losses are likely to be even more important. In any case, these losses are likely to be bounded by [2] dB on either Tx or Rx side. Further studies are needed so as to clearly evaluate the additional losses induced before specifications can be finalised.

- Options 1+2:

As diplexers and duplexers are carefully designed for specific frequencies, a classical implementation is to have one duplexer for each band pairing supported by the terminal. This combination will thus require 2 duplexers with very different requirements. Two complete receivers are needed for this combination. The general transceiver requirements from GSM 1800 are different, so reuse of GSM 1800 RF components for UMTS on 1800 is not possible. Further studies are needed before specifications can be finalised.

Note: The coexistence of Option 2 with the PCS1900 band is an open issue. The closeness of the bands will further complicate the RF filter requirements and/or require large guard bands.

6.1.3 VDT Conclusion

Having terminals able to operate over several band pairings will facilitate roaming and will also enable operators to provide service in multiple bands. Any vendor-specific implementation is suitable as long as RF performance are carefully studied and specified. A choice is to be made between having the terminals implementing variable duplex separation on a frequency block basis or on a frequency channel basis. It is however recommended not to have this variable duplex spacing capability mandatory in terminals.

6.2 Solutions for having a terminal accommodating frequency band asymmetry

7 Examples for viable implementations of spectrum arrangements

7.1 DL usage of the new band in 2500 – 2690 MHz in conjunction with the Band I for UTRA FDD

This clause discusses the usage of the 2500 - 2690 MHz spectrum for UTRA in conjunction with an assumed operation of the UTRA within the 1920 - 1980 / 2110 – 2170 Band I (core band). The following aspects shall be covered:

- Expected asymmetry between UL/DL capacity needs to support future 3G services
- Relevant radio network propagation and performance aspects for UL/DL operation within the 2.5 GHz band
- UTRA system requirements for efficiently supporting the 2500 – 2690 MHz band for asymmetric DL operation
- Required changes of current UTRA specifications in order to support efficient operation within the 2.5 GHz band

7.1.1 Expected Future DL/UL Traffic Asymmetry

UMTS Forum Spectrum Aspects Group (SAG) is currently studying the traffic characteristics of future 3G traffic and, based on the results, the possible band plans in anticipation of 2.5GHz licence awards within CEPT during the next 5 years. This new band resulted from WRC2000 where it was concluded that for each ITU region an additional 160 MHz is required of spectrum over and above their present mobile bands, i.e. both 2G bands and those already identified for 3G/IMT-2000. The SAG work is based on market forecasts for different types of mobile voice and multimedia services that have been published during the past two years [7,8].

Some initial studies in SAG [9] indicate that increasing multimedia traffic would drive average asymmetry from today's near 1:1 voice-dominated ratio towards the region of 2.5:1 in favour of the downlink, although it should be emphasised that SAG seeks to establish a methodology rather than to propose actual values. Subsequent SAG analysis [10] accommodated more variation in individual multimedia service asymmetries and their relative price attributes by adopting a Monte Carlo simulation tool which had the effect of lowering asymmetry towards the 2:1 region.

One contribution [6] highlighted the sensitivity of the results to price assumptions for the highly asymmetric Customised Infotainment category by showing that if the relative price was reduced, asymmetry might soar to 12:1.

Clearly, more work needs to be done and agreements reached regarding market assumptions. Furthermore, this traffic asymmetry does not map directly to spectrum asymmetry, especially when downlink capacity might be increased due to HSDPA and potential pseudo-broadcast techniques such as MBMS combined with digital rights management. However there do seem to be some clear trends already emerging:

1) There is a clear bias towards downlink traffic asymmetry of the order of at least 2:1 within the next 6 years – even this is a very high overall figure considering the high level of symmetric traffic in today's 2G bands.
2) The total asymmetry is assumed to be heavily influenced by the cost of delivery (and hence affordability) of mass-market services such as entertainment.
3) The new 3G bands (i.e. WARC '92 and WRC 2000) will likely bear the brunt of asymmetric services and thus must handle these at the lowest possible cost.

Given the apparent market sensitivity to multimedia service cost, it would seem appropriate when considering the use of the WRC 2000 bands to focus heavily on re-use of existing 3G infrastructure. This would allow maximum network scalability and economies of scale to be extracted to provide coverage and capacity at the lowest possible cost of service. If the entire 190 MHz at 2.5GHz were allocated to a VDT UTRA downlink solution, then the resulting 2G (GSM 900/1800) + 3G (UTRA Band I + 2.5GHz) spectrum asymmetry ratio would be in the region of

$$(35 + 75 + 60 + 190) / (35 + 75 + 60) = 2.1 : 1$$

The balance between this spectrum asymmetry and the assumed traffic asymmetry of up to 12:1 would then have to be met through downlink capacity enhancements. Asymmetry would then to a certain degree be self-balancing through market forces and laws of supply and demand. Whilst not a normal or ideal way to balance a network, apportioning all the 2.5GHz band to UTRA downlink might be the only way to maximising coverage of asymmetric capacity at the lowest possible prices needed to stimulate new mass-market multimedia services.

7.1.2 Radio Network Performance Aspects regarding utilization of the 2500 – 2690 MHz Band

In this clause we consider propagation and radio performance aspects related to the UTRA operating efficiency in the 2.1, respective, 2.5 GHz bands.

7.1.2.1 Relevant Propagation Aspects for 2.5 GHz Band

There are no significant differences in the basic physical mechanisms of radio propagation in 2.5 GHz compared with 2 GHz. All effects (PL, diffraction losses, building/wall penetration losses, etc) are understood to scale as a continous function of frequency and thus the basic modeling assumptions concerning radio propagation developed for the 2 GHz band can be re-used without much loss of accuracy.

