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March 26, 2004

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth Street, SW
Washington, DC 20554

Re: Amendment of Parts 1, 21, 73, 74 and 101 of the Commission's Rules to Facilitate the Provision of Fixed and Mobile Broadband Access, Educational and other Advanced Services in the 2150-2162 and 2500-2690 MHz Bands -- WT Docket No. 03-66; Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, including Third Generation Wireless Systems – ET Docket No. 00-258.

Notice of Ex Parte Presentation

Dear Ms. Dortch:

On Friday, March 26, 2004, the undersigned, together with Roger Quayle and Jim O'Connor, as representatives of IPWireless, Inc. ("IPWireless"), met with the following staff members of the Wireless Telecommunications Bureau regarding the above-captioned proceedings: John Muleta, Catherine Seidel, Uzoma Onyeije, Tom Stanley, Jennifer Tomchin, Greg Vadas, Nancy Zaczek, Mary Woytek and Stephen Zak. The issues discussed and the views expressed by representatives of IPWireless are set forth in the attached presentation and exhibits.

Should you have any questions regarding this matter, please contact the undersigned.

Sincerely,

Gray Cary Ware & Freidenrich LLP

/s/ Larry A. Blosser

Larry A. Blosser
lblosser@graycary.com

cc: WTB Staff Attendees listed above

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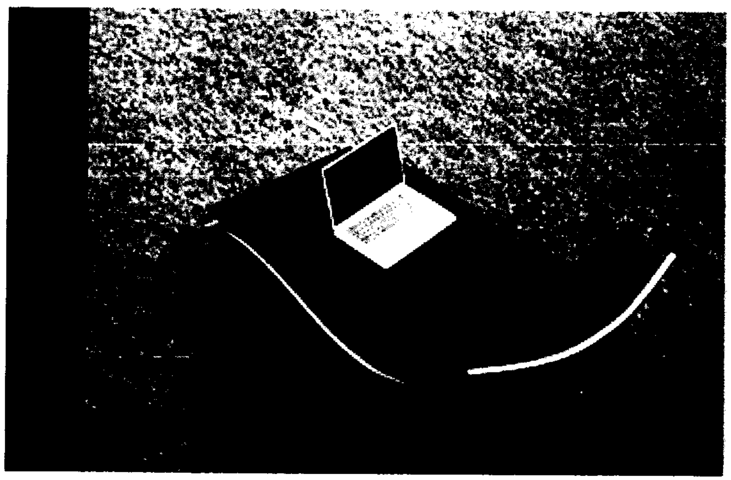


Presentation to FCC
March 2004

Overview

- TDD benefits
- The Importance of International Harmonization of TDD allocations
- TDD opportunities in the 1710 – 2200 MHz band
- TDD opportunities in the 2500 – 2690 MHz band
- TDD and FDD coexistence
- Comments on 2.5 GHz NPRM

TDD offers significant benefits which will be denied US consumers unless TDD spectrum is allocated in the 1700 – 2200 MHz band.

- TDD infrastructure and CPE are at the leading edge of 3G technology, deployed commercially and providing services today, at peak downlink throughput of 12 Mbps per sector with 10 MHz allocation.
- TDD is ideally suited to carry Internet traffic - asymmetry can be efficiently supported by TDD. FDD results in underutilized uplink spectrum.
- TDD efficiently supports packet-based traffic, including Internet traffic, IM and VoIP.
- TDD devices are smaller and use less power than equivalent FDD devices.

Reason for international support for TDD is the advantages of TDD over FDD.

- Better supports the asymmetrical transmission characteristics of broadband.
- Flexible (easier to find unpaired frequency than properly paired frequency for FDD).
- Supports competition/entrance of new companies/small entrepreneurial business.
  - For example, much easier for small business to gather TDD spectrum to operate in 2.5 GHz band than FDD frequency.

TDD Technology is already deployed successfully around the world (data & Voice)

- Successful TDD technologies include:
  - TD-CDMA (IMT-2000 WAN mobile broadband wireless data)
  - PHS – many millions of users (Japan, China)
  - DECT
  - 802.11a/b/g (unlicensed portable/fixed broadband wireless data)
  - GSM (CPE is TDD based)
  - Proprietary solutions (primarily developed in the U.S.)
- Currently active and/or recently announced broadband TDD deployments include U.S., New Zealand, Portugal, South Africa, Germany, Malaysia, U.K., Mexico, Canada.

UMTS TDD has Broad Global Support

- Global UMTS TDD Alliance (GUSTA)
- Recently formed group with goal of promoting IMT-2000, UMTS TD-CDMA technology development and deployment.
- 18 operators from 5 continents
  - Airdata (Germany), AtlasOne (Malaysia), IPMobile (Japan), IQ Networks (Australia), Kite Networks (US), Mobicom (Mongolia), Net2Cell (Ireland), Nextwave (US), Sentech (S. Africa), Softbank (Japan), SonaeCom (Portugal), Askoran (Kazakhstan), Whoosh Wireless (New Zealand)
- Vendors and support companies
  - Andrew, Axcera, Fastcomm, InCode Telecom, IPWireless, MRiC, Possio, Samsung, UTStarcom.
- Web site: www.UMTStdd.org

TDD Spectrum Worldwide

- ITU Recommendation ITU-R M.1036-2 identifies TDD spectrum allocation possibilities in the following bands:

  1880 – 1930 MHz, 2010 – 2025 MHz, 2500 – 2690 MHz

- Of the 6 bandplans identified in Table 2 for 1710 – 2200 MHz, 5 comprise TDD allocations which overlap one or both 1910 – 1920 MHz and 2020 – 2025 MHz.
- Note 3 to Table 2 indicates that "TDD may be introduced in unpaired bands and also under certain conditions in the uplink bands of paired frequency arrangements and/or in the center gap between paired bands."
- Over 120 major European and Asian operators hold TDD spectrum allocations in the 1900 – 1920 MHz and 2010 – 2025 MHz bands, including:

  Vodaphone, T-Mobile, Eurotel, KPN, Orange, Telefonica, SonaeCom, STET Hellas, Sonera, France Telecom, SFR, Radiolinja, Swisscom, PTC, Polkomtel, Cellcom, etc. See Exhibit 1 for listing.

TDD Spectrum Harmonization

- The U.S. has NO TDD allocation which overlaps the TDD spectrum in 1710 – 2200 MHz identified by the ITU.
- Harmonized worldwide TDD allocations offer many benefits:
  - Lower cost infrastructure due to economies of scale
  - Lower cost, smaller CPE – single band CPE instead of dual and triple band CPE required for worldwide roaming
  - Single CPE delivers both voice and broadband data
- IPWireless believes the following bands offer the greatest potential for harmonized TDD allocations and asks the FCC to consider designating all or parts of them for TDD use:

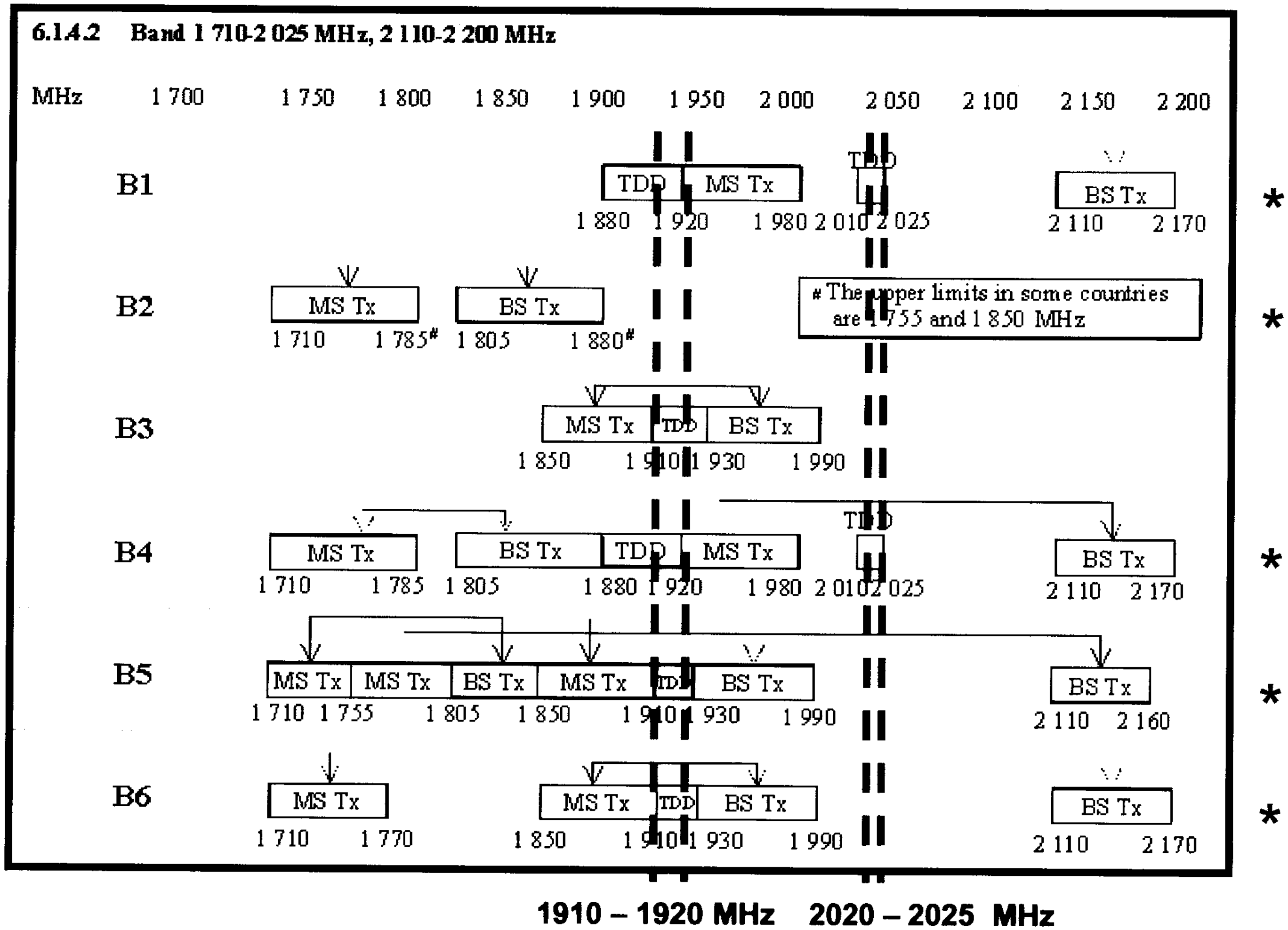
1910 – 1920 MHz, 2020 – 2025 MHz, 2.5 – 2.69 GHz

Absent harmonized TDD allocations, the US consumer may not benefit fully from TDD technology

- As shown in Europe and Asia, TDD allocation adjacent to FDD allocations allow the established mobile carriers to deploy TDD in conjunction with FDD to reduce deployment costs through equipment sharing.
- While up to 35 MHz has been allocated to TDD in spectrum adjacent to 2G or 3G FDD allocations in Europe and Asia, the U.S. has no TDD allocations near current or planned 2G/3G FDD allocations.
- IPW and its partners have shown that TDD and FDD can coexist and share spectrum, and that operators are motivated to do so in order to save deployment capital and operating costs.

