Tdoc R1-01-391

OFDM as a candidate for stand-alone DSCH

Wavecom, France Telecom, Nortel Networks

3GPP RAN1#19
Las Vegas
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Proposal

- Notion presented at TSGR2#19 and introduced in TR 25.950.
  - Rel'99 architecture is already suitable for its support
- **What is a stand-alone DSCH?**
  - a DSCH on a DL carrier different from the DL carrier that carries its companion DPCH
- **Proposal:** use of OFDM modulation to achieve high data rate in downlink up to 250 km/h
  - **OFDM based stand-alone DSCH**
  - **Optional** feature for the UE

COFDM principle (Coded OFDM)

- OFDM modulation (Orthogonal Frequency Division Multiplex)
  - High data rate information is spread over a multiplex of adjacent orthogonal sub-carriers
  - Low data rate sub-carriers are sent simultaneously

    => OFDM symbol duration >> maximum propagation delay

Intrinsic robustness to multipath effect

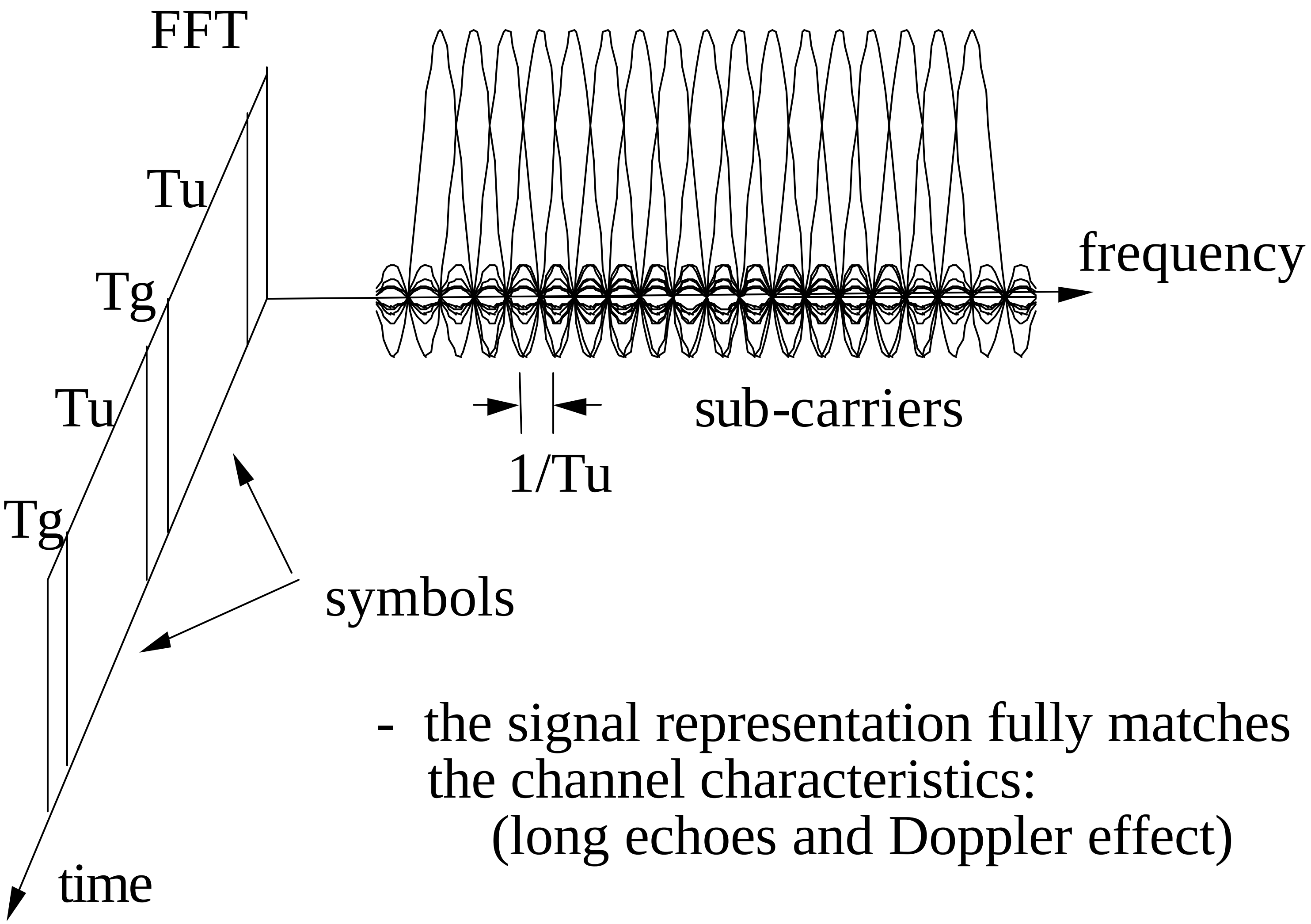
- Guard interval adding (cyclic prefix) => absorption of all ISI