However, and this is significant for the following discussion, there will be a larger path loss (PL) for the 2.5 GHz bands compared to the 2 GHz . Assuming that the Okumura-Hata (OH) model (see e.g. [5]) is still valid around 2.5 GHz, we can estimate the additional PL from the frequency dependent term in the OH model, *B*log10(f)*, where B = 33.9 [1]:

$$\Delta PL = B * \log 10(2.5/2.1) = 2.57 dB$$

Compared to operation in the 2 GHz bands, also additional cable losses for the 2.5 GHz signal relative to the one around 2 GHz will occur at Node B sites - these are typically in the order of 1 … 3 dB/100 m, depending on the cable type and size. Thus, for cable length of up to 20 m (typical for rooftop installations) the additional cable losses in 2.5 GHz will be in the order of 0.3 … 0.6 dB – these are the values used in the following calculations.

7.1.2.2 Impact of increased PL in the 2.5 GHz band on UTRA UL/DL Cell Coverage

Currently deployed urban UMTS cells are frequently co-sited with existing GSM cells and are typically designed for a coverage target on UL of about 64 – 144 kbps data and for DL of up to 384 kbps data, thus matching the GSM cell footprint with typical PLs of some 150 – 155 dB. Typically an UL load factor of 0.3 … 0.6 is assumed resulting in an equivalent noise rise of some 1.5 … 4 dB. For DL larger load factors of up to 0.8 are frequently assumed. Under these (typical) conditions *the UTRA UL becomes coverage and the DL capacity (or interference) limited*, for a more detailed discussion see e.g. references [4,5].

It is important to note now that the increased PL in the 2.5 GHz band of approximately 3 dB effects the UTRA UL/DL cell coverage limitations. In fact, an additional PL will not affect *an interference limited link* such as the UTRA DL typically is. However, the UTRA coverage limited UL (data coverage being essentially limited by the limited UE Tx power) would be adversively affected by the increased PL if deployed within the new 2.5 GHz band. In order to retain the same cell coverage as in the 2 GHz Band I, additional and costly means to recover this 3 dB PL loss would need to be deployed (e.g. UE with higher power class, smart antenna solutions in Node B, etc).

A more detailed case study analysis has been conducted to illustrate this dynamics and the results are presented in Appendix A. When introducing additional carriers in the 2.5 GHz band to share the DL traffic with the Band I carriers the following observations can be made (see also to Fig.1 in the Appendix A):

- at each DL throughput point, the fractional DL load value is equal for 2.1 / 2.5 GHz carriers, in particular for the pole capacity (DL load = 1). No DL capacity is lost due to the extra PL. This is a consequence from the fact that the DL load equation (see [4], p. 159) does *not* depend on the path loss.
- The introduction of each additional DL 2.5 GHz carrier adds the same DL capacity as a corresponding Band I carrier would do
- The introduction of each additional DL 2.5 GHz carriers increases the achievable DL / UL throughput asymmetry of the system

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[1] This value for B is expected to be larger for 2.5 GHz, thus in here we may underestimate the increase of the PL compared to 2.1 GHz

- There appears to be no need for power compensating the additional 3 dB PL on the 2.5 GHz carrier for *coverage reasons* as there is ample margin for DL coverage available

- As long as the DL / UL throughput asymmetry is high enough, the UL can carry the additional traffic to support the 2.5 GHz carrier with no adverse effect on the cell size / coverage

- Significant DL capacity gains (and thus the DL / UL throughput asymmetry ratios) could be effectively gained by introducing additional carriers in 2.5 GHz. The maximum achievable capacity asymmetry ratio is essentially limited by the amount of spectrum available for DL operation. E.g. the case of deploying the full 2500 – 2690 MHz band for DL operation a ratio of up to 4:1 for DL / UL throughput could be obtained for UTRA (now considering operation in 3G spectrum allocations only).

Considering the desire to operate also future UTRANs supporting operation within the 2500 – 2690 MHz band from today's site grid and to minimize construction of additional sites to compensate for the extra 3 dB PL of a hypothetical UL operation, it appears advantageous to utilize carriers in these new 2.5 GHz bands for DL operation. Operation of DL carriers within the 2500 – 2690 MHz band will not suffer from any propagation related impairments under realistic operating conditions when compared to Band I operation and thus deliver very similar capacity / performance as in the Band I. This effective use of the spectrum can then conveniently be used to increase the available DL / UL throughput ratio of UTRA to meet the expected needs of future 3G services.

7.1.3 Towards an UTRA Standard for supporting DL optimised utilisation of the 2500 – 2690 MHz band

Having noted the motivations of the previous clauses we shall explore in this clause the main avenues a 3GPP standards development UTRA may take in order to support DL optimised utilisation of the 2500 – 2690 MHz band.

In particular, a number of conceptional UTRA system design decisions will need to be made, in order to establish detailed requirements for enhancing the (evolving) 3GPP standards to support DL optimised utilisation of the 2.5 GHz band. On a high level a number of system design issues have been identified, including but not limited to:

- How will the operation of DL physical channels / TrCHs on 2.5 GHz carriers be linked to those residing on UL Band I carriers ?

- What are the supported DL physical channels / TrCHs on 2.5 GHz carriers, in particular CCCHs ?

- What are the supported cell topologies / hierarchy (ie macro/micro/pico cells) when using 2.5 GHz DL carriers in addition to those within the Band I?

- Should a UE be prepared to use *simultaneously* or *alternatively* use a 2.5 GHz DL carrier with/to a DL carrier active in the Band I?

- Should a UE support the same RRC states and state transitions as in the current Band I standard as well in the 2.5 GHz band?

- What additional RRM measurements and RRC procedures are needed for extending existing IFHO mechanisms to include inter-band handovers (IBHO) between the core and 2.5 GHz bands?

In order to find meaningful answers to these questions we suggest consideration and discussion on the overall objectives for UTRA 3GPP standards development in order to support DL optimised utilisation of the 2500 – 2690 MHz band.