Harmonization Scenarios

ITU M.1036-2: 1710 – 2200 MHz Recommendations



* Five of Six bandplans include a TDD allocation

The total US TDD allocations in the 1700 – 2200 MHz band should be on par with EMEA region allocations, which are typically 20 – 35 MHz

- The opportunities outlined earlier in this report would total only 15 MHz of TDD spectrum.
- IPW believes that the US consumer would benefit from additional spectrum being allocated to TDD, given the proven substantial advantages that TDD offers for IP-based data and voice traffic. Candidate bands available in the US include:

  1990 – 2000 MHz, 2155 – 2180 MHz
- Both opportunities above were identified in AWS proceeding, ET Docket 00-258.
- In addition, IPW believes that TDD can be deployed in the PCS band, utilizing the PCS uplink band for traditional TDD and using the PCS downlink band for "Auxiliary Downlink" which is downlink-only mode for capacity enhancement of the primary carrier in the PCS uplink band.

1990 – 2000 MHz

- This band is a logical candidate for TDD especially if the 1910 – 1920 MHz band is also allocated to TDD, enabling two mobile data operators (10 MHz each) or 4 new operators (5 MHz each).
- This allocation could allow an existing PCS operator to offer advanced data services with excellent economics, since antenna sharing would be possible with adequate filtering on the PCS transmitter.
- TDD operations in this band would be subject to noise interference from the PCS "C" band downlink in some situations such as uncoordinated site co-locations, although the C band is relatively unused and this interference could be cured by better filtering on the C band base stations.

2155 – 2180 MHz

- This band is an excellent adjunct to the AWS FDD allocations in 1710 – 1755 MHz (UL) and 2110 – 2155 MHz (DL).
- An operator in the AWS FDD band deploying a UMTS 3G technology could benefit from equipment sharing between compatible FDD and TDD systems, whilst using the TDD and FDD systems to support different application using the air interface technology best suited to that application.
- As per the 1990 – 2000 MHz band, site sharing and antenna sharing is possible with available filtering on the FDD base station transmitter.
- The FCC should consider including a 5 MHz TDD allocation with each AWS FDD allocation, as has been done in Europe for the 3G UMTS allocations.

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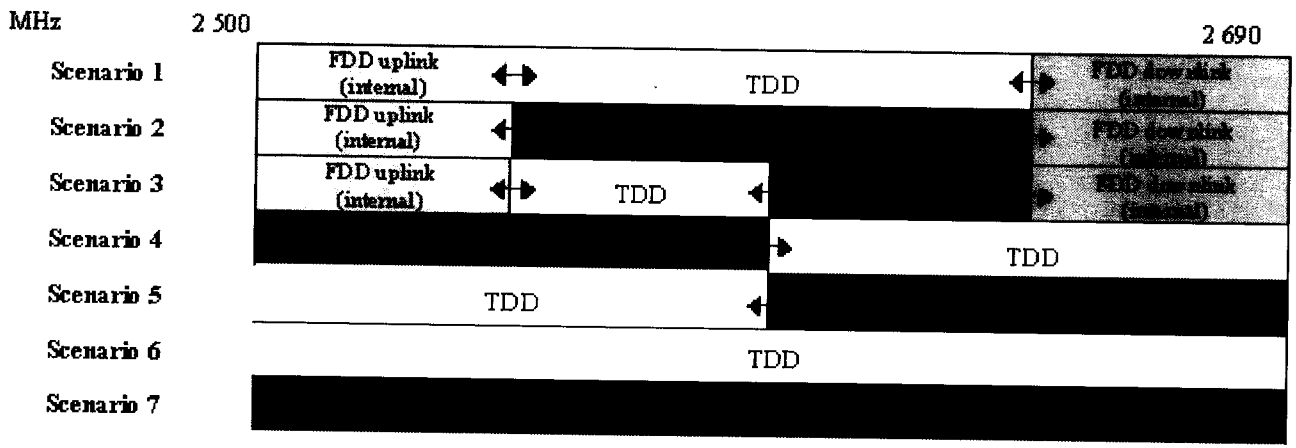
Harmonization Scenarios

ITU M.1036-2: 2500 – 2690 MHz Scenarios

6.1.4.3 Scenarios for the band 2 500-2 690 MHz



- As discussed in detail later, the ITFS/MMDS band offers great potential for global TDD harmonization.
- TDD is already being deployed in the 2.5 – 2.69 GHz band in the US, Mexico, Canada, Germany, Malaysia, and other countries.

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2.5 – 2.69 GHz

- Designated as an expansion band in Europe for UMTS 3G systems.
- Offers great harmonization potential worldwide as this spectrum is underutilized and typically used for antiquated broadcast of analog TV if and when it's actually in use.
- Operators in the U.S., Mexico and Canada are deploying TDD systems in this band.
- Coalition White Paper proposal for interference mitigation is flexible, efficient and practical, allowing operators to tailor the filtering and isolation requirements depending on the use of the adjacent block.

2.5 – 2.69 GHz continued

- IPW suggests that the FCC adopt the flexible use spectrum concept of WCA/NIA/CTN coalition as it presents the best potential for immediate widespread deployments and future global harmonization with the bandplans in ITU-R M.1036-2.
- IPW believes that TDD and FDD can coexist if the emission masks suggested by the WCA/NIA/CTN are implemented.
- Exhibits 2 and 3 demonstrate that sufficient filtering for both Tx and Rx is possible with current technology.
- Acceptable receiver blocking performance can be achieved with the addition of outboard filtering on an as-needed basis.

U.S. allocations to match international allocations

- 1910-1920 MHz.
- 2020-2025 MHz.
- Flexibility in the 2.5 GHz band.
  - Allowing operators to coordinate with future TDD allocations planned internationally for the band.
- Additional opportunities at 1990 – 2000 MHz and 2155 – 2180 MHz to place TDD next to FDD allocations, as is common in other regions to allow infrastructure sharing.

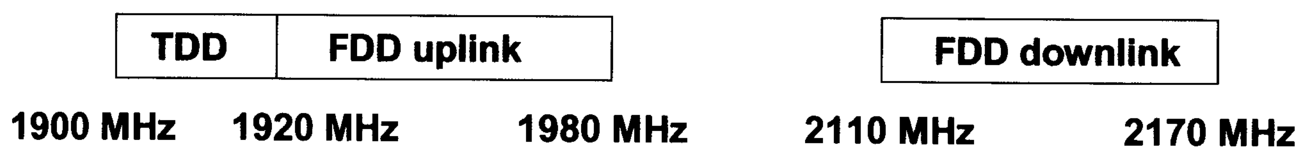
TDD and FDD Coexistence

- FCC should move away from FDD centric regulation now that TDD is a deployment option.
- Allowing TDD to co-exist with FDD is in line with FCC policy to promote more efficient use of spectrum.
- Large operators oppose TDD in U.S. for competitive reasons.
- Tier 1 vendors often oppose TDD for competitive reasons.
- Technology allows co-existence, and will allow greater co-existence in the future, particularly if regulation moves to more equality between FDD and TDD.
- CTIA and large operators which have filed to argue TDD can't co-exist with FDD have not done the testing.
  - IPW has done the testing, with Nortel in France (see Exhibit 3)
  - Extra filtering cost is minimal compared to the public benefits.
- Internationally TDD is operated next to FDD without preventing either FDD or TDD operation.

TDD can coexist with FDD and vice versa

- Concerns about TDD and FDD coexistence are based on typical FDD base station equipment performance, which has been designed for low cost in an FDD-only environment.
- IPWireless has conducted coexistence testing with Tier-1 vendors and operators and concludes that TDD and FDD coexistence is possible with available technology.
- Exhibit 2 documents the results of coexistence testing for the European 3G TDD and FDD allocations

European 3G Spectrum Allocation



- TDD and FDD coexistence can be facilitated by FCC-imposed transmitter emission restrictions, and industry-imposed receiver performance requirements.

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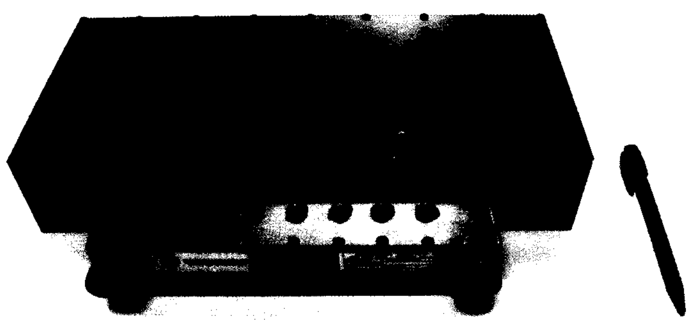
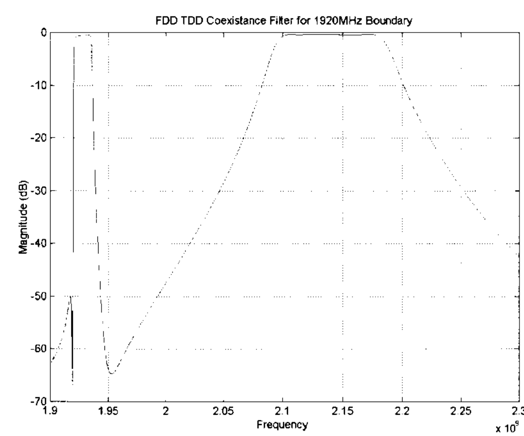
Coexistence: *1910 – 1920 MHz*

- IPW has shown in coexistence testing that low power TDD cellular systems can coexist and be co-sited with adjacent FDD cellular systems. These results can be extended to the US 1.9 GHz band.
- This allocation would allow an existing PCS operator to offer advanced data services with excellent economics, since antenna sharing would be possible with available filtering. Greenfield deployment by a new operator is also economical.
- Recommended parameters:
  - TDD BTS transmit power: maximum +37 – 40 dBm
  - TDD BTS adjacent channel power: - 80 dBm
  - Minimum coupling loss: assume 45 – 48 dB
- Result: TDD noise in the FDD UL band is below the noise floor.
- See Exhibit 2 for detailed analysis of UMTS TDD and FDD coexistence in adjacent channels.