- Frequency selectivity (deep fades) to be overcome:

  Interleaving + Error Correcting Code

- Widely used technique

OFDM symbol representation



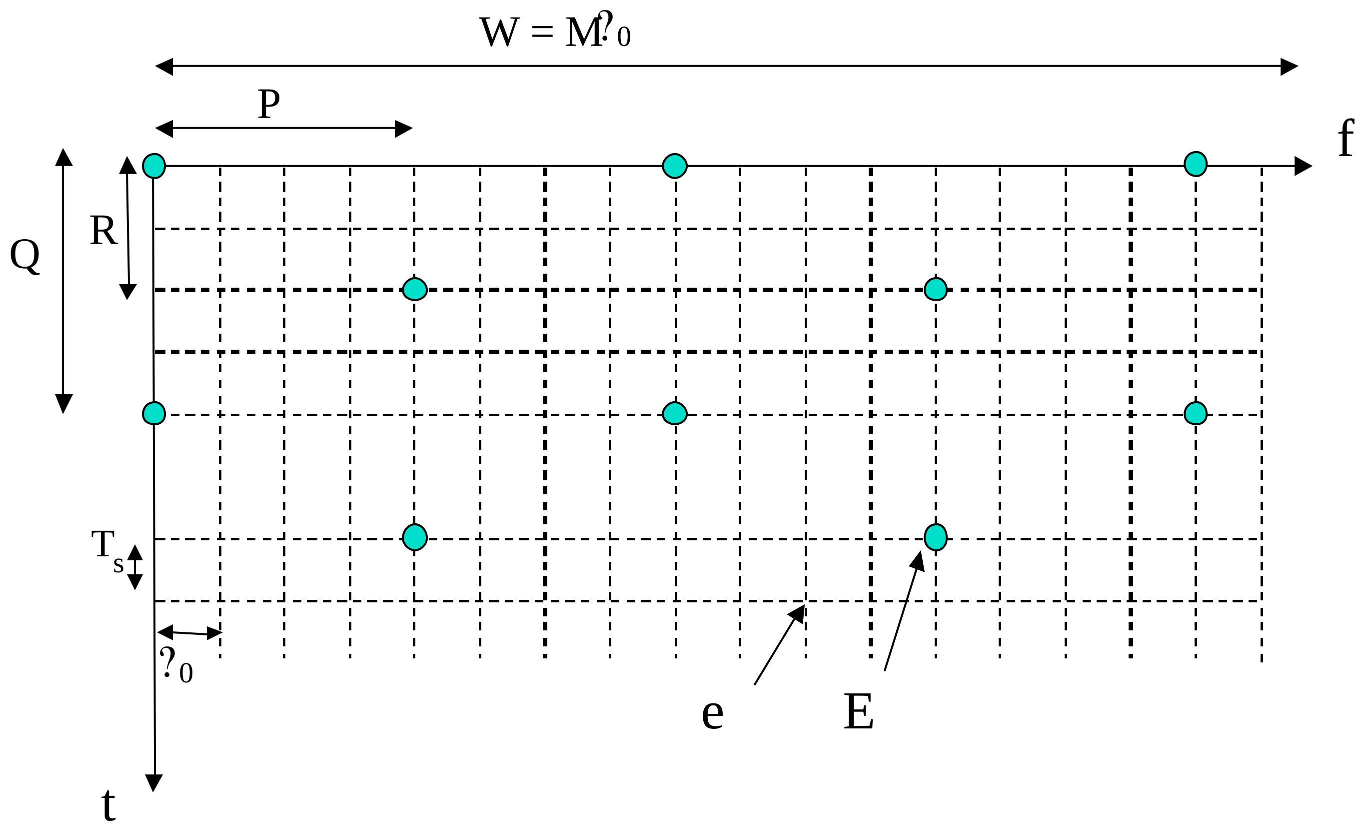
- the signal representation fully matches the channel characteristics:
  (long echoes and Doppler effect)