7.1.3.1 Overall Objectives for UTRA 3GPP standards development to support DL optimised utilisation of the 2500 – 2690 MHz band

We propose that the following overall objectives shall be taken into account when developing the 3GPP UTRA specifications for supporting DL optimised utilisation of the 2500 – 2690 MHz band:

- No or minimum restrictions in the utilization of services and features available from the (evolving) 3GPP UTRA Band I specifications, including those currently under development (such as e.g. HSDPA). There shall be full flexibility in locating services and features between the core and 2.5 GHz bands primarily limited by the basic capability of UE and Node B to operate in the 2500 – 2690 MHz band (in addition to the Band I).

- Reuse of all standard UTRA TrCH and physical channels in 2.5 GHz DL carriers, including those currently under development (such as e.g. HSDPA). The goal shall be that the required capabilities and mechanisms for

UTRA to operate in the 2500 – 2690 MHz band are *orthogonal* to the features developed for the UTRA Band I specifications, in order to simplify UTRA standards development and minimise adverse affects from feature interactions.

- Possibility to implement the 2.5 GHz DL capability into UE and UTRAN Band I product families at low cost and with comparably small development effort. In particular, it shall be possible for the UE to retain low cost single-receiver architectures (as supported by today's Band I UTRA standard) also for the 2.5 GHz DL enhancement. This is seen as important to migrate mass-market data traffic into the 2.5 GHz band.
- Support for flexible range of achievable DL-UL traffic asymmetry, limited by the available spectrum (up to 1:4 ratio) only
- Spectrally efficient utilization of carriers residing within the additional 2.5 GHz spectrum in order to support increased DL throughput
- No or minimal negative impact (other than the required traffic handling capacity) on the operation and performance of the utilized UL carriers in the Band I
- Smooth evolution of operational Band I UTRANs and operational and network planning practices when utilizing additional 2.5 GHz DL carriers. A 2.5 GHz enabled UTRAN shall not be a "new mode", but an additional capacity enhancing capability which does not require to enter a new significant learning curve. Adding a 2.5 GHz DL carriers to a deployed UTRAN should be an effort comparable to adding an additional carrier in the Band I.

7.1.3.2 Towards a technical framework for extending UTRA to support DL optimised utilisation of the 2500 – 2690 MHz band

We feel that the above overall objectives for development of the 3GPP UTRA standard for supporting DL optimised utilisation of the 2500 – 2690 MHz band can be effectively met when making the following *technical working assumptions* the starting point for further concept development:

1) Each additional 2.5 GHz DL carrier should be seen simply as an additional "other-frequency layer" for DL capacity addition, *matched* to one of the corresponding layers already existing within the Band I. The additional layer(s) within the 2.5 GHz band could thus "mirror" either a macro, micro, or indoor/pico layer implemented in the Band I in a certain geographical area. This concept does *not* support eg a 2.5 GHz DL micro cell matched with a Band I macro cell UL[2], however, there could be a 2.5 GHz micro cell layer coverage-matched to a Band I micro cell layer. Mirroring an existing Band I UL/DL cell footprint/layer in 2.5 GHz, is the key for the simplicity in the areas of

    - Re-using to maximum extent existing UTRA procedures and mechanisms (cell reselection, IFHO, RRM measurements and control); minimal impact on the UTRA standard
    - Ease of radio network evolution; utilization of the additional 2.5 GHz cells is then building on known cell designs / concepts / cell coverage plans and operational practices already available within the Band I UTRAN
    - Full leverage of existing (mostly proprietary) RRM features for traffic management between cell layers

2) VDT is utilized to flexibly pair a carrier within the 2.5 GHz band with a Band I UL carrier; this pairing can be determined by UTRAN based on e.g. UE capabilities, UL/DL load reasons, etc. The UE should not be required to receive at the same time the associated Band I DL carrier other than occasionally monitor eg the CPICH Ec/Io for inter-band HO (IBHO) purposes when instructed so by the UTRAN, in a similar fashion as UTRA currently manages IFHO procedures.

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[2] this is for following reason: for soft HO detection UL and DL cell coverage should be similar, in particular we should be able to derive the need for soft HO from the UL perspective (for interference avoidance) from measurements of CPICH Ec/Io measurements obtained from 2.5 GHz carriers

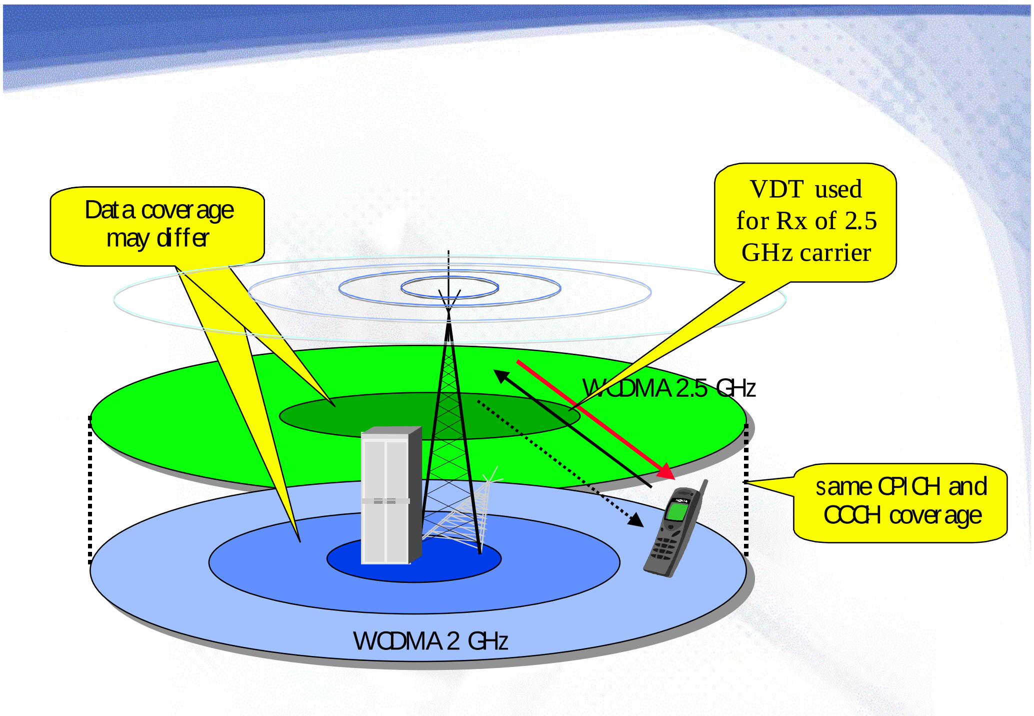

Figure 4

3) The DL 2.5 GHz DL coverage[3] (for the various service bit rates) shall be the same as the coverage of the associated Band I DL. Thus also the Band I coverage of the used UL carrier will be matched and we are able to rely on all the standard UE RRM measurements (CPICH Ec/Io, RSCP, etc) for cell reselection and soft handover purposes.