Coexistence: *1910 – 1920 MHz continued*

- IPW ships European TDD BTS for 1.9 GHz band with the Tx filter specified previously (cost ~ $700), coupled with antenna isolation the FDD Rx is protected.
- IPW has sourced the FDD Rx filter required in extreme cases (immediate adjacent channel, cosited BTS) to prevent FDD Rx blocking. See graph and picture below.
- IPW and Andrew have developed a duplexer to allow Antenna Sharing between UMTS FDD and TDD BTS. See Exhibit 4.





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Coexistence: *2020 – 2025 MHz*

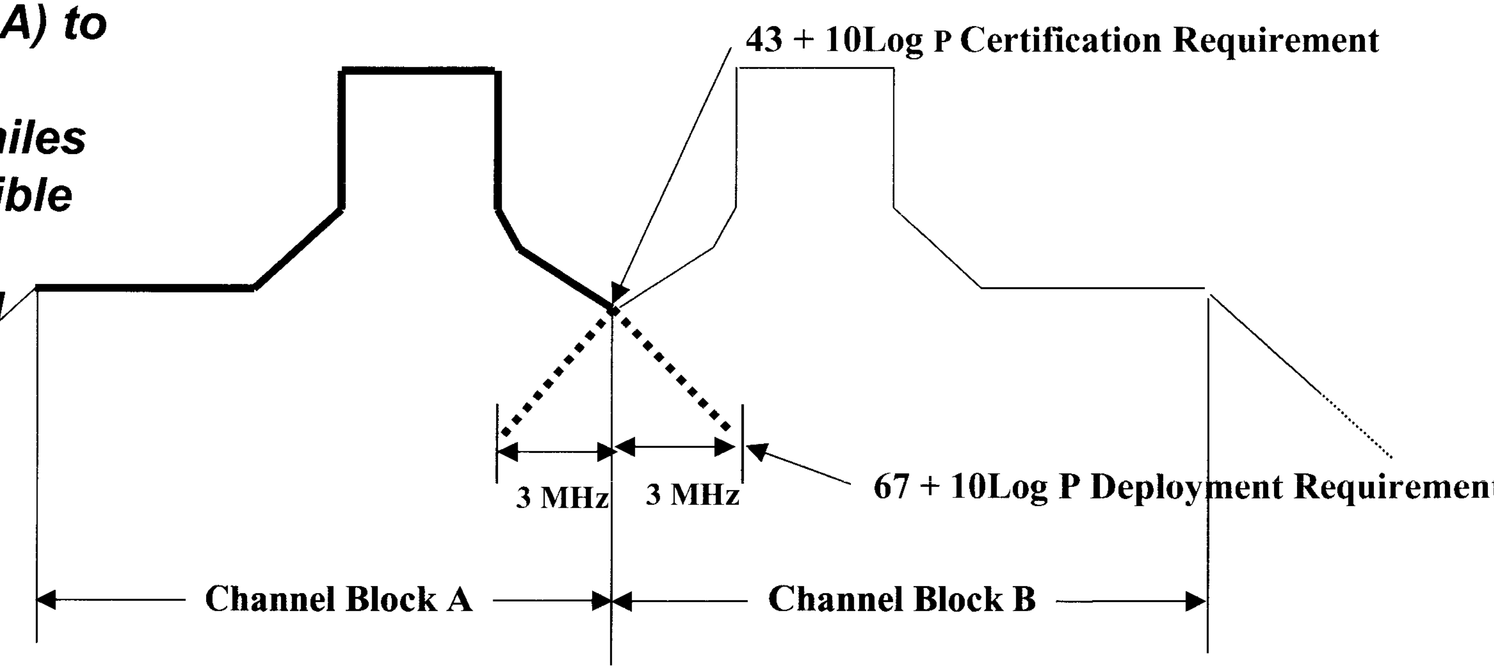
- TDD, with parameters identical to those mentioned for the 1910 – 1920 MHz band, can coexist with a variety of disparate non-cellular systems.
- This band offers potential for global roaming due to the existence of allocation in the EMEA region.

Coexistence: 1990 – 2000 MHz, 2155 – 2180 MHz

- TDD next to FDD downlink requires additional filtering on the FDD base station.
- Similar power level and attenuation requirements on the FDD BTS as for the case of TDD next to FDD uplink.
- Co-siting and antenna sharing possibilities are facilitated by available filtering for both the FDD BTS and the TDD BTS (to avoid receiver blocking).
- Regulatory approach for the Tx mask, and industry approach for the Rx performance specifications will result in TDD and FDD equipment that can coexist.

WCA/NIA/CTN Coalition Base Station Spectral Mask for 2500 – 2690 MHz band

•When:
a) BTS (operator A) to BTS (operator B) distance > 0.92 miles
b) Two Incompatible Technologies
c) Uncoordinated Operations



- Effectively creates a 6 MHz shared transition region to ease filtering requirements.
- 43 + 10logP certification is per PCS rule 24.238, –13 dBm in 1 MHz measurement bandwidth
- 67 +10logP is triggered on demand by adjacent channel operator
- Additional attenuation required if distance < 0.92 miles

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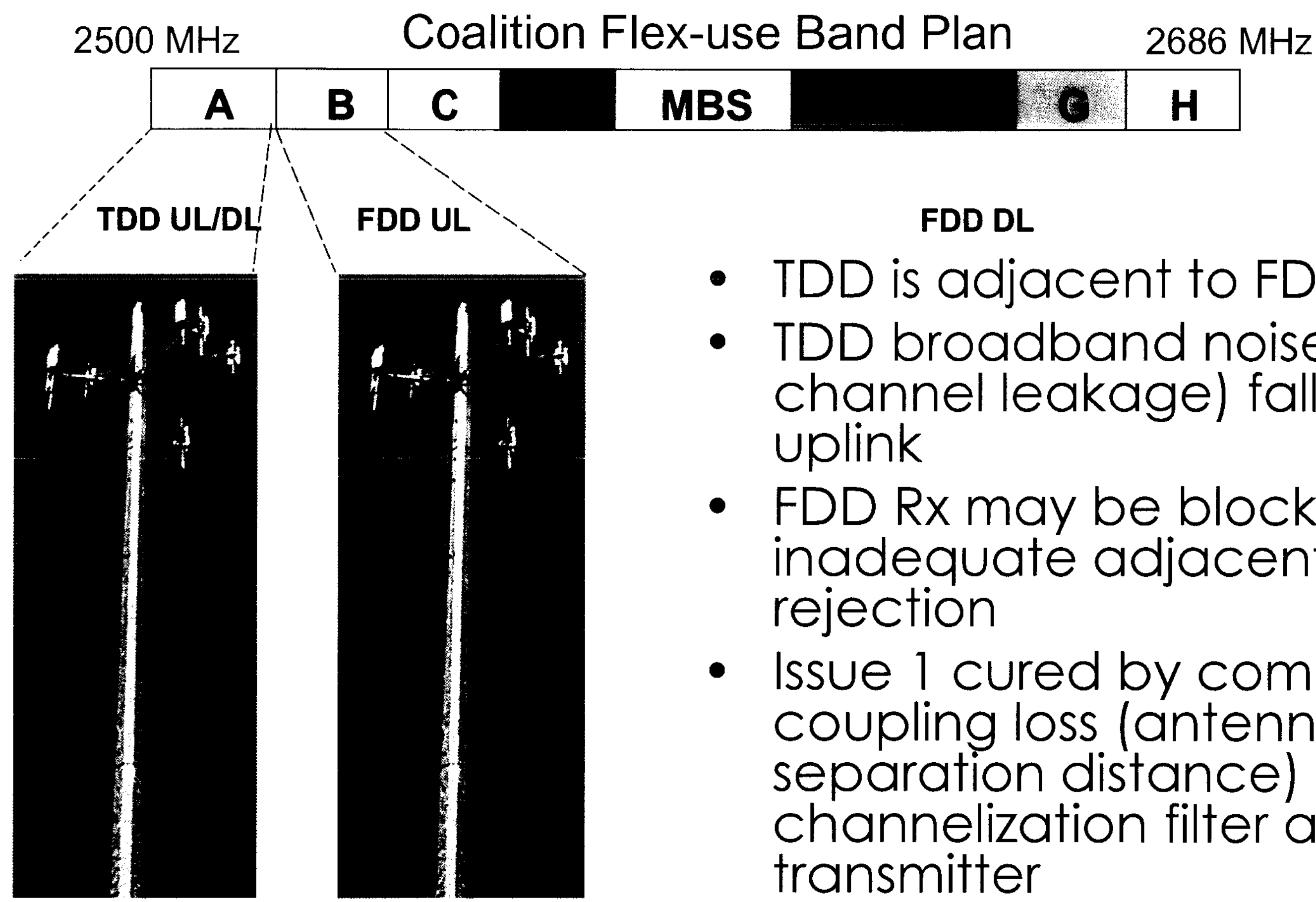
Flexible Use Spectrum Scenario 1



- TDD is adjacent to FDD Uplink
- TDD broadband noise (adjacent channel leakage) falls into FDD uplink
- FDD Rx may be blocked due to inadequate adjacent channel rejection
- Issue 1 cured by combination of coupling loss (antenna separation distance) and/or channelization filter at transmitter
- Issue 2 cured by combination of coupling loss and/or channelization filter at the receiver