Example of COFDM parameters

Physical Channel	Type 1	Type 2	Type 3
UMTS propagation conditions (vehicle speed: km/h)	Indoor A (3, 10) Indoor B (3, 10) Out-In A (3, 50, 120)	Out-In B (3, 50, 120) Vehicular A (50, 120, 250)	Vehicular B (50, 120, 250)
3GPP propagation conditions*	Cases 1, 3, 4, 5		Case 2
Useful symbol duration T_u (?s)	15.625	78.125	140.625
Guard interval duration T_g (?s)	1.04	5.2	26.04
T_g / T_u (%)	6.7	6.7	18.6
Overall symbol duration $T_s = T_u + T_g$ (?s)	16.67	83.325	166.67
Carrier separation $?_0$ (kHz)	64	12.8	7.11
FFT size	120	600	1080
Number of sub-carriers	80	400	720
Number of OFDM symbol per frame (10 ms)	600	120	60
Constellation	QPSK	QPSK	QPSK
Channel bit rate	9.6	9.6	8.625

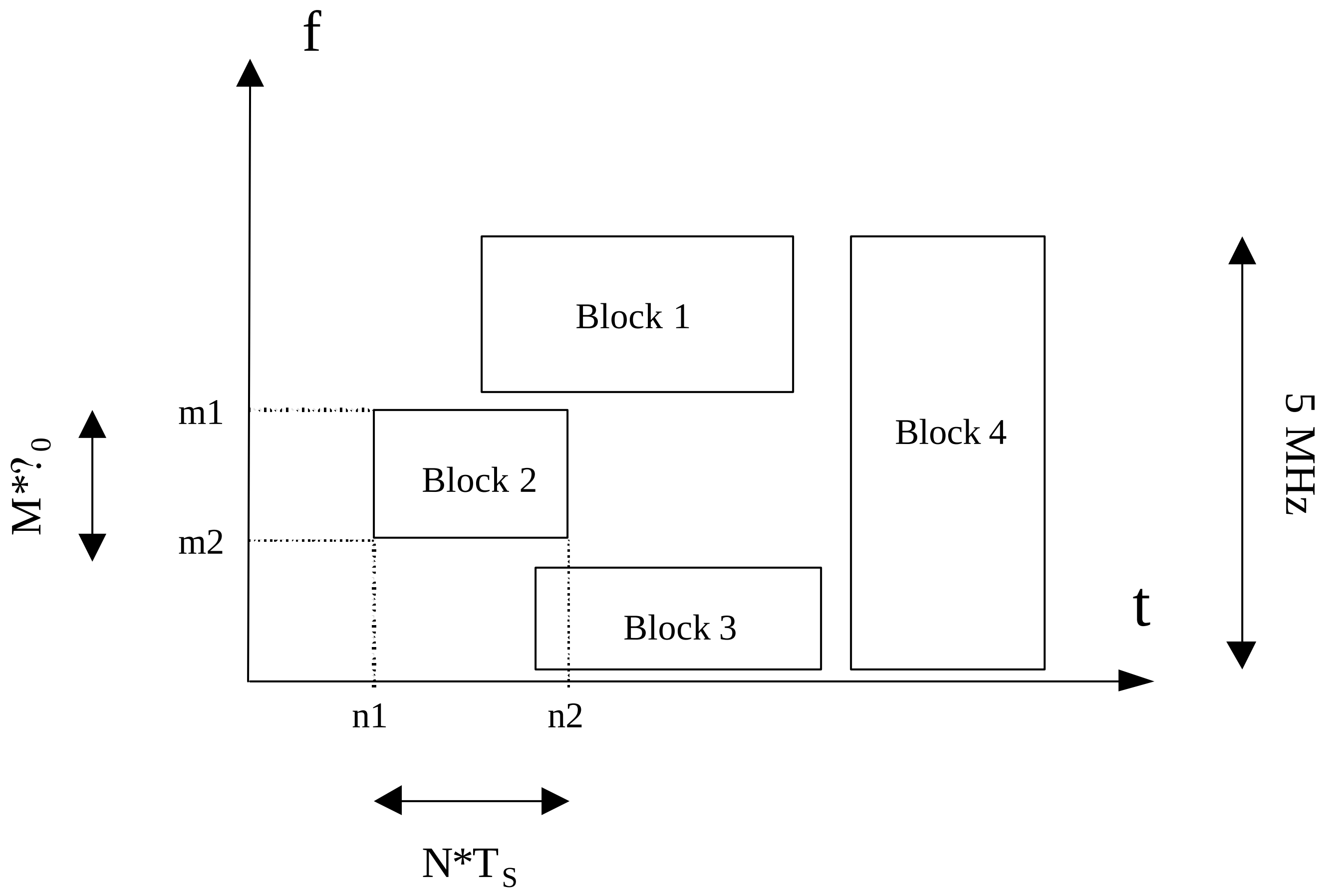
Physical Channel	Type 1	Type 2	Type 3
Coding rate	3/4	3/4	4/5
Channel bit rate	9.6	9.6	8.625
User bit rate**	7.2	7.2	6.9