4) It is assumed that all standard UTRA DL physical and TrCHs (CPICH, SCH, AICH, …; BCH, PCH, FACH, DCH, DSCH, HS-DSCH, etc) can be made available within the 2.5 GHz carriers. Consequently, one is able able to offer

   - The same services and bit rates, whether RT or NRT

   - The same performance enhancing features (eg TxDiv, BF)

   as in the Band I. Also load sharing and trunking gains across the DL bands can be achieved according to the network operators needs.

5) UEs currently camped or active on 2.5 GHz carriers should be able to perform all RRC state transitions (e.g. Cell_FACH <-> cell_DCH) as would be the case on a Band I carrier. This again minimizes the need for additional procedures to distribute traffic between the bands and allows flexible UTRAN controlled distribution of the UE population during RRC connection setup.

The additional 2.5 GHz DL carriers shall be co-located with the associated matching UL / DL carriers within one node B. Thus, we can use all the standard UTRA fast L1 related processing (fast closed PC, any form of L1 related feedback signaling typically carried on DPCCHs) between UL-DL[4]. The philosophy is to treat the additional 2.5 GHz DL carrier just as any other additional Band I carrier, except for the obvious items related to the different carrier frequency. Certainly this list of technical assumptions is neither complete, nor "canonical", however, we believe these are an indication of the kind of items 3GPP would be required to study further when developing an efficient UTRA support for the new 2.5 GHz bands.

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[3] here and in the following with *DL coverage* we mainly refer to the *CPICH Ec/Io* coverage, ie we don't assume the necessarily that the *user bit rate* coverage is the same between the bands. Thus it shall be feasible to offer in either DL band better data coverage than in the other (eg by deploying more efficient schemes such as HS-DSCH).

[4] Otherwise there is either a large impact on 3GPP standard or one would need some RF-over-fiber type of concept for remote RF heads, however, then still all the DL BB processing would to be in same Node B as the UL BB.

7.1.4 Needed Additions to the UTRA Standard for supporting DL optimised utilisation of the 2500 – 2690 MHz band

It is perhaps premature to list the precise impact on the 3GPP UTRA specifications, before the overall system concept has been agreed and stabilized.

However, assuming the UTRAN support for DL optimised utilisation of the 2500 – 2690 MHz band would be build within the framework of Sect. 3.3, the most significant revisions are believed to be required for the following TSs:

TS 25.101 UE Radio Transmission and Reception (FDD)

UE RF requirements for 2.5 GHz band

TS 25.133 Requirements for Support of Radio Resource Management (FDD),

Additional RRM measurements for IBHO

TS 25.104 UTRA (BS) FDD; Base station Radio Transmission and Reception,

Node B RF requirements for 2.5 GHz band

TS 25.304 UE Procedures in Idle Mode,

Extending the cell selection/reselection procedures for to support the 2.5 GHz band

TS 25.331 Radio Resource Control (RRC) Protocol Specification,

"cleaning up" some of the missing parameters in RRC signalling required to fully utilize VDT, e.g. currently only fixed distance duplexing for UL/DL CCCHs is supported

As can be seen from the list, this SI will also impact other WG's than TSG RAN WG4 alone.

7.1.5 Summary of section 7.1 for usage of the new band in 2500 – 2690 MHz in conjunction with the Band I for UTRA

The section 7.1 has presented key system considerations and requirements for 3GPP UTRA standard development towards supporting DL optimised utilisation of the 2500 – 2690 MHz band with the goal to obtain a capacity enhancing complement for UTRA operating in the Band I.

The main findings presented in this section were:

- There appears to be evidence that the nature of future mobile traffic points towards an increased asymmetry of DL/UL traffic volume and that the use of the 2.5 GHz bands to increase DL capacity may be required to sustain these future traffic needs at reasonable a cost

- There appears to be evidence that the use of the 2500 – 2690 MHz band for DL transmission is preferred from the perspective of UTRA radio system performance and propagation related reasons

- It appears entirely feasible to augment the existing UTRA Band I standard in order to support DL optimised utilisation of the 2500 – 2690 MHz band with reasonable work effort effecting the specifications only in a few localized areas (RRM measurements, RRC procedures)

- Use of VDT is an essential technological element in providing this solution

- Such an enhanced the UTRA standard would be able to offer a large degree of DL / UL traffic handling asymmetry at reasonable complexity and cost

7.2 Use of VDT for deployment of public indoor systems

7.2.1 Introduction to the scenario

Figure 5 below shows an example where an indoor system with general public access is deployed in a building within the coverage area of a macro site. When entering the building, handover is provided from the macro cell to the indoor system.

Indoor systems may be required also in the early deployment of WCDMA to improve indoor coverage and/or off-load the macro cells at local hot spots.

Spectrum is a scarce resource. Available spectrum is often needed to serve the wanted wide area traffic. Therefore the indoor cells will normally reuse all spectrum or parts of the spectrum used by the macro site.

