Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Flexible TDD Frame for UL/DL Allocation**
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Source:	Wen Tong, Peiying Zhu, Jianglei Ma, Ming Jia ,Hang Zhang, Mo-Han Fong and Brian Johnson Nortel Networks 3500 Carling Avenue Ottawa, ON. K2H 8E9 CANADA Voice: (613)-763-1315 Fax: (613)-765-7723 wentong@nortelnetworks.com
Re:	IEEE 802.16e D2 Draft
Abstract	This contribution proposes changes to OFDMA PHY description in the 802.16e D2 Draft
Purpose	To incorporate the changes here proposed into the 802.16e D2 draft.
Notice	
Release	
Patent Policy and Procedures	

Flexible TDD Frame for UL/DL Allocation

1 Background

In this contribution, we present the solution for more flexible TDD UL/DL switching point allocation. With a pre-defined the super frame structure in the multi-cell network, in order to allow flexible adding/removing the TDD UL/DL switching with reduced over-head, the tail symbol is introduced. The flexible switching point enables the flexible allocation of fast feedback channel and traffic symmetry/asymmetry.

2 TDD slot configuration scalability

The proposed the *hybrid* TDD frame structure which consists of the network planned fixed DL/UL switching point and cell/beam specific flexible DL/UL switching point, the fixed DL/UL switching point ensures the minimum level of TDD specific interference and the TDD specific interference caused by the flexible DL/UL switching point can be mitigated by the BS scheduler and to allow each cell/beam to adjust the DL/UL traffic symmetry ratio. In addition, the *tail symbol* concept allows minimizing the TTG/RTG overhead caused by the flexible assignment of the DL/UL switching point. The hierarchy of the frame and slot structure is shown in **Error! Reference source not found.**. The TDD frame duration is 10 ms; one TDD frame consists of 5 TDD slots. One TDD slot consists of 8 OFDM pairs and one tail symbol. The duration of TDD slot is 2ms. The tail symbol serves as TTG and RTG if switch happens during this slot and it can be used as regular traffic channel if on switching occurs during this slot. The OFDM pair consists of two OFDM symbols. For each TDD frame, the Tx/Rx gap (TTG) and Rx/Tx transition gap (RTG) are inserted between DL burst and UL burst to allow BS transceiver to turn around. The TTG and RTG are required in each TDD slot to allow TDD slot based DL/UL switching. The duration of TTG and RTG depends on the minimum switch time and the cell size, the flexibility of the traffic asymmetry improves system efficiency and can be used for dynamic resource allocations depending on cell/beam traffic symmetry ratio. Switching may not be assigned every TDD slot especially for fixed and nomadic deployment. The overhead reserved for TTG/RTG will be wasted if no DL/UL switching is allocated in a specific slot boundary, A tail symbol is introduced. The tail symbol is a single OFDM symbol, and it is used as regular traffic OFDM symbol or combined with another OFDM symbol to generate an OFDM pair. It can be split into two parts, one serves as TTG and the other serves as RTG when DL/UL switch enabled.

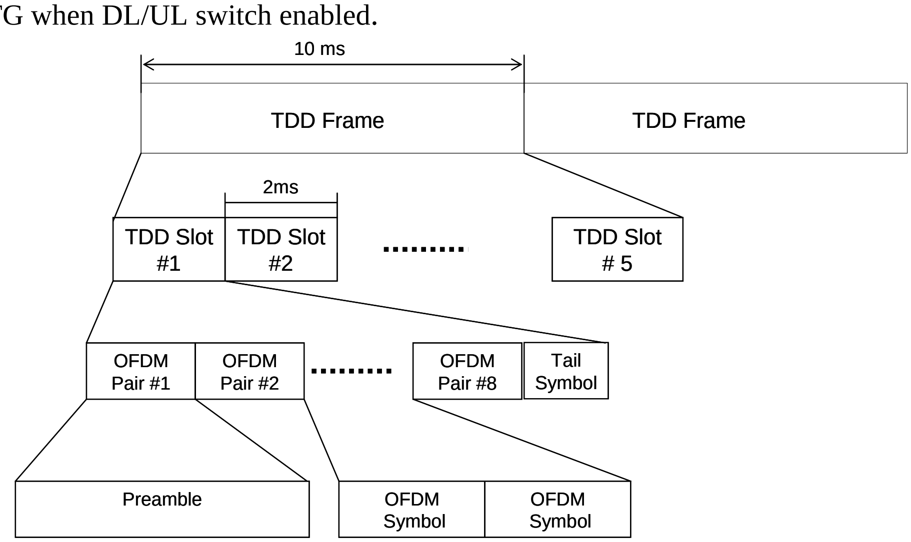

Figure 1 Frame/slot structure

2.1.1 Example of OFDM parameters for the 2048 OFDMA and 20MHz channel

The 20MHz channel bandwidth and 2048-FFT is designed as the based modes for the scalable OFDMA system parameter set as listed in Table 1