Time-frequency frame setting



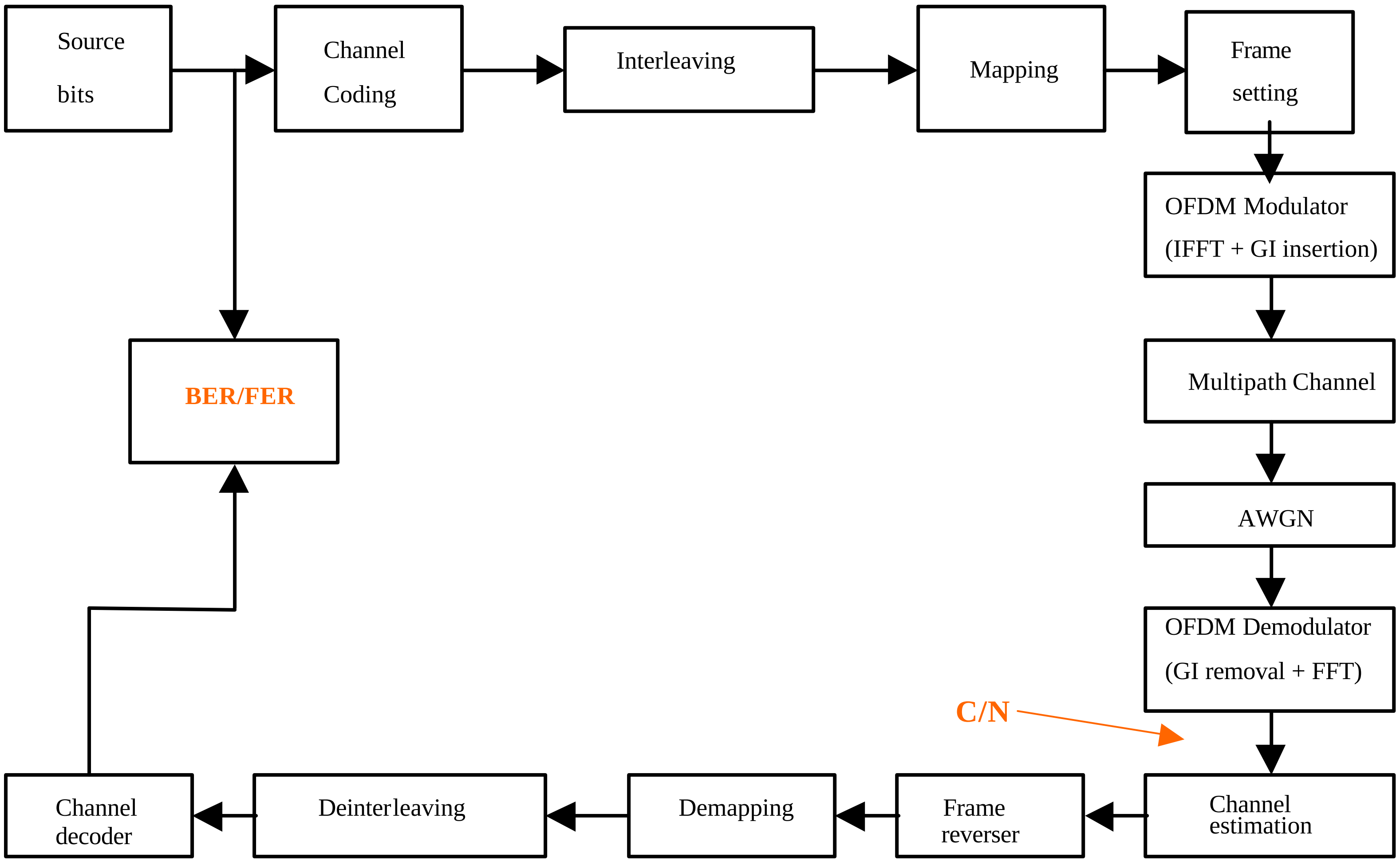
Channel estimation can help for synchronization and scheduling