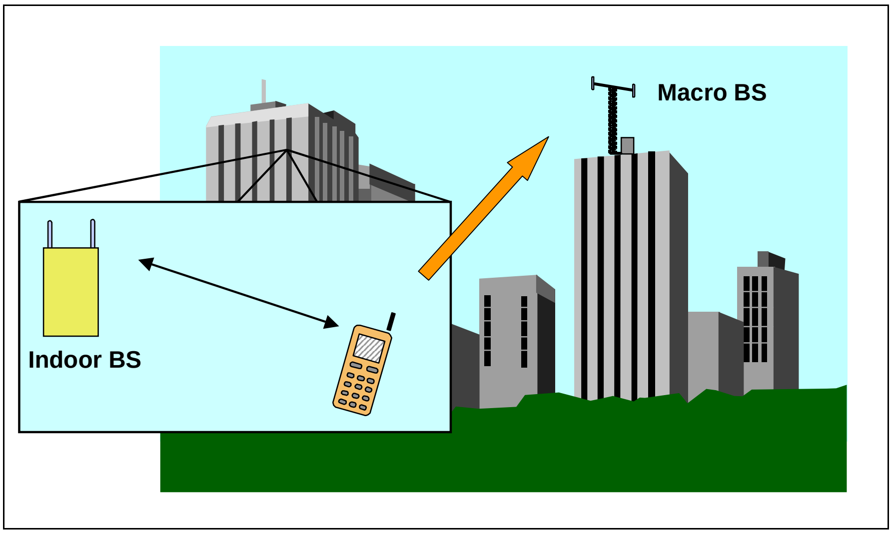

Figure 5: Indoor system for public access within the coverage area of a macro site.

7.2.2 Assumptions for the scenario

The example used in this report is operators with at least a 2x10 MHz license block, enabling 2 UTRA FDD carrier pairs.

For the indoor BSs, each operator will use at least one of the WCDMA carrier pairs that are used by the outdoor macro system, thus providing soft handover between the macro and indoor cells on this carrier. Indoor systems are expected to be mainly deployed in urban areas, but could be introduced also in hot spots surrounded by medium and low traffic areas (e.g. airports and shopping centres located outside of city centres). In an initial phase the deployment of WCDMA is expected to take place as macro sites for coverage, complemented by some limited indoor systems. When traffic increases within the area covered by the macro site, further deployment of indoor systems may be expected to further off-load the macro sites. Once indoor systems are installed, they will not only be able to off-load present indoor users from the macro site, but may manifold multiply the total traffic supported within the area covered by the macro site. Each indoor cell (each building or each floor of a building) is well isolated compared to outdoor macro cells. Therefore the capacity per carrier pair of each indoor cell will be equal to the macro site capacity per carrier pair, if the capacity is code limited, else it may be e.g. twice as high as for the macro site.

This above application of indoor cells is straightforward in non line-of-sight cases, but off-loading will be limited in indoor areas (floors) in line-of-sight from the macro site, since the macro site field strength is dominating there. Designing the indoor system for full off-loading in line-of-sight areas and additionally using the full indoor system capacity in line-of-sight areas may cause increased up-link interference for the macro site. This interference can be eliminated by the use of Variable Duplex Technology.

A scenario without VDT is described in Table 2. The table indicates columns for areas with different average traffic densities from high to low. In each type of area there could be hot spots where an indoor system is beneficial. Dx and

Uy are notations for downlink and up-link carriers. Dx-Ux indicates a coupled pair with the standard duplex separation (190 MHz for band I). The terminology Initial Phase means that providing coverage is most important. Carrier pairs within parenthesis indicate possible application, but the traffic requirements do not require any special measures to protect the macro cell from up-link interference. In the Second Phase traffic requirements increases also for indoor systems. This may lead to increased up-link interference to the macro site. See next section.

Table 2:Scenario without VDT. Dx-Ux are coupled Downlink/Uplink carrier pairs. Pairs in brackets are with limited or no traffic.

Phase	High traffic areas		Medium traffic areas		Low traffic areas		Comment
	Indoor Systems	Macro	Indoor Systems	Macro	Indoor Systems	Macro	
Initial	(D1-U1)	D1-U1 (D2-U2)	(D1-U1)	D1-U1	(D1-U1)	D1-U1	Coverage only. Mainly D1/U1.
Second	D1-U1	D1-U1 D2-U2	(D1-U1)	D1-U1	(D1-U1)	D1-U1	Traffic increases. Indoor Systems are introduced. D2/U2 is added.

7.2.3 UL interference from increased traffic in indoor system

When assessing the impact of additional up-link, UL, interference, it is important to note that the WCDMA macro site capacity normally is downlink, DL, limited for symmetric (speech) traffic. We could furthermore assume that there could substantial asymmetric (internet) traffic as well. This would make the WCDMA capacity even more DL limited when using a symmetric DL/UL spectrum allocation. Thus we could assume that the macro site could stand additional interference on the UL before the macro site capacity is affected.

In the example of Figure 6 below we assume that the macro base station UL could be degraded to about 2/3 of its available capacity before the macro cell capacity is degraded. The figure indicates how the macro site will have full U1 capacity, but when the indoor traffic increases, the U1 capacity in the same macro site may be reduced due to interference. The U1 capacity may for this example be reduced to 1/3 before the macro cell capacity is affected.

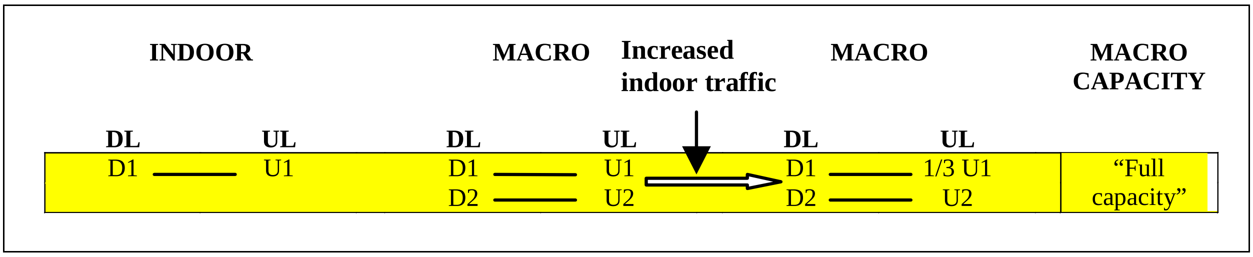

Figure 6: Indoor system for public access within the coverage area of a macro site.