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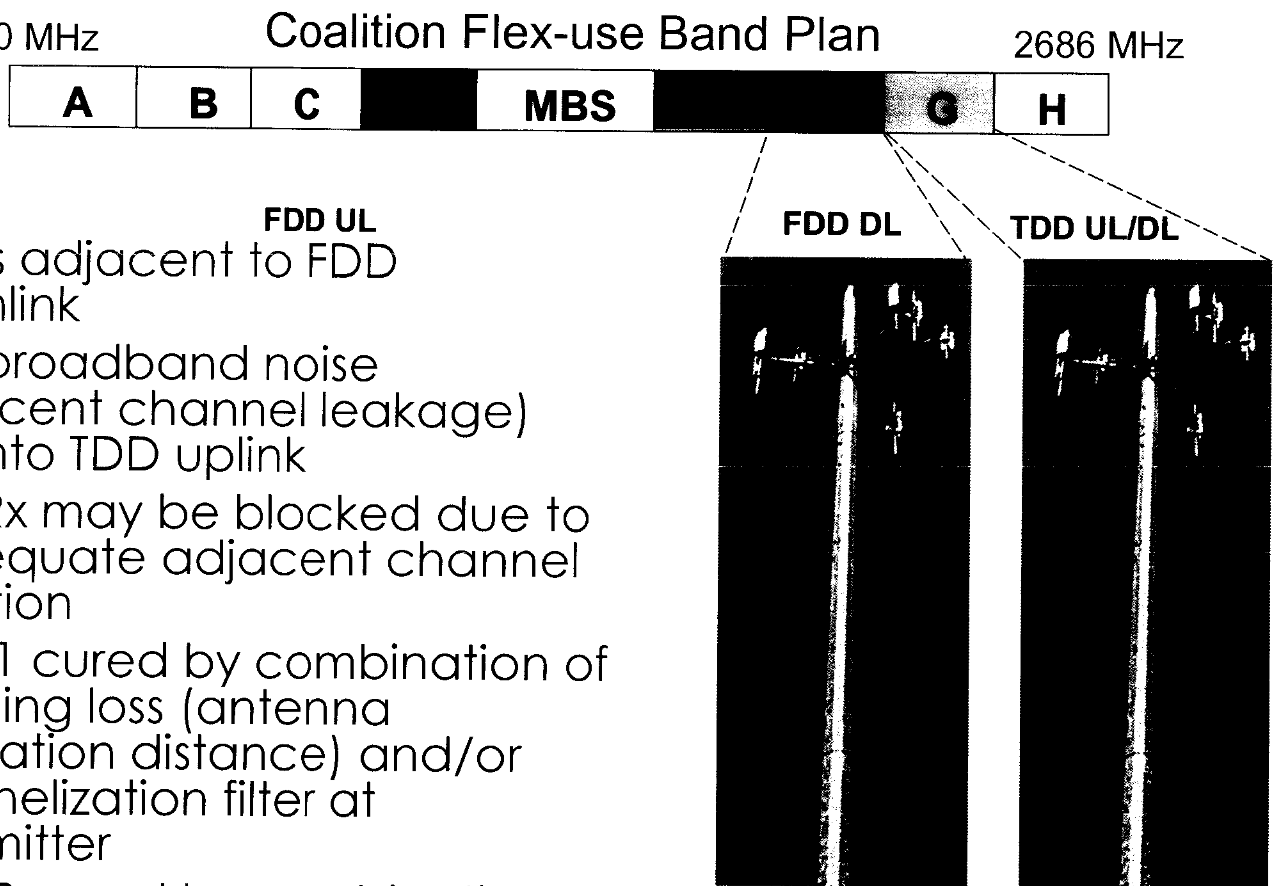
Flexible Use Spectrum Scenario 2



- TDD is adjacent to FDD Downlink
- FDD broadband noise (adjacent channel leakage) falls into TDD uplink
- TDD Rx may be blocked due to inadequate adjacent channel rejection
- Issue 1 cured by combination of coupling loss (antenna separation distance) and/or channelization filter at transmitter
- Issue 2 cured by combination of coupling loss and/or channelization filter at the receiver

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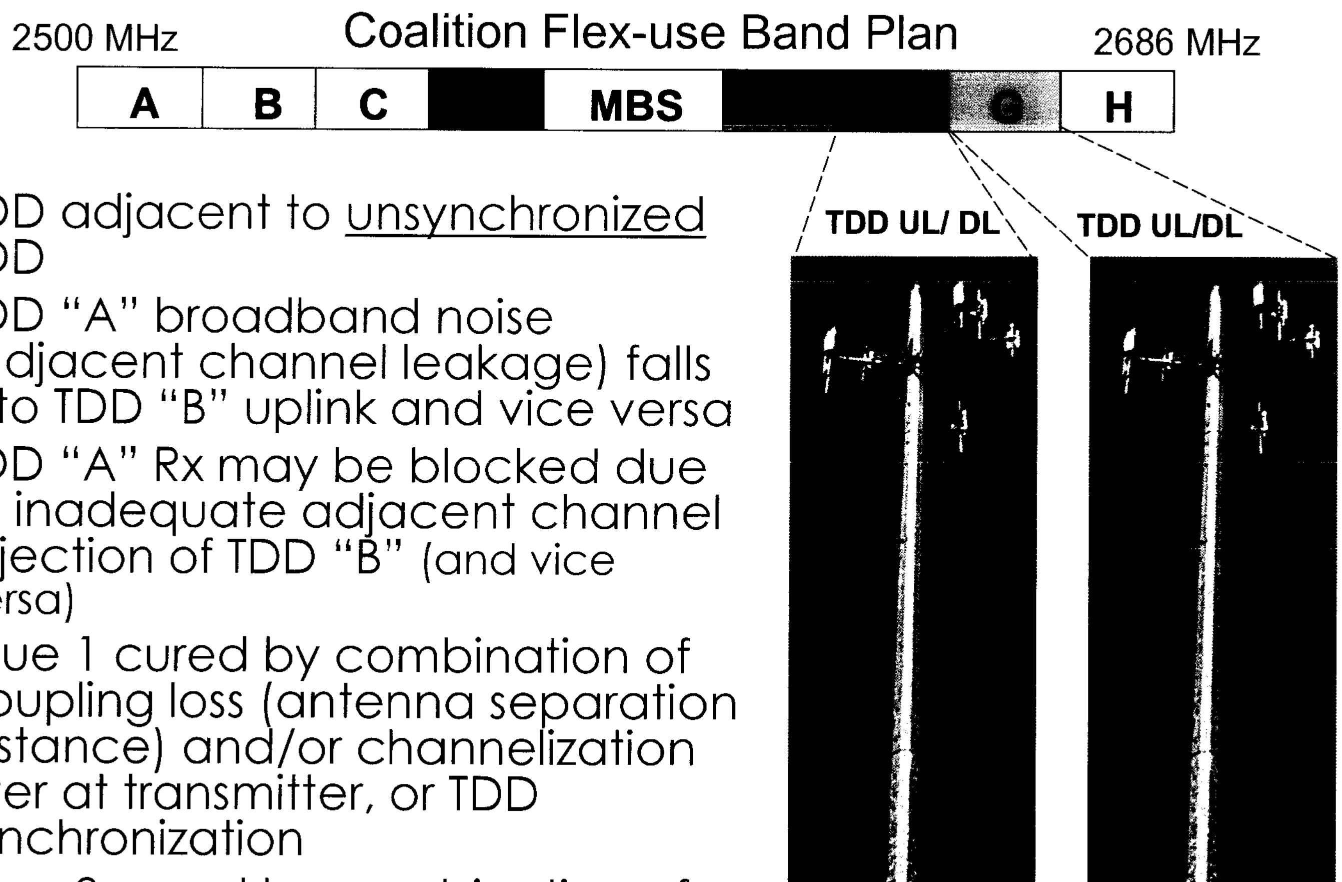
Flexible Use Spectrum Scenario 3



- TDD adjacent to <u>unsynchronized</u> TDD
- TDD "A" broadband noise (adjacent channel leakage) falls into TDD "B" uplink and vice versa
- TDD "A" Rx may be blocked due to inadequate adjacent channel rejection of TDD "B" (and vice versa)
- Issue 1 cured by combination of coupling loss (antenna separation distance) and/or channelization filter at transmitter, or TDD synchronization
- Issue 2 cured by combination of coupling loss and/or channelization filter at the receiver, or TDD synchronization

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Summary

- The US lacks any TDD spectrum allocation which overlaps the ITU TDD allocations of ITU-R M.1036-2.
- At least 20 MHz of TDD spectrum in the 1700 – 2200 MHz band should be allocated in the US, to put the US on par with EMEA region countries.
- TDD offers significant benefits to consumers and operators.
- Testing and deployments have shown that TDD and FDD BTS can coexist using available conventional filtering.
- IPWireless has identified several possible locations for TDD allocations in the spectrum bands that the FCC is currently contemplating new assignments.
- The ITFS/MMDS band proposals by the White Paper Coalition facilitate harmonization with future EMEA TDD allocations.
- TDD deployments in the US, Canada and Mexico in the ITFS/MMDS band have already started, thus TDD allocations must be preserved in the forthcoming Report and Order.

Issues Relating To NPRM (APRIL 2, 03)

- A band plan with high power at the top rather than in the middle should be considered.
- One channel of each for channel group (A4, B4, C4, D4, E4, F4, G4) would be tentatively designated for high power operation and moved to the top of the band.
- A guard channel of 6 MHz is then tentatively assigned below the high power channels.
- The owner of the channel (e.g. C4) can then opt out of high power video transmission and instead opt for low power " cellular" transmission.
- With the opting out C4 is moved down below the guard band to the top of the Upper Band with the guard channel moved up to be between C4and the remaining high power transmissions at top of band.
- If more than one channel is initially opted out (e.g B4 and D4 along with C4) these channels would then be put above the Upper Band and below the guard band in alphabetical order (B4 lowest and D4 highest).
- If a channel is opted out after the initial opting out period it moves above all channels previously opted out and below the guard band.

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Advantages of Proposed Plan

- Provides a way to have a gradual conversion from high power to "cellular".
  - The Coalition plan does not provide for opting out in a way that a opted out channel would be useable for low power.
- An opted out channel at the top of the Upper Band could be paired with a Lower Band channel for FDD, or used for TDD, whereas if the same opting out approach was take under the Coalition Middle Band plan only TDD would be possible on the opted out channel.
- Only one guard channel is needed; more frequency is available for use.
- The 6 MHz "saved" can be shared across channels so each low power channel becomes 5.75 MHz rather than 5.5 MHz as in the Coalition proposal.
- Creates a buffer between low power operation and interfering aeronautical/radiolocation band above 2.7 GHz.
- Response channels could be positioned at very top of band as guard band to protect high power.
- Provides 138 MHz of flexible use spectrum which can be coordinated by operators with future international TDD/FDD designations.

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Tight Construction Deadlines to Prevent Warehousing of Spectrum

- Unlike most other frequencies the history of the 2.5 MHz spectrum has one of extremely delayed deployment.
- More stringent construction requirements are therefore required than in many other frequency bands.
- The construction deadlines proposed by IPW are reasonable under these circumstances.