Multiple Access



Flexible and dynamic

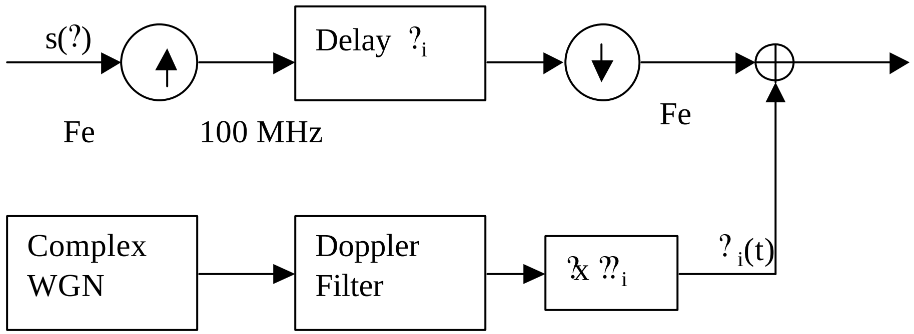
Simulation chain synoptic



Simulation conditions

- UMTS channels
  IB10, OIA50, OIA120, OIB120, VA50, VA250, VB120

- 3GPP channel : case 3
  speed: 120 km/h
  4 taps (delay[ns], attenuation [dB]):
  (0,0); (260,-3); (521,-6); (781,-9)