When continuously increased Indoor Systems, traffic degrades the macro cell UL capacity below e.g. 1/3 UL capacity, the remaining U1 capacity may be very small. This is indicated in Figure 7below. The D1-U1 carrier pair cannot carry much traffic any longer, and the resulting total macro cell capacity may approach ½ of its original capacity (in case of two carrier pairs).

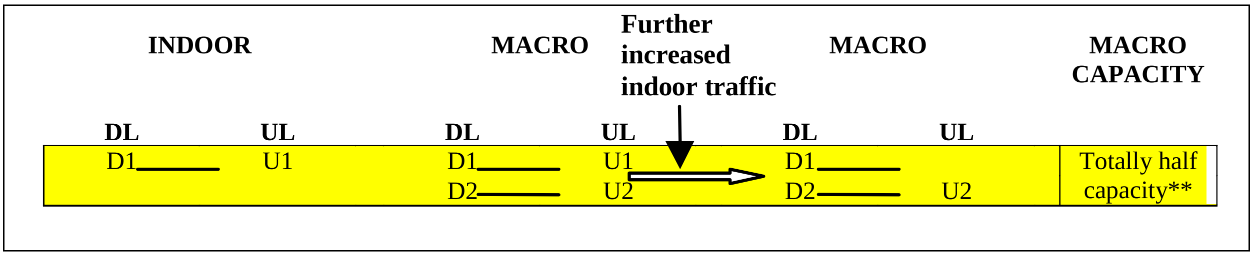

Figure 7: Indoor system for public access within the coverage area of a macro site.

7.2.4 Controlling the UL interference with the use of VDT

A suggested migration path to full utilization of both Indoor Systems and macro cell traffic capabilities is to de-coupling of the macro base station DL/UL frequency associations using VDT as indicated in Figure 4. The D1 carrier is allowed to be associated with U1 and U2.

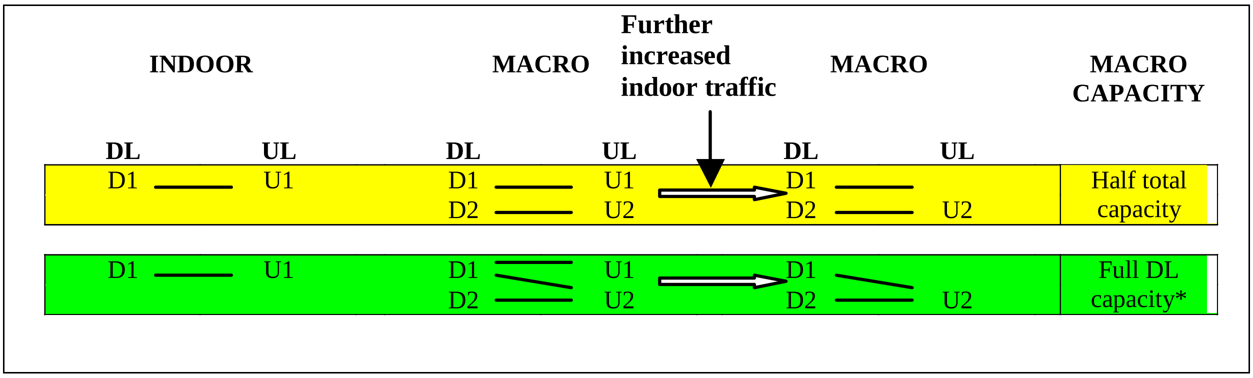

Figure 8: Indoor system for public access within the coverage area of a macro site.

Further increased aggregated indoor traffic may almost block U1. In this case carrier pairs D1-U2 and D2-U2 will carry the macro site traffic. Full macro site capacity equals full total capacity if DL traffic > 2 times the UL traffic, which may be a typical case.

This migration path requires mobiles that can perform handover between cells with different duplex distances. Such functionality is supported by the WCDMA standard.

The concept provides for a mix of handsets with and without VDT during a transition period. Handsets without VDT will in the macro site mainly use D2-U2. (VDT could additionally if wanted also be applied for the indoor system by adding D2-U1).

This solution provides full Indoor Systems and macro cell capacity. The capacity of the indoor systems can be increased as much as wanted by adding equipment (e.g. cell splitting) without damaging the planned macro site coverage.

Table 3 below is an extension of Table 2. The Third Phase with de-coupling of the macro base station DL/UL frequency associations, where macro base stations using carriers D1-U1 and D2-U2 to also support D1-U2, has been added. This phase is relevant when the indoor system traffic (aggregated traffic over the coverage area of a macro site) has further increased, so that the U1 carrier at the macro site is substantially interfered.

Table 3. Scenario with VDT. Dx-Ux are coupled Downlink/Uplink carrier pairs. Pairs in brackets are with limited or no traffic.

Phase	High traffic areas		Medium traffic areas		Low traffic areas		Comment
	Indoor Systems	Macro	Indoor Systems	Macro	Indoor Systems	Macro	
Initial	(D1-U1)	D1-U1 (D2-U2)	(D1-U1)	D1-U1	(D1-U1)	D1-U1	Coverage only. D1/U1 only. Full macro capacity/coverage.
Second	D1-U1	D1-U1 D2-U2	(D1-U1)	D1-U1	(D1-U1)	D1-U1	Traffic increases, need for Indoor Systems. D2/U2 added. Full macro capacity/coverage.
Third	D1-U1	D1-U1 \ D2-U2	D1-U1	D1-U1 D2-U2	D1-U1	D1-U1	Aggregated indoor traffic increases further, add D1-U2 association.Full macro capacity/coverage.

Figure 9 below gives an example of a graphic representation of the three phases of evolution for the macro site traffic on carrier pair D1-U1 shown in Table 3 and Figure 8.