TDD Spectrum Holders in Europe, the Middle East and Africa (EMEA) in the 1900-1920 MHz band

3G Blue
Airtel Móvil
Ålands
Amena
Bouygues Telecom
Cellcom
Centretel
CosmOTE
Dutchtone
EMT
E-Plus
EPT
Europolitan
Eurotel
France Telecom
Group 3G
HI3G
IPSE
KPN
Latvijas Mobilais
Libertel
LuXcommunications
Max.mobile
MobilCom
Mobilkom
Mobiltelefon
Mobitel
Netcom GSM
O2
Omnitel
One2One
Oni way
Optimus
Orange
Panafon
Partner
Pele-phone
Polkomtel
PTC
Radiolinja
SFR
Sonera
Song Networks
STET Hellas
Sunrise
Suomen 3G
Swisscom
Tango S.A.
TDC Mobile
Team 3G
Tele2
Telecel
Telefónica Móviles
Telenor
Telia
Telia Mobile
TIM
TMN
T-Mobil
VIAG
Vodafone D2
Vodafone Ireland
Wind
Xfera

TDD Spectrum Holders in Asia/Pacific Region (Partial List)

Chunghwa Telecom
CKW Wireless (Aust)
CSL (Hong Kong)
HI3G (Hong Kong)
MobileOne (Singapore)
Optus (Australia)
SmarTone 3G (Hong Kong)
Starhub Mobile (Singapore)
STM
SUNDAY 3G (Hong Kong)
Vodafone (Australia)
Taiwan Cellular
Taiwan PCS
Telecom NZ
Telekom Malaysia
UMTS (Australia)
Vodafone NZ
Yuan-Ze Telecom

Current Worldwide Trials and Commercial Deployments of TDD Systems in the 1900-1920 MHz and 2010-2025 MHz Bands

Country	**Band**	**Number of Operators**
Singapore	1900-1920 MHz	2
Malaysia	2010-2025 MHz	1
Japan	2010-2025 MHz	2
China	1900-1920 MHz 2010-2025 MHz	1 1
United Kingdom	1900-1920 MHz	3
Germany	1900-1920 MHz	1
France	1900-1920 MHz	1
Italy	1900-1920 MHz	2
Ireland	1900-1920 MHz	2
Spain	1900-1920 MHz	1
Portugal	1900-1920 MHz	1
Austria	1900-1920 MHz	1
Czech Republic	1900-1920 MHz	1

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TDD and FDD Coexistence Issues for 3GPP-compliant Technology in the 1.9 GHz UMTS Band

INTRODUCTION

In any coexistence problem between adjacent channel radio systems there are two things that need to be controlled

1. The ACLR or ACP (Adjacent Channel Power) of the Interferer
2. The ACS or Blocking of the Victim

The out-of-band power of the interferer that is in-band for the victim is controlled by 1 (the victim has no control over this because it is in-band for it). The in-band power of the interferer that is out-of-band for the victim is controlled by 2 (the interferer has no control over this because it is in-band for it). So a system can only exert control over its out-of-band issues.

Both ACLR/ACP and ACS/Blocking of interferer or victim are specified in standardisation. However, the standards which are written at the conception of a technology give only an indication of what can be achieved in the final technology. The final technology may fall short of or exceed these specifications by significant margins. Consequently, it is important to look at what has been achieved in practice especially when projecting the experience with a deployed standard in an existing allocation onto a new allocation. This is particularly the case for the existing UMTS core and future extension bands.

In the UMTS core bands the TDD allocation 1900-1920MHz is immediately adjacent to the FDD Uplink allocation 1920-1980MHz.

With this particular allocation there is potential for interference

- TDD Node B to FDD Node B; TDD DL to FDD UL
- FDD UE to TDD UE; FDD UL to TDD DL

The Node B to Node B problem is the more critical as it could prevent co-siting and antenna sharing if one system were to interfere with the other. Analysis of the impact of this problem yields to deterministic analysis.

The UE to UE problem is less critical as it happens to individual UEs in special circumstances and therefore may only cause a minimal effect on capacity. Analysis of the impact of this requires probabilistic analysis.

It is clear that to eliminate the interference between TDD and FDD measures need to be taken on both technologies. Any measures taken will have some impact on equipment cost. At the time that the 3GPP standards were initiated TDD was perceived to have a secondary role to FDD such that the interference measures imposed by the standards on TDD were stringent and FDD were lenient. This is mainly true of the specifications for the Node Bs contained in TS25.104 (FDD) and TS25.105 (TDD). The specifications for the UEs TS25.101 and TS25.102 are essentially the same but are lenient to ensure low terminal cost.

So the key question for new UMTS bands is not do the standards indicate that co-siting is possible but does the existing deployed equipment permit co-siting in a commercially viable way. The practical reality should drive the decisions made for any new allocations because if this can be achieved today it could be bettered tomorrow and certainly by the time these allocations are used. This approach is critical as the alternative to interference measures is guard bands or wasted spectrum which is not acceptable especially if technology makes this unnecessary.

The scenarios are broken down into their component parts in the following sections and each is analysed in the light of practical equipment performance to answer the questions where the stringent requirements on TDD achieved and where the lenient requirements on FDD exceeded such that the problems were solved.

TDD NODE B to FDD NODE B

Introduction

In the 3GPP specifications for TDD and FDD where interference is the consideration there are three categories of specifications generally referred to as

1. Minimum requirement
2. Operation in the same geographical area
3. Co-located base stations

In the following discussion it is the co-located base stations category that is considered in detail for obvious reasons.

TDD Node B ACLR/ACP

Standards situation

There are various specifications for the ACLR in TS25.105 but those that are of relevance here are "Requirement in case of co-siting with FDD BS operating on an adjacent channel". The relevant sections from R99 of TS25.105 are copied below for ease.

If a BS provides multiple non-contiguous single carriers or multiple non-contiguous groups of contiguous single carriers, the above requirements shall be applied to those adjacent channels of the single carriers or group of single channels which are used by the co-sited FDD BS.

This is specified such that an FDD Node B should experience a 1dB of noise rise with a minimum coupling loss between the TDD interferer and the FDD victim of 30dB.

ACP	-80dBm
Minimum Coupling Loss	30dB
Resulting Interference	-110dBm
FDD Noise Floor (4dB NF)	-104dBm
Noise Rise	**1dB**

A coupling loss of 30dB is typical of two separate antennas in the same radome. A coupling loss of 45-48dB is more typical of separate antennas on the same mast. This figure is used by many operators as the default.

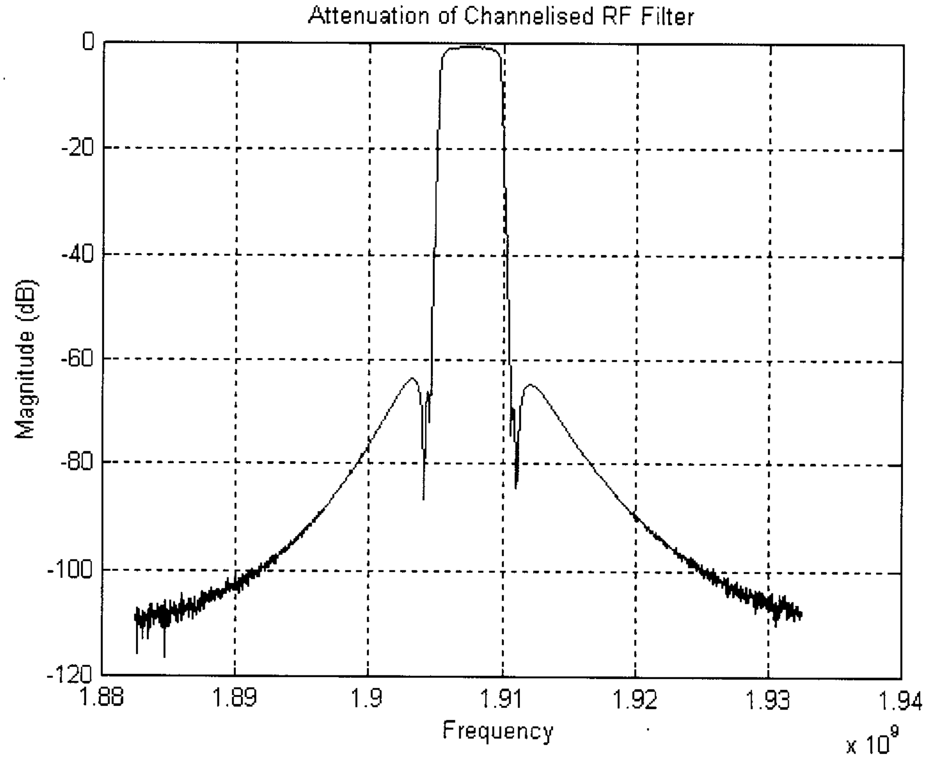
In this case the standard provides for adequate protection however we must determine whether it is feasible to meet these specifications.

Practical reality

An absolute ACP of -80dBm in the adjacent channel may initially appear a very difficult requirement to meet. However it has been achieved in commercial TDD equipment that is deployed now. As the requirement is an absolute requirement it is eased by a modest reduction in transmit power, from +43dBm to +37dBm. The specification is then achieved through careful control of spectral re-growth in the HPA in combination with a channel or band specific RF filter at the output of the HPA as detailed below.

Transmit Power	+37dBm
ACLR after HPA	-57dB
ACP after HPA	-20dBm
RF filter rejection	>-60dB
ACP	**<-80dBm**

The response of a typical RF filter used for this purpose is given below. This filter is constructed using conventional, low cost technology and incurs minimal insertion loss.



These components are easily installed integral to the Node B.

Note the incorporation of such a filter improves both ACLR on transmit and ACS on receive by 60dB. Indeed this allows interference free co-siting of unsynchronised adjacent channel TDD systems with a minimum coupling loss of 30dB.

Conclusion

The TDD ACLR/ACP specifications in the 3GPP standards are adequate to ensure no interference in co-siting. Furthermore, they can be met in practice with minimal cost impact.