- Channel model (1 tap)
  simulated in a continuous way

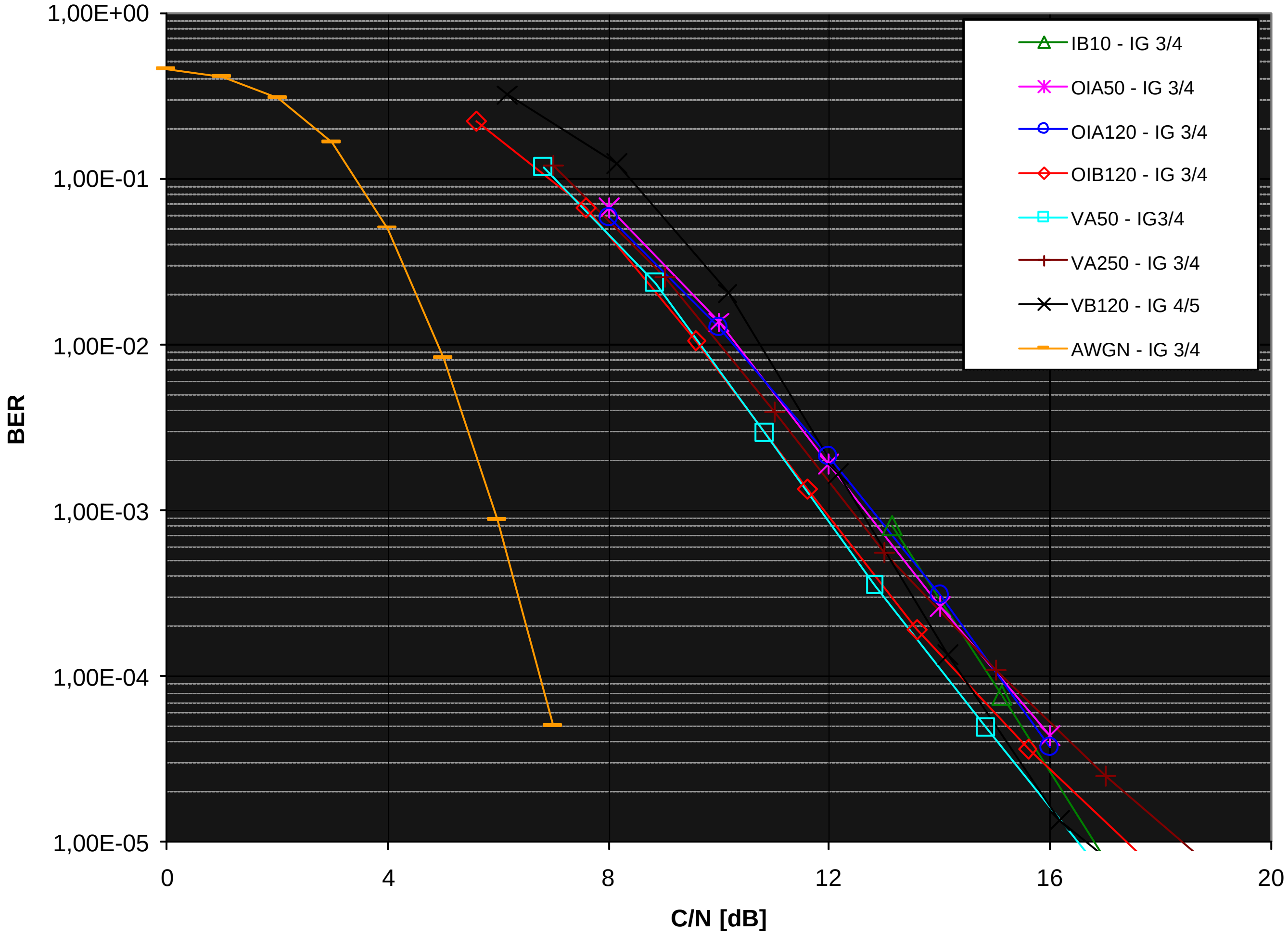
- Nb of simulated bits :
  10, 50 km/h : 10 Mbits
  120, 250 km/h : 5 Mbits

- Interleaving depth : 3.33 ms (5 slots)

- Perfect channel estimation

- Error Correcting Code
  - Convolutional for UMTS
  - Turbo-code (8 it.) for 3GPP