Table 1 Example of OFDM Parameter Set

Parameter	Value
IFFT/FFT Block	2048
Sampling Rate	20 MHz
No. of Prefix Samples	256 (1088 for Tail Symbol)\
Guard Time	12.8 µs (54.4 for Tail Symbol)
No. of Samples per Symbol	2304 (3136 for Tail Symbol)
Useful Symbol Duration	102.4µs
Total OFDM Symbol Duration	115.2 µs (156.8 µs for Tail Symbol)
Sub-carrier Separation	9.765625 KHz
No. of useful Sub-carriers	1728
The index of the first useful sub-carrier (K_{min})	160 (start from 1)
The index of the last useful sub-carrier (K_{max})	1888
Bandwidth	16.875 MHz
DC sub-carrier	1024^{th} sub-carrier is not used

2.1.2 Flexible TDD frame structure

The minimum TDD switch unit is one TDD slot, such a 2 ms TDD slot based switching allows dynamically DL/UL channel resource allocation. The resource allocation for DL and UL depends on the traffic symmetry ratio between DL and UL and also the service latency requirement. In addition, this allows less storage required in PHY layer transmit and receive processing. The 2ms TDD slot also supports fast channel quality measurement of the change of the radio link condition, and fast power control loop response.

Table 2 Example of Frame/Slot Structure Parameters

Parameters	Value	Comments
Duration of Super-Frame (ms)	80	Network Synchronization
TDD Frames/Super-Frame	8	
Duration of TDD Frame (ms)	10	Radio Frame
TDD Slots/Frame	5	DL slot/UL slot
Duration of TDD Slot (ms)	2	Minimum TDD switch unit, Power Control, C/I Measurement
OFDM-Pair /TDD Slot	8 (plus 1 tail symbol)	Space-time coding
Duration of OFDM-Pair (µs)	230.4	
Duration of TTG+RTG (µs)	156.8	Tx/Rx transition gap and Rx/Tx transition gap
OFDM Symbols/ OFDM-Pair	2	
Duration of OFDM Symbols (µs)	115.2	OFDM modulation burst

The flexible TDD slot allocation with tail symbol is shown in Figure 1 The allocation of AMC sub-channel (ASC) and Diversity sub-channel (DSC) is based on the OFDM pair unit in time for DL; such an assignment is determined by the BS or network. In this configuration, the UL/DL switching point is fixed at every 4ms, slot 1 and slot 2 are assign the DL, slot 3 is assigned for the UL. However, an additional flexible switching point is assigned at the UL period of slots 4, such an assignment can be used to adjust the DL/UL traffic symmetrical ratio and to allow slot 1 and slot 2 support nomadic DL users and slot 4 to support mobility DL user due to a faster CQI feedback is available.

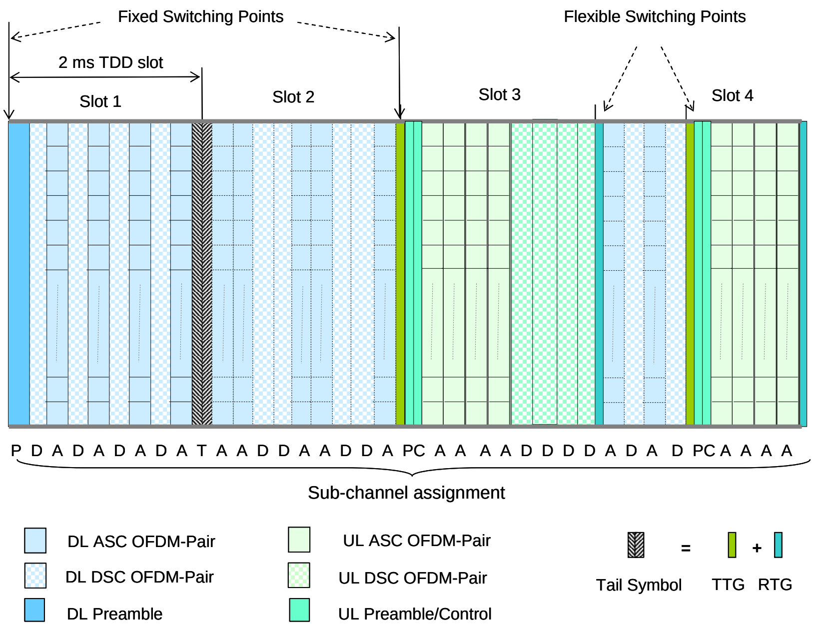

Figure 2 TDD Frame/Slot and Sub-Channel Structures