FDD Node B ACS/Blocking

Standards situation

There is a note on the blocking requirement for FDD in the TDD bands TS25.104 stating "The current state-of-the-art technology does not allow a single generic solution for co-location with UTRA-TDD on adjacent frequencies for 30dB BS-BS minimum coupling loss." Thus the general blocking specifications apply. These require tolerance to a signal of -40dBm. However, these are only relevant for carrier separations of greater than or equal to 10MHz therefore the ACS specifications apply for a carrier spacing of 5MHz. These require a tolerance to a signal of -52dBm. In both cases the wanted signal is -115dBm which is 6dB higher than reference sensitivity or -121dBm. Therefore these represent a 6dB noise rise or in linear terms the interference is 3x the thermal noise. If we assume the FDD Node B noise floor is - -104dBm (4dB NF) then the interference is 5dB higher than this -99dBm. For less than 1dB noise rise the interference must be -110dBm so these specifications need to be adjusted by 11dB e.g. -63dBm @ 5MHz and -51dBm @ >=10MHz. For comparison the blocking specification for the GSM1800 bands is +16dBm (also defined for a 6dB noise rise). The relevant sections from R99 of TS25.104 are copied in Appendix B for ease.

Practical reality

A blocking specification -63dBm (5MHz) or -51dBm (>=10MHz) for an FDD Node B in the TDD bands is not designed to allow co-siting as the required minimum coupling loss will be excessive. However, the question is whether this can be and is exceeded in practice and whether the actual blocking specification of FDD equipment would allow co-siting of TDD with FDD.

Actual blocking measurements have been performed in generic programs with co-operative partner FDD vendors and indirectly as part of co-siting tests on UMTS operators FDD networks. These experiments have been performed on seven different FDD vendors equipment and across all TDD channels in the core UMTS bands. These measurements have been averaged to protect confidentiality and are summarised below.

TDD channel	TDD signal level for 1dB noise rise in 1922MHz FDD UL
1900MHz – 1905MHz	-9dBm
1905MHz – 1910MHz	-17dBm
1910MHz – 1915MHz	-27dBm
1915MHz – 1920MHz	-37dBm

Note these are from 26dB to 42dB better than the default specification.
Also note these improve dramatically as the FDD UL is increased above 1922MHz.

There are strong design reasons why this might be the case.

- The RF duplexor roll-off is aggressive achieve the blocking specification for GSM1800 (lower side of TDD). Note the amount of additional attenuation provided for by this depends on the TDD channel as this response is fixed.
- FDD Node B ACS is improved to protect against the dead spot problem, FDD UE to FDD Node B interference. Note the amount of additional attenuation provided for by this depends on the FDD channel as this response is tunable.

This results in the following minimum coupling loss for a TDD transmit power of +37dBm.

TDD channel	Minimum coupling loss from TDD to 1922MHz FDD UL
1900MHz – 1905MHz	46dB
1905MHz – 1910MHz	54dB
1910MHz – 1915MHz	64dB
1915MHz – 1920MHz	74dB

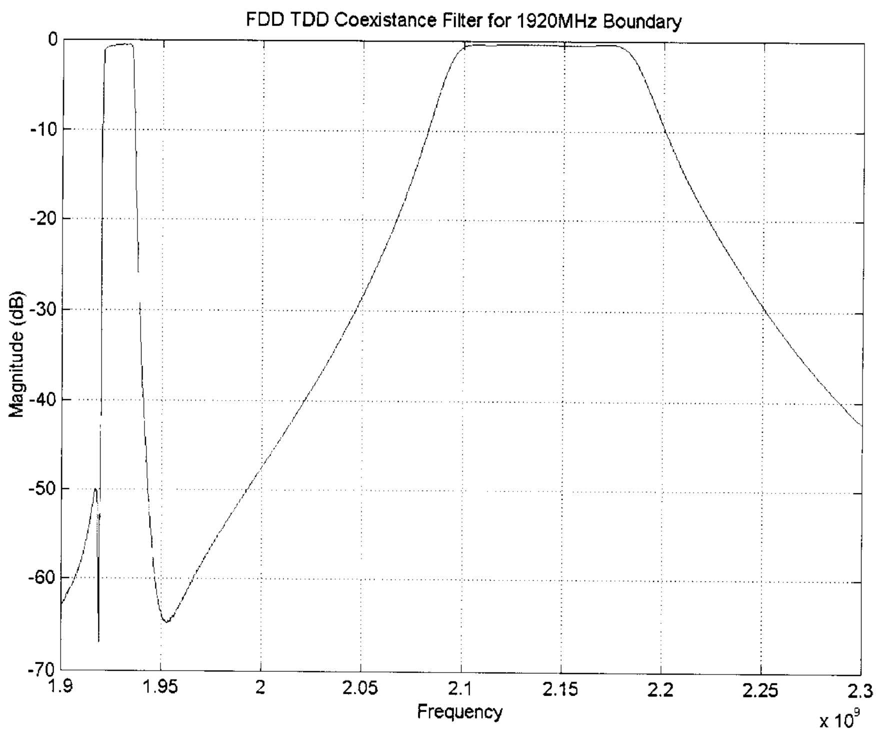
Note the minimum coupling loss required reduces dramatically as the FDD channel is increased in frequency, a 20MHz separation reduces minimum coupling loss by ~15dB. Consequently, TDD can be co-sited with FDD for all operator combinations of allocations TDD and FDD in the UMTS core bands except for the combination that sits either side of the boundary assuming the following site engineering guidelines for the coupling loss for separate antennas on the same mast.

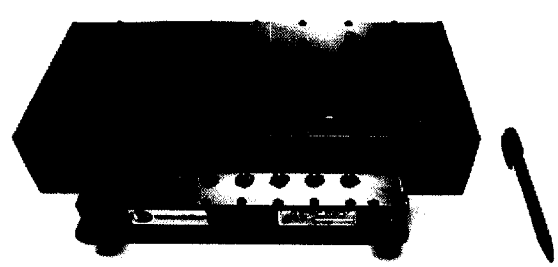
Antenna configuration	Coupling loss
Dual antennas in the same radome	30dB
Default separation on the same mast <1m	45-48dB
Careful separation on the same mast >1m	55-65dB

Indeed, the minimum coupling loss required is such that antenna sharing is feasible with a duplexor component designed to provide the necessary minimum coupling loss to protect against both aspects TDD ACP and FDD blocking. The specification of such a standard duplexor component from Forem (Andrew Corp) is given in Appendix C. This duplexor is constructed using conventional low cost technology and incurs minimal insertion loss.

Providing the minimum coupling loss required for the combination of allocations that sits either side of the boundary it is not feasible with antenna separation alone.

However, additional filtering can be applied to the FDD Node B to allow this. The response of such a filter is shown below. This filter provides minimal insertion loss to the lowest three FDD UL channels and all FDD downlink channels whilst providing 50dB rejection of the TDD channels which is sufficient rejection for co-siting with 30dB minimum coupling loss. This filter is constructed using conventional low cost technology and incurs minimal insertion loss. Thus, even for this allocation co-siting is possible if desirable.





FDD Coexistence Filter

Finally, additional protection is provided for in MHAs deployed with FDD systems. MHAs have a curious position with respect to standards as they not technically specified by the standards and therefore are not usually considered in co-existence studies yet they are almost universally deployed in UMTS FDD networks. Being the first system component after the antenna they are the key component in co-existence analyses. These MHAs contain duplexor components to separate the FDD uplink and downlink. Several of these are designed to provide up to 50dB rejection in the TDD channels.

Conclusion

The FDD ACS/Blocking specifications in the 3GPP standards are not adequate to ensure no interference in co-siting. However, these specifications can and are being exceeded in practice to such and extent that co-siting and antenna sharing is feasible now.

Overall Conclusion

The overall conclusion of the results presented here is that the existing collective 3GPP specifications do guarantee that co-siting of TDD and FDD in the core bands is feasible. Specifically the TDD specifications are stringent but can be met in practice and the FDD specifications are lenient or non-existent but are exceeded in practice such that co-siting and antenna sharing feasible. This is feasible without any special measures for all TDD channels except the 1915MHz-1920MHz and it can be facilitated even for this channel with additional filtering on the FDD Node B which is technically and economically viable.

FDD UE TO TDD UE

Introduction

The question of UE-UE coexistence is a complex one as it necessarily involves probabilistic analysis. It is not the aim of this paper to perform such analyses because that has been done elsewhere but to just simply examine the validity of the assumptions used in such studies by looking at the 3GPP specifications in the light of practical UE performance.

FDD UE ACLR/ACP

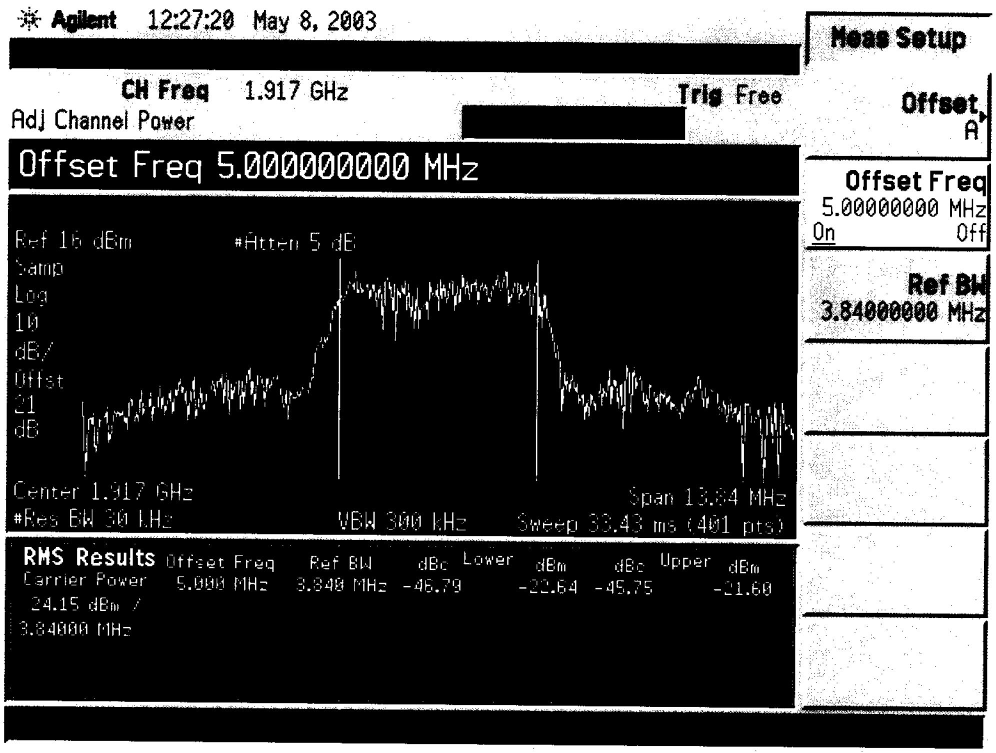
Standards situation

The ACLR specifications of both FDD UEs in TS24.101 and TDD UEs TS25.102 are the same and summarised state that the ACLR must be less than -33dB in the first adjacent channel and less than -43dB in the second adjacent channel. This reasonable as these devices will be designed and manufactured in a similar way and are therefore subject to the same technical and economic constraints. Moreover as these devices use the same UMTS components (filters and PAs) and pass the same 3.84Mcps signals at the same power levels their performance is likely to be identical. The only exception to this being the duplex specific components (duplexors switches and circulators) but these are unlikely to impact this performance aspect.