N is the maximum traffic on D1-U1 in the macro site, supposing no limiting interference on U1.

An indoor cell (a building or e.g each floor of a building) is well isolated compared to outdoor macro cells.

Therefore the maximum capacity on D1-U1 is supposed to be between N and 2N at each indoor cell, depending on whether the capacity is code limited or not. In the example of Figure 9 the total aggregated indoor traffic reaches about 6N before the macro site capacity becomes UL limited. At further increase of indoor traffic the D1-U1 macro site traffic would approach zero, unless the D1 is de-coupled to allow D1-U2 pairing as shown in figure 8 and table 3.

The 6N break point is arbitrary. It could be much higher when all indoor systems are designed without trying to "force" off-loading the LOS parts of the building. NLOS areas could carry e.g. 20 N or higher aggregated traffic from several systems, without affecting the macro site. However, a single indoor system close to the macro site, where users on LOS floors are “forced” to connect to the indoor system, and the full indoor system capacity is utilized, could severely affect the macro site UL.

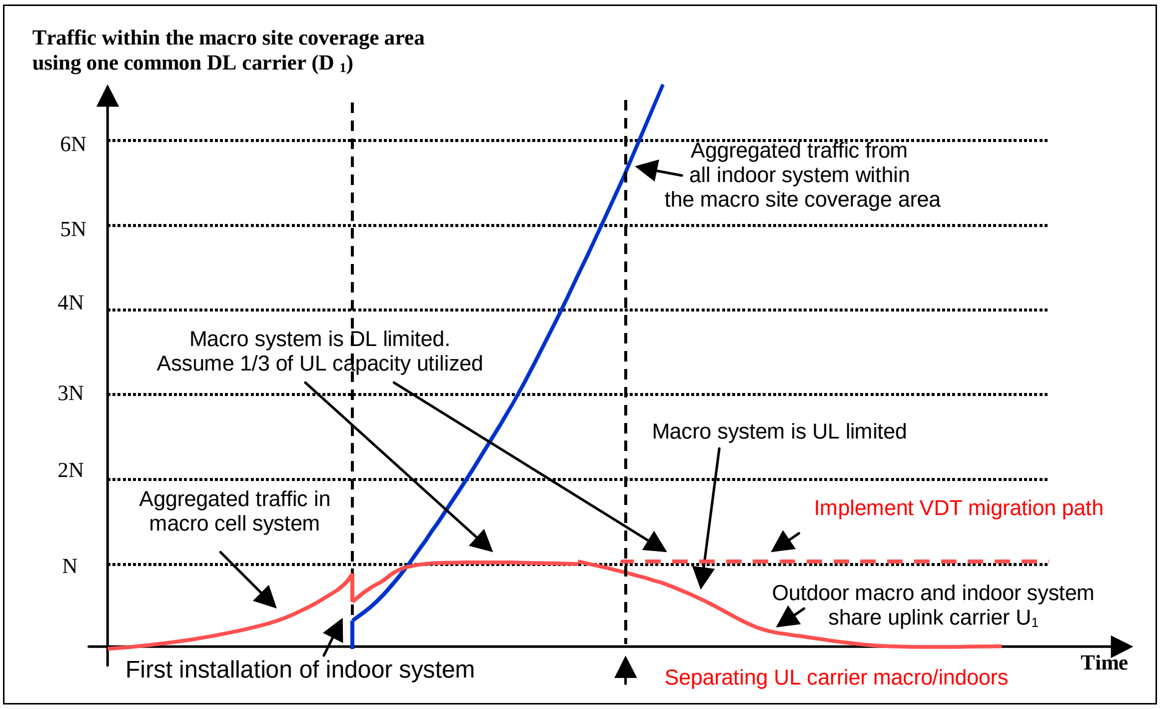

Figure 9. Example of traffic evolution for the macro site and the indoor systems within the coverage area of a macro site.

7.2.5 Summary of the use of VDT for deployment for public indoor systems

This section 7.2 describes one opportunity for using VDT in a scenario with macro and indoor cells using a common set of carrier frequencies. A prerequisite for the method to be implemented is that the Variable Duplex Technology has been developed and ready to be used in commercially available terminals.

The method suggests a de-coupling of the nominal up-link and down-link carrier associations, to provide full off-loading of macro cells and utilising the full additional capacity provided by indoor cells. VDT is implemented allowing for two downlink carriers to be coupled to one up-link. As a result, a serving macro base station can be capable of manifold multiplying the total traffic within a WCDMA macro cell area.

As a summary, the main objectives of the proposed method using VDT is to:

- give improved spectrum utilisation
- provide capacity of the indoor systems, that can be increased as much as wanted by adding equipment (e.g. cell splitting) without damaging the planned macro site coverage
- admit for a smooth transition of cellular network when traffic increases

7.3 UL/DL usage of the new band in 2500 – 2690 MHz in conjunction with the Band I for UTRA FDD

7.4 UL/DL plus additional DL usage of the new band in 2500 – 2690 MHz in conjunction with the Band I for UTRA FDD

7.5 The use of UTRA TDD in the 2500-2690MHz band

8. Recommendations

1) Do not require terminals to accommodate several band pairings. This is left to the discretion of the UE manufacturers in consort with the operators.
2) Because of the additional losses in the Rx and Tx parts, further study for Rx and Tx RF performance is required before specifications can be finalised for UEs accommodating several band pairings.
3) Choose between having the terminals implementing variable duplex separation on a frequency block basis or on a frequency channel basis.
4) Further studies are required on possible solutions for signalling to terminals the system duplex configuration.
5) Develop protocol to allow a UE to declare if it can operate in more than one band and what are the bands in which it can operate.

9. Open issues

- How can the requirements for the 2.5 GHz band be addressed?
- How can the requirements for the frequency band asymmetry be addressed?
- Feasibility of UL next to DL allocations with flexible positions?

10. Conclusion

Annex <A>: Impact of increased PL in the 2.5 GHz band on UTRA UL/DL Cell Coverage

Under typical operating conditions of currently fielded UMTS networks, the UL becomes *coverage* and the DL *capacity* (or interference) limited, for a more detailed analysis please refer to e.g. references [4,5].

