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**Agenda item:** 10 A Inputs to TR on 1.28 Mcps TDD

**Source:** Ericsson, Nortel, NTT DoCoMo, Telia, Vodafone

**Title:** Operating scenarios for the unpaired TDD spectrum

**Document for:** Decision

# Introduction

In [1] the usage of the UMTS TDD mode was discussed and a number of operating scenarios were described. The paper did not build on any particular TDD technology but was general in content although at the time for presentation only a wide band (WB) TDD option was specified in 3GPP. Since [1] was presented a narrow band (NB) TDD option operating at 1.28 Mcps has been decided upon. Currently, work is ongoing in 3GPP to define the details of this new option [4], [5].

The introduction of the NB TDD option gives the operators new possibilities in addition to the ones offered by the WB TDD option.

Consequently, it is important to consider the scenarios in [1] in the light of the latest updates of the TDD standard. This includes studies of the co-existence properties of these two TDD options (individually and in mixed scenarios) and investigations how well they are adapted to the business scenarios in [1]. In this paper we outline a few operating scenarios where the WB or NB TDD mode could be used. The interfering/interfered system may be another NB TDD system or WB TDD system, possibly run by another operator in a possibly uncoordinated way. This other system may be in adjacent frequency bands or in the same band with a geographical separation.

The purpose of this contribution is to highlight some important scenarios that may occur, show potential usage of the currently defined WB and NB options, and to analyse potential coexistence problems. With this a discussion can start on how to prevent these problems from happening while still taking into account the key features of the individual proposals.

A final conclusion whether the *potential* problems are in fact *actual* problems or not will not be drawn in this paper.

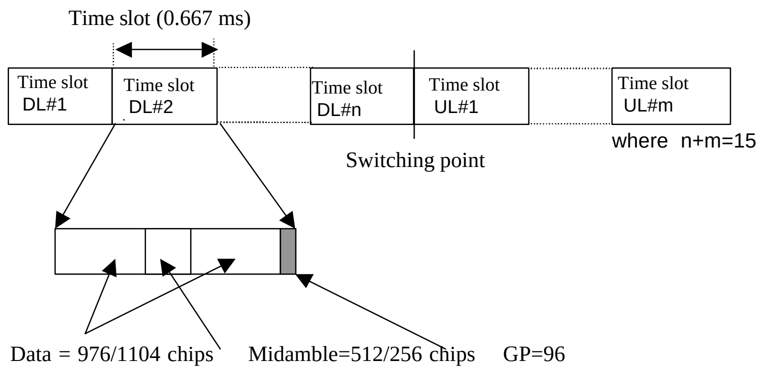
One intention with this contribution is to provide material for an inclusion of requirements and operational scenarios needed for chapter 4.3.1: “Deployment scenarios” of the technical report TR 25.928 [6].

# Outline of the paper

We start with describing the frame structures of the two current proposals for WB and NB TDD, respectively. Then we describe some relevant operator scenarios assuming the usage of the current WB and NB proposals (NB only, WB only and mixed NB/WB) and analyse the problems that might occur due to the differences in the respective proposals.

# Basic properties of current WB TDD

The frame structure in WB TDD consists of 15 equally sized slots per 10 ms. Any slot could be configured to carry either uplink or downlink traffic. The random access attempts take place in a predefined uplink slot that can be reconfigured by the BS if needed. The Physical Synchronisation Channel (PSCH) is superimposed on the data in one or more of the downlink slots.