BER vs C/N on UMTS channels

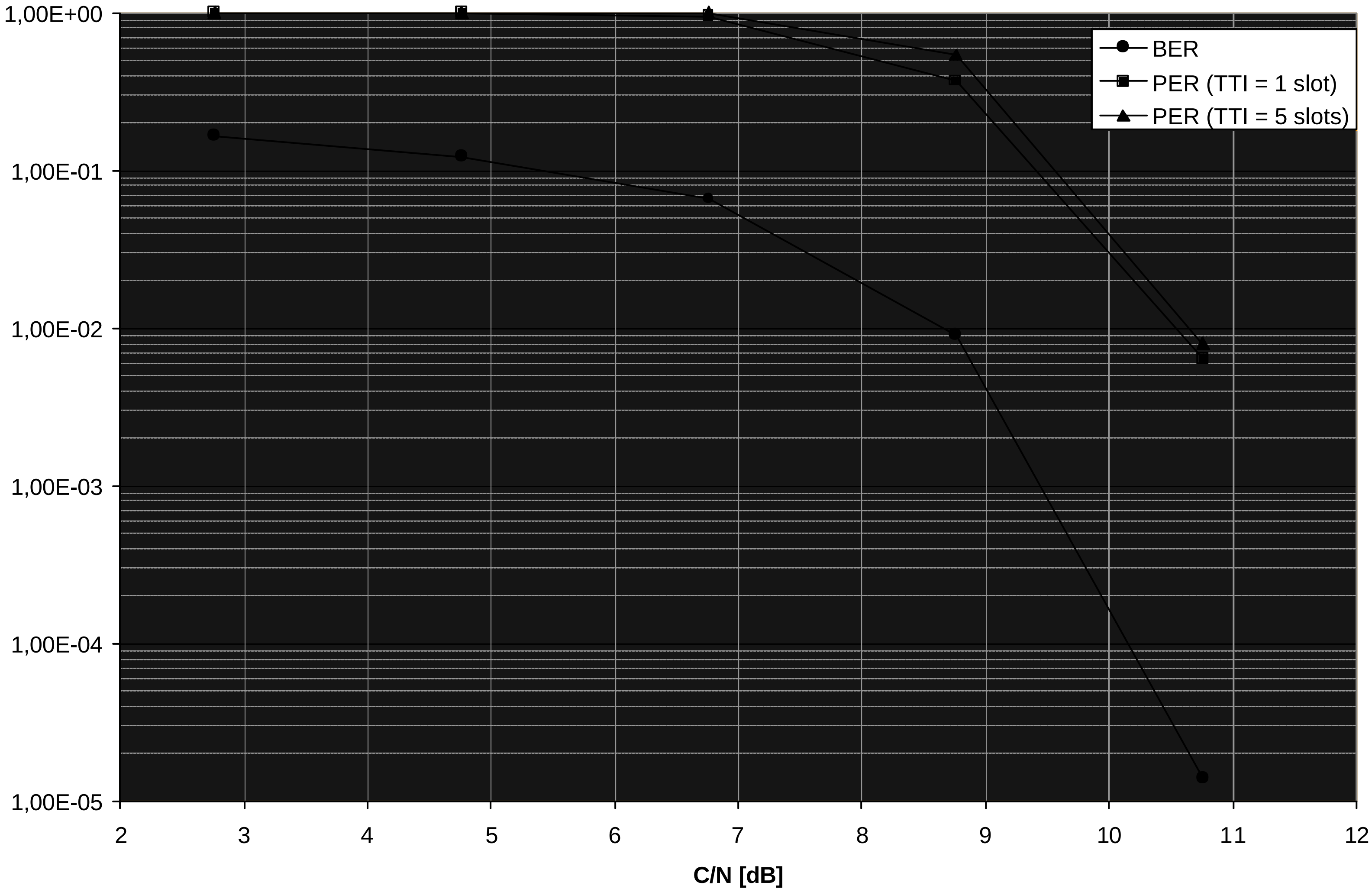


NORTEL NETWORKS

C/N @ BER = 10^{-4}

Environment propagation	C/N (dB)
AWGN	6.3
IB 10	14.9
OIA 50	15.1
OIA 120	15.1
OIB 120	14.4
VA 50	14.1
VA 250	15.1
VB 120	14.4

PER vs C/N on 3GPP Case 3 channel



UE's Complexity

- **Base-band architecture**

  - Services taken into account: voice and high bit rates data services

  - Silicon surface reference: base-band component performing both WCDMA, GSM and GPRS

  ➡ **additional silicon area due to OFDM is only 3.5%.**

- **Radio architecture**

  - RX WCDMA and RX OFDM: while using SAWs one can couple the two bands at the stage of the duplexer.

  -**TX WCDMA and RX OFDM:** one antenna (large enough separation) 2 antennas or one antenna with a specific duplexer (close bands).

Possible improvements

- Higher order sub-carrier modulation
- Larger bandwidth
- Combination with AMC, H-ARQ, FCS, MIMO
- Further optimization of the OFDM spectral efficiency

Conclusion

- Stand-alone DSCH: important concept to increase DL data rate
  - Will enable efficient asymmetrical services
- Stand-alone DSCH modulation:
  - Different solutions, among which OFDM is worth being considered:
    - High spectral efficiency
    - Robustness to multipath and high Doppler
    - Compatible with HARQ, AMC, MIMO and FCS
  - Study still open
- Proposal: include in the HSDPA TR the possibility to study different type of modulations for stand-alone DSCH
  - See R1-01-0293.doc