This fundamental dynamics can be read off from Fig. 1 when comparing the load curves marked "Uplink path loss" respectively "Downlink path loss_all_traffic_in_2.1GHz" for a single carrier reference case operating in the Band I. The cell is UL coverage limited at 153 dB PL achieving an UL throughput of 1000 kbps corresponding to a load factor of 0.6. However, the DL capacity limit (here as example: load factor of 0.78, giving 700 kbps throughput) is reached *before* the UL reaches it's load limit of 0.6. On the other hand, there is ample margin for DL *coverage* compared to the UL, here approximately 8 dB. Also we note from Fig. 1, that the *asymmetry ratio* DL / UL throughput is only 0.7, i.e. the DL has only 70% of the UL capacity.

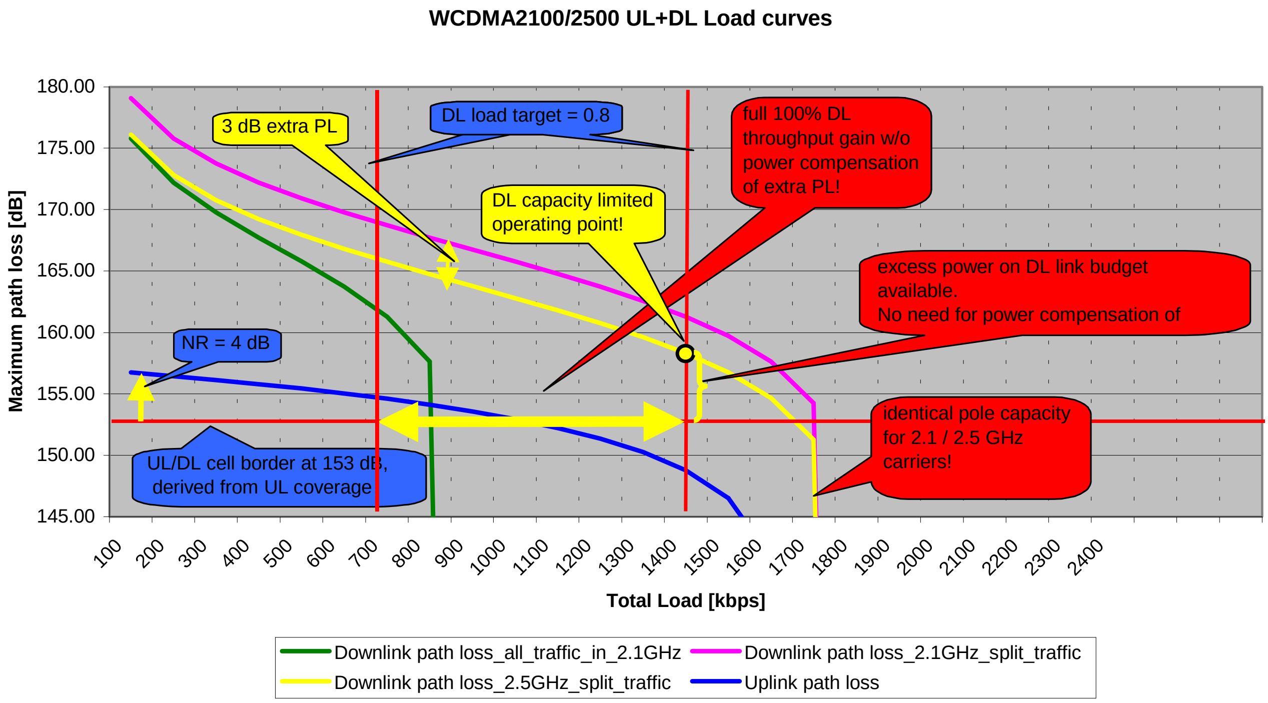

Figure A.1: UL/DL Load Curves for UTRA Operation in 2.1/2.5 GHz band

Figure A.1 also shows how the increased PL in the 2.5 GHz band of approximately 3 dB effects to the UL/DL cell coverage limitations by introducing an additional carrier in the 2.5 GHz band and splitting the DL load equally between these 2 DL carriers. The following observations can be made:

- at each throughput point, the fractional DL load value is equal for 2.1 / 2.5 GHz, in particular for the pole capacity (DL load = 1). No DL capacity is lost due to the extra PL. This is a consequence from the fact that the DL load equation (see [4], p. 159) does *not* depend on the path loss.

- The introduction of the additional DL 2.5 GHz carrier doubles the DL capacity

- The introduction of the additional DL 2.5 GHz carrier doubles the DL / UL throughput asymmetry

- There appears no need for power compensating the additional PL on the 2.5 GHz carrier for coverage reasons as there is ample margin for DL coverage available (5 dB)

- As long as the DL / UL throughput asymmetry is > 1.4 (for this example), the UL can carry the additional traffic to support the 2.5 GHz carrier with no adverse effect on the cell size

The following parameters were assumed in preparing Figure A.1:

Table A.1: Uplink parameters

UL_EbN0_dB	1.5
UL_Cable_loss_dB	2
UL_Other_cell_interference	0.65
UL_load_factor	0.6

Table A.2: Downlink parameters

MS_noise_figure_dB	9
MS_antenna_gain_dBi	0
Peak_to_average_path_loss_dB	6
EbN0_dB	5.0
DL_load_factor	0.78
Orthogonality	0.5
Other_cell_interference	0.65
Antenna_gain_dBi	18
Common_channel_OH	15%
Common_channel_OH_2.5GHz	15%
Cable_loss_dB	2
Body_loss_dB	0

Table A.3: Parameters for 2.5 GHz

additional_Cable_loss_dB	0.4
additional_Path_loss_dB	2.57
additional_Comb_loss_dB	0

Annex <X>: Change history

TSG RAN WG4 #23: Version 1.0.0 approved to be presented to TSG RAN #16

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**