Practical reality

Due to the unavailability of FDD UE results and the similarities identified above only TDD UE practical performance is presented here.

The figure below shows a measurement of -46dBc in the first adjacent channel @ +24dBm transmit power (measured with 21dB atten). This is 12dB better than the 3GPP specifications.



The figure below shows a measurement of -64dBc in the first adjacent channel @ +24dBm transmit power (measured with 21dB atten). This is 21dB better than the 3GPP specifications.

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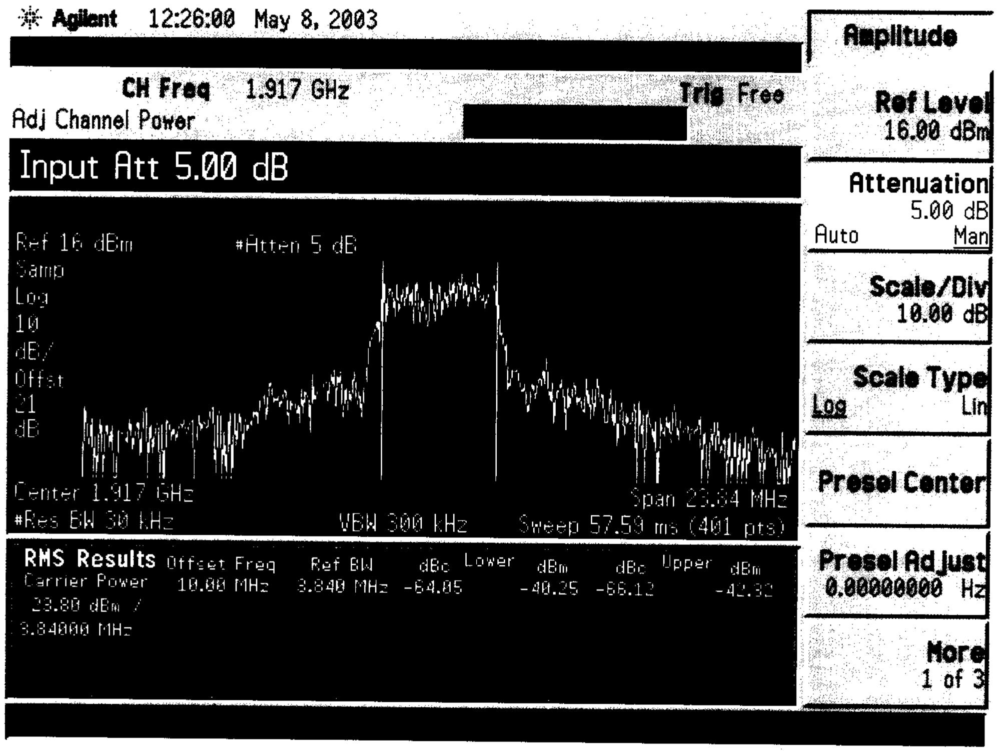

TDD UE ACS/Blocking

Specifications

The Specifications for the TDD ACS in TS25.102 are not that significant in practice because the TDD UE is the victim of the FDD UE interference and anything that can be done in the design of the TDD UE to optimise the ACS is of benefit in an interference scenario at least until the problem is dominated by the FDD ACLR. However, for comparison purposes the specifications are interpreted as requiring -33dB ACS in the first adjacent channel.

Practical reality

The ACS of a UE is provided for by the combination of the SAW filter selectivity and the RRC filter selectivity.

The SAW response of a TDD UE is shown below.

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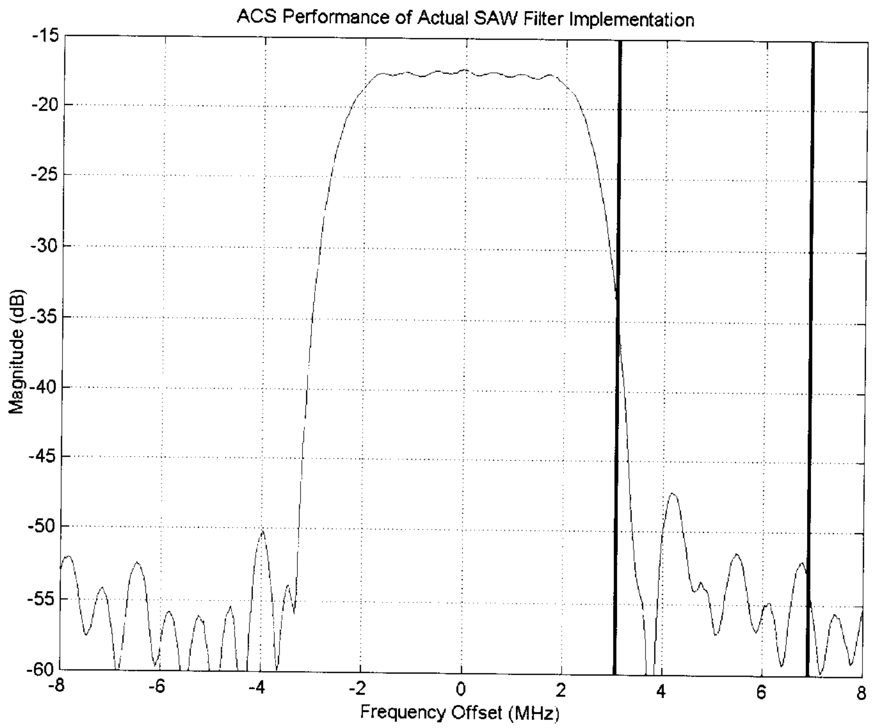
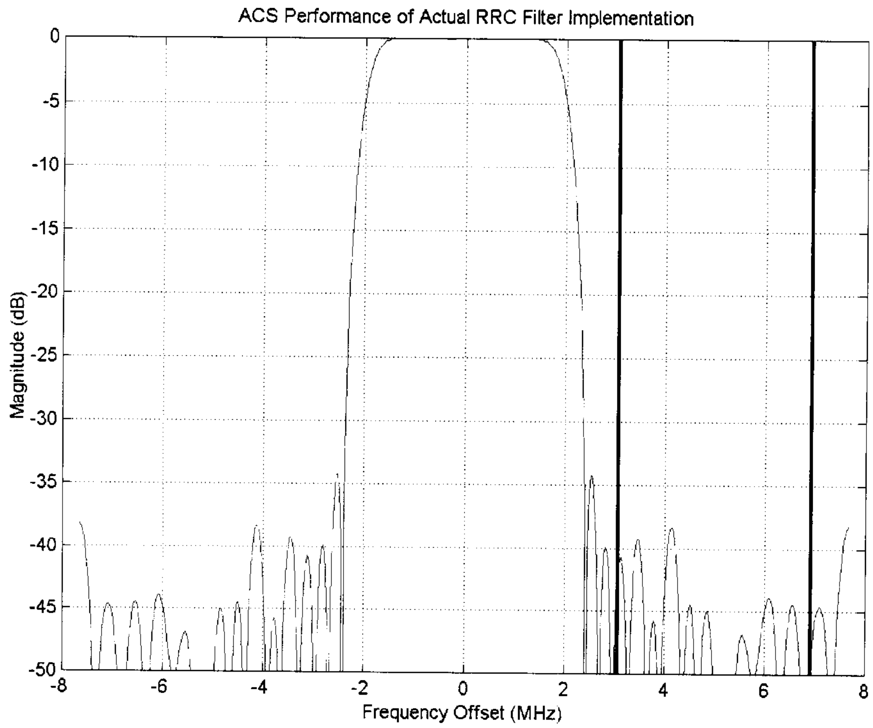


This filter gives around 25dB of rejection integrated across the first adjacent channel.

The RRC response of a TDD UE is shown below.



This filter gives around 44dB of rejection integrated across the first adjacent channel.

The combined effect gives around 55-60dB of adjacent channel selectivity when other factors are taken into account. **Note this is 22-27dB better than specification.**

This significantly outperforms the specifications but the motivation for this is clear.

Furthermore if this can be achieved in the UE it can also be achieved in the Node B FDD or TDD and therefore it is explanation and justification for the improved ACS figures discussed earlier.

Conclusion

It has been shown that FDD and TDD UE ACLR and ACS specification can be exceeded by up to 20dB in practice. This kind of differential would have a profound influence on the result of probabilistic studies into FDD UE to TDD UE interference.

SUMMARY AND RECOMMENDATIONS

We have shown that where the existing 3GPP specifications are adequate to facilitate TDD/FDD co-siting in the core UMTS bands these specifications can be achieved. In addition where the 3GPP specifications are inadequate to facilitate they are exceeded in practice such that co-siting is feasible.

We have also shown that the key performance specifications for UEs can also be exceeded in practice by a significant margin.

The most important conclusion from this for new UMTS bands is that the 3GPP specifications and the in turn the co-existence studies should be re-visited in the light of actual equipment performance.

This is essential because it is clearly nonsensical to apply standards developed in 1999 that are exceeded by a significant margin (~20dB) in commercial equipment in 2003 to spectrum to be allocated in 2008 and used in 2010.

Appendix A

6.6.2.2.3.2 Requirement in case of co-siting with FDD BS operating on an adjacent channel

In case the equipment is co-sited to a FDD BS operating on the first or second adjacent channel, the adjacent channel leakage power shall not exceed the limits specified in Table 6.9A.

Table 6.9A: Adjacent channel leakage power limits in case of co-siting with FDD on adjacent channels

BS Adjacent Channel Offset	Maximum Level	Measurement Bandwidth
+/- 5 MHz	–80 dBm	3,84 MHz
+/- 10 MHz	–80 dBm	3,84 MHz

NOTE: The requirements in Table 6.9A are based on a coupling loss of 30 dB between the FDD and TDD base stations.