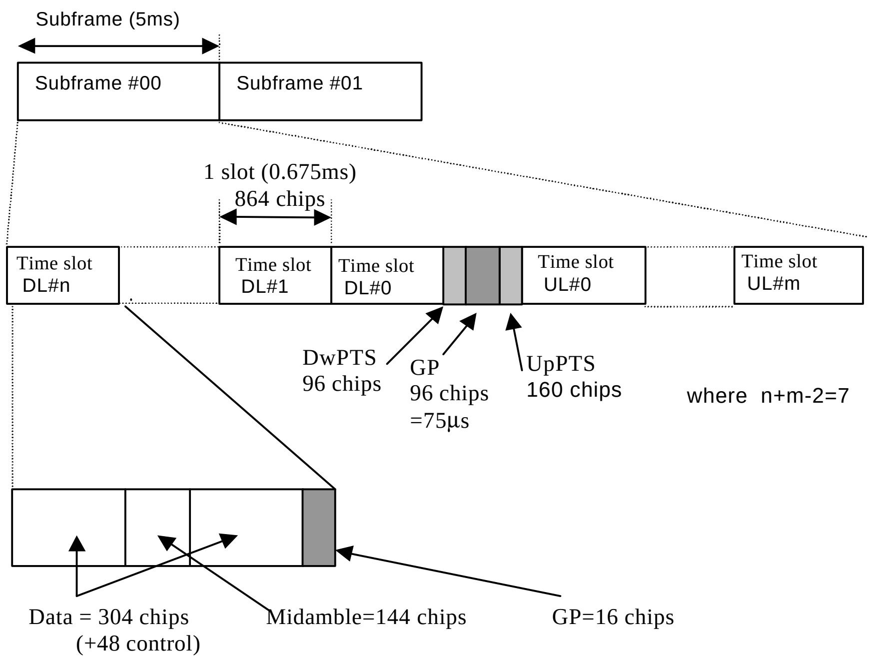



An important property of the WB mode is that all traffic and control channels can be re-allocated in case of strong interference. This is a prerequisite for efficient DCA.

# Basic properties of proposed NB TDD system

The frame structure for the proposed NB TDD [4] consists of two parts of 5 ms each. These are subdivided into 7 traffic and one signalling slot each. The traffic slots are allocated in one downlink part and one uplink part separated by the signalling slot.

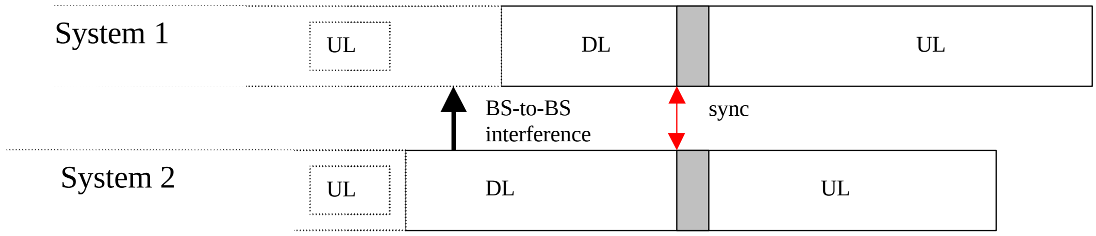
The signalling slot consists of one downlink part DwPTS, a guard period, and an uplink part, UpPTS. The DwPTS part consists of cell parameter information and is used for synchronisation, while UpPTS is used by the mobile to signal that a Random Access (RA) attempt is upcoming. The BCH/PCH/FACH channels take place in DL#1. The UpPTS or the DwPTS can not be re-allocated in case of heavy interference in the respective slot.




# Scenario 1: NB TDD vs. co-ordinated NB TDD in adjacent bands

In this basic operation scenario the NB TDD systems are used in a co-ordinated way, that is, the systems are aligned in a way as to minimise the interference between the two systems. This means that the respective signalling slots are aligned in both the systems regardless of the current configuration of up- and downlink slots. That is, the configuration changes by shifting of the start of the sub frame boundaries.

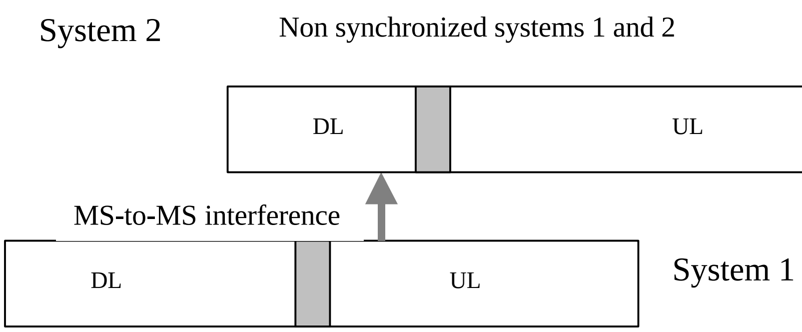
Synchronized carriers/systems 1 and 2. Synchronization of signaling slots




The base to base interference that might occur when UL traffic in System 2 is transmitted simultaneously as DL traffic is transmitted in System 1 is typical for every TDD system and can be minimised by dynamical channel allocation (DCA) procedures.

# Scenario 2: NB TDD vs. uncoordinated NB TDD in adjacent bands

In this scenario different operators run the two interfering NB TDD systems in adjacent bands. The relative frame boundaries are unknown and there is no synchronisation between the two systems. One especially difficult situation is when UL traffic in System 2 is transmitted simultaneously as the slot DL#1 in System 1, since this slot (and this slot only) holds the System 1 BCH.  Thus, System 1 may in effect be locally jammed from operation since crucial control channels are blocked. Similarly System 1 UpPTS maybe jammed by a strong System 1 DL signal.