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Appendix B

7.5.3 Minimum Requirement - Co-location with UTRA-TDD

The current state-of-the-art technology does not allow a single generic solution for co-location with UTRA-TDD on adjacent frequencies for 30dB BS-BS minimum coupling loss.
However, there are certain site-engineering solutions that can be used. These techniques are addressed in TR 25.942 [4].

7.5.1 Minimum requirement

The static reference performance as specified in clause 7.2.1 shall be met with a wanted and an interfering signal coupled to BS antenna input using the following parameters.

Table 7.4: Blocking performance requirement for operation in frequency bands in sub-clause 5.2(a)

Center Frequency of Interfering Signal	Interfering Signal mean power	Wanted Signal mean power	Minimum Offset of Interfering Signal	Type of Interfering Signal
1920 - 1980 MHz	-40 dBm	-115 dBm	10 MHz	WCDMA signal with one code
1900 - 1920 MHz 1980 - 2000 MHz	-40 dBm	-115 dBm	10 MHz	WCDMA signal with one code
1 MHz -1900 MHz, and 2000 MHz - 12750 MHz	-15 dBm	-115 dBm	—	CW carrier

Table 7.5: Blocking performance requirement for operation in frequency bands in sub-clause 5.2(b)

Center Frequency of Interfering Signal	Interfering Signal mean power	Wanted Signal mean power	Minimum Offset of Interfering Signal	Type of Interfering Signal
1850 - 1910 MHz	- 40 dBm	-115 dBm	10 MHz	WCDMA signal with one code
1830 - 1850 MHz 1910 - 1930 MHz	-40 dBm	-115 dBm	10 MHz	WCDMA signal with one code
1 MHz - 1830 MHz 1930 MHz - 12750 MHz	-15 dBm	-115 dBm	—	CW carrier

7.2.1 Minimum requirement

Using the reference measurement channel specifications in Annex A, the reference sensitivity level and performance of the BS shall be as specified in Table 7.1.

Table 7.1: BS reference sensitivity levels

Reference measurement channel data rate	BS reference sensitivity level (dBm)	BER
12.2 kbps	-121	BER shall not exceed 0.001

7.4.1 Minimum requirement

The BER shall not exceed 0.001 for the parameters specified in Table 7.3.

Table 7.3 : Adjacent channel selectivity

Parameter	Level	Unit
Data rate	12.2	kbps
Wanted signal mean power	-115	dBm
Interfering signal mean power	-52	dBm
Fuw offset (Modulated)	5	MHz

7.5.2 Minimum Requirement – Co-location with GSM900 and/or DCS 1800

This additional blocking requirement may be applied for the protection of FDD BS receivers when GSM900 and/or DCS1800 BTS are co-located with UTRA BS.
The static reference performance as specified in clause 7.2.1 shall be met with a wanted and an interfering signal coupled to BS antenna input using the following parameters.

Table 7.5A: Blocking performance requirement for operation in frequency bands in sub-clause 5.2(a) when co-located with GSM900

Center Frequency of Interfering Signal	Interfering Signal mean power	Wanted Signal mean power	Minimum Offset of Interfering Signal	Type of Interfering Signal
921 -960 MHz	+16 dBm	-115 dBm	—	CW carrier

Table 7.5B: Blocking performance requirement for operation in frequency bands in sub-clause 5.2(a) when co-located with DCS1800

Center Frequency of Interfering Signal	Interfering Signal mean power	Wanted Signal mean power	Minimum Offset of Interfering Signal	Type of Interfering Signal
1805 – 1880 MHz	+16 dBm	-115 dBm	—	CW carrier

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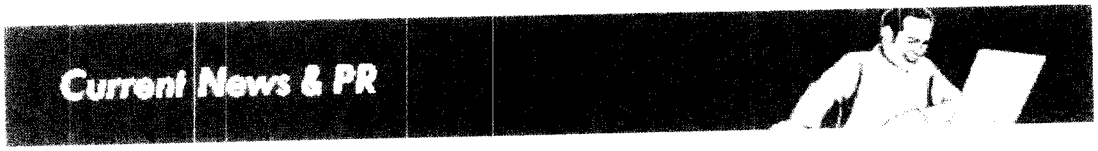

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IPWireless Announces the World's First, Fully Interoperable, 3G Network for Mobile Voice and Broadband Data

IPWireless Successfully Completes Interoperability and Co-Existence Tests

SAN BRUNO, CA - June 25, 2003 - IPWireless has successfully completed the world's first interoperability (IOT) and co-existence testing between UMTS TDD (UMTS TDD) and UMTS FDD (WCDMA) networks at Nortel Networks wireless headquarters in Châteaufort, France. The test, completed during a trial of the IPWireless™ TDD solution, demonstrated that both FDD and TDD standards of 3G UMTS can co-exist in the same cell site and interface together as one network solution.

The tests also showed the co-existence of both FDD and TDD Node Bs at the same cell site without any interference or degradation of service using paired and unpaired spectrum allocations. These findings prove conclusively that mobile network operators can safely offer the high-bandwidth low-latency services available on a TDD network on the cell sites with existing or planned FDD deployments.

Chris Gilbert, CEO of IPWireless said, "This is another important step for IPWireless, demonstrating that there is a UMTS solution for operators unpaired TDD spectrum which can leverage and work seamlessly with other UMTS solutions. This solution will allow operators to offer a host of attractive new services that have proven market appeal."

The world's first IOT test integrated IPWireless' TDD Radio Access Network (RAN) via the Iups interface (between RNC and SGSN) with Nortel Networks market leading packet core solution, which is deployed by a number of major European operators.

Alain Biston, president and general manager, UMTS Networks, Nortel Networks said, "This test with IP Wireless demonstrates the high interoperability of our intelligent packet core solution with multiple wireless access technologies."

IPWireless is supplying their 3GPP standards compliant UMTS TDD Mobile Broadband technology equipment including Node Bs, Integrated Network Controllers and end user PC cards (PCMCIAs). Via the PC card, the IPWireless solution gives laptop and PDA users mobile Internet access at speeds up to 1.5Mbps - faster than the fixed line Broadband rates currently available. In a fully deployed network, broadband coverage is as ubiquitous as with today's GSM networks. This offers a multitude of new revenue streams for mobile network operators and the services that business and residential users are demanding.

About IPWireless
IPWireless offers mobile broadband, an extremely disruptive technology that is on track to change the way people around the world communicate, access the Internet, and use a host of applications at home, at the office, or on the road. IPWireless has quickly established itself as a leader in the market, with commercial deployments around the world and trials with ten of the top twenty global wireless operators. IPWireless has announced strategic partnerships and relationships with some of the largest companies in the industry, including Alcatel and Solectron. Founded in April 1999, IPWireless is led by a world-class management team of seasoned entrepreneurs and technology and marketing executives from leading mobile and communication companies including Cisco, Lucent, Motorola, and Qualcomm. The company, backed by more than $150 million in funding from leading venture capital firms, is headquartered in San Bruno, California, with R&D and sales facilities based in the U.K. For more information about IPWireless, visit the company's Web site at www.ipwireless.com.

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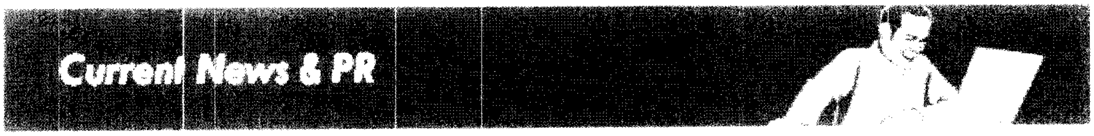

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Andrew and IPWireless Jointly Develop Technology That Enables Sharing of 3G Cell Site Antennas

Duplexer Reduces Expense and Complexity of Deployments for 3G Operators

Cannes, France - February 22, 2004 - Andrew Corporation and IPWireless have jointly developed a product that lowers operators' costs and simplifies deployment of wireless systems by enabling them to combine transmission of two 3G radio technologies onto a single cell site antenna.

This new duplexer allows wireless operators to deploy both UMTS Frequency Division Duplex (FDD) and UMTS Time Division Duplex (TDD) systems using a single antenna, efficiently taking full advantage of their 3G spectrum to deploy new broadband services and offload traffic from their circuit switched networks. Now commercially available, the UMTS FDD/TDD duplexer has already been proven in a number of trials across Europe, and will be used by a number of operators including the recently announced UMTS TDD deployment by Sonaecom in Portugal.

UMTS TDD systems were designed to operate in the unpaired IMT-2000 frequency bands (1900 - 1920 MHz and 2010 - 2025 MHz) that are adjacent to the paired WCDMA frequencies. The TDD systems use time division to separate the uplink and downlink instead of using separate frequency bands, allowing the TDD system to have flexible asymmetry and better match typical data traffic patterns. Operators around the world are deploying packet based UMTS TDD systems because of the economical high-speed services enabled by the platform's very high capacities and low latencies.

"Over the last few years, in addition to demonstrating the performance of UMTS TDD, we have worked with numerous mobile operators to show that TDD and FDD have very similar coverage characteristics and can co-exist on the same towers," said Bill Jones, executive vice president, technology and cofounder, IPWireless. "Operators have also let us know that it is very important that the two technologies can share key infrastructure to lower cost and ease deployability, which is why we are so excited about this announcement with Andrew."

"This new product provides wireless operators with a cost-effective and proven solution for TDD deployment, enabling them to provide their customers with wireless data while reducing their infrastructure costs" said John DeSana, group president, filter products, Andrew Corporation. "It is a solution that both Andrew and IPWireless believe will greatly benefit the operators."

About Andrew Corporation
Andrew Corporation (NASDAQ: ANDW) designs, manufactures, and delivers innovative and essential equipment and solutions for the global communications infrastructure market. The company serves operators and equipment manufacturers from facilities in 33 countries. Andrew (http://www.andrew.com/), headquartered in Orland Park, IL, is an S&P 500 company founded in 1937.

About IPWireless
IPWireless offers advanced standards-based broadband wireless technology that will drastically improve the way people around the world connect and communicate at home, at the office, or on the road. With a full range of commercial network solutions and devices, IPWireless allows operators to offer a spectrum of fixed, portable, or completely mobile wireless services with unmatched economics and broadband performance. IPWireless has quickly established itself as a leader in the market, with commercial deployments in service for more than a year, trials with ten of the top twenty global wireless operators, and strategic partnerships and relationships with industry leading companies. For more information, visit the company's Web site at http://www.ipwireless.com/.

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