# Scenario 3: NB TDD vs. uncoordinated NB TDD in same band

This scenario is feasible when one operator owns a spectrum band and rents it out to private operators for example running corporate business systems. These systems are run in an uncoordinated way but possibly with some geographical distance between them. The interference situations that can occur are similar as for Scenario 2 but potentially more severe since the systems operate in the same band.

# Scenario 4: NB TDD vs. WB TDD in uncoordinated operation in adjacent bands

Scenario 4 is similar to Scenario 2 except that we consider a WB TDD and a NB TDD system and the cross interference between them.

Of course, both systems will interfere with each other occasionally. It is important to investigate the effect of this cross-interference to ensure good quality in both systems. It is especially important to verify the quality of the NB option since many control channels are fixed and cannot be re-allocated.

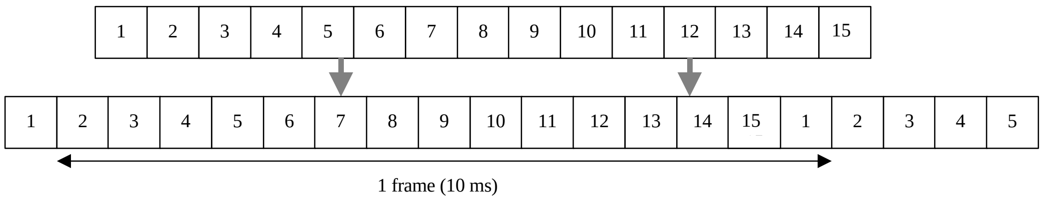
# Scenario 5: NB TDD vs. WB TDD in uncoordinated operation in same band

The business model behind this scenario is similar as for Scenario 3 but with different types of interfering TDD systems.

The problems and underlying causes are similar as scenario 4 but potentially more serious since the systems operate in the same band.

# Scenario 6: WB TDD vs. uncoordinated WB TDD in adjacent bands

In this scenario different operators run the two interfering WB TDD systems in adjacent bands. The relative frame boundaries are unknown and there is no synchronisation between the two systems. Operators deploy UTRA TDD in adjacent bands. Both systems are deployed in the same geographical area. Depending on the UL/DL configuration of both systems BS-to-BS and MS-MS interference can occur as in any TDD system. Because of this advanced DCA is needed.




# Scenario 7: WB TDD vs. WB TDD in uncoordinated operation in same band

The business model behind this scenario is similar as for Scenario 3. The problems and underlying causes are similar as scenario 6 but potentially more serious since the systems operate in the same band. Again advanced DCA is required to reduce the inter system interference.

# Conclusions

We have shown a number of scenarios involving the NB TDD option based on [4] and the WB TDD option [2] and thus displayed some of the possibilities the operators have.

We have also highlighted some potential problems that may occur in many uncoordinated scenarios and mixed scenarios.

In scenarios and environments where the systems can be co-ordinated many problems are reduced provided that the interfering systems are of the same type.

Other general methods that may partially reduce interference is to use:

- Efficient DCA
- Smart antennas
- Careful location of the base stations

Since many feasible scenarios involve mixed WB/NB scenarios or uncoordinated systems there is a need for investigating the potential interference described for these cases. If necessary, modifications or improvements to the NB and/or WB options could be made to solve possible remaining problems while still keeping the key features from the original proposals.

The above potential problems essentially come from the differences in frame structures and the different way of operation for essential control channels.

The list of benefits with having two TDD options that work well together includes:

- The above scenarios can be efficiently fulfilled
- It preserves the original key features
- It might open up the possibility for a larger market for both options

Finally, it is proposed that 3GPP include the described scenarios in [6].

# References


[1] Operator requirements for UMTS TDD mode. 3GPP TSG R1-99c59. Source: Vodafone.
[2] UTRA TDD specs. 3GPP TSG RAN TS25-221-300,TS25-222-300,TS25-223-300, TS25
[3] TD-SCDMA specs. CWTS TS CS101 v3.0.0, TS CS102 v3.0.0, TS CS103 v2.2.0, TS CS104 v3.0.1, TS CS105 v3.0.0.
[4] Frame structure for low chip rate TDD option, 3GPP TSG R1-00-0092. Source: CWTS/CATT
[5] CWTS input papers for WG1 #12 (Distributed on the reflector. No Tdoc numbers yet)
[6] Technical Report: TR 25.928, 3GPP TSG R1-00423.