Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [SC-PHY MCS Updates of the baseline document]
Date Submitted: [January 16, 2008]
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Re: []
Abstract: [SC-PHY MCS Updates of the baseline document is shown.]

Purpose: [To be considered in TG3C baseline document.]

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SC-PHY MCS Updates of the baseline document

Jan. 16, 2008

Summary

- The number of Single Carrier (SC) Modulation and Coding Schemes (MCSs) is reduced from 40 in total to 10+2 based on many comments received: the number of MCSs is too high and a down-selection is necessary

Why the number of MCS has to be reduced

- The proposers have received many comments after Atlanta meeting: the number of MCSs is too high
- The proposers took the comments seriously and have reduced the number of MCS

Reasons for smaller number of MCS

- Minimalist implementation preference of silicon implementers

  1) To keep the architecture simple.

  2) To reduce pre-tape-out design verification time.

  3) To reduce the probability that chips must be re-spun to correct DV failures.

  4) To reduce silicon bring-up time.

  5) To reduce software driver complexity and development time.

- Elimination of similar BER/PER performance MCSs for reducing difficulties in implementation selection

- Reduction of market confusion

MCS confirmed in Atlanta meeting

- 40 MCSs
  - CR (Common rate: 50.6 Mbps)
  - MLR(Mandatory low rate: 1518.4 Mbps)
  - 17 LR (Low rate: up to 2 Gbps) including CR and MLR
  - 4 MR (Medium rate: from 2Gbps to 3 Gbps)
  - 15 HR (High rate: over 3Gbps)
  - 4 SC OOK
- 8 different modulation schemes
  - π/2 BPSK, π/2 QPSK, Dual Rail Bipolar(DRB), π/2 star 8QAM, π/2- NSQAM, π/2 8PSK, π/2 16QAM, OOK
- 7 different coding schemes
  - 2 RS: (255,239), (63,55)
  - 2 LDPC family: [(576,288), (576,432), (576,504)]; [(1440,1344)]
  - 2 CC: family Rates:1/2 and 3/4 (K=5), Rate:2/3 (K=4)
  - 1 TCM family: Rates:2/3 and 3/4

Rationale for MCS selection

- Need logical reasons -

- Necessity of its data rate
- Relative performance compared with other MCSs in the same/similar data rate range
- Relative complexity and power consumption compared with other MCSs in the same/similar data rate range
- Additional performance improvement versus complexity of more complicated MCS introduction

Regrouping by application

- The Modulation and Coding schemes (MCSs) are regrouped
  - Class 1: 50Mbps~1.5Gbps (Some mandatory)
  - Class 2: 1.6Gbps~3Gbps (All optional)
  - Class 3: 3Gbps~6Gbps (All optional)
  - Class 4: SC OOK and DRB (child piconet only)
- FECs reduced to two types: RS and LDPC

Selected MCS by class

- Class 1 (3 MCSs)
  - $\pi/2$-BPSK with:
    - RS(255,239): **50.6**/379.6/759.2/**1518.4** Mbps*
    - LDPC(576,288): 810.0 Mbps
    - LDPC(576,432): 607.5/1215.0 Mbps**
- Class 2 (5 MCSs)
  - $\pi/2$-QPSK with:
    - RS(255,239): 3036.7 Mbps
    - LDPC(576,288): 1620.0 Mbps
    - LDPC(576,432): 2430.0 Mbps
    - LDPC(576,504): 2835.0 Mbps
    - LDPC(1440,1344): 3024.0 Mbps

* Spreading factors (SFs) are 32/4/2/1

** Spreading factors (SFs) are 2/1

Selected MCS by class

- Class 3 (2 MCSs)
  - $\pi/2$–Star 8QAM with RS(255,239): 4555.1 Mbps
  - $\pi/2$–16QAM with RS(255,239): 6073.4 Mbps

- Class 4 (2 MCSs)
  - OOK with RS(255,239): 759.2/1518.4** Mbps
  - DRB with RS(255,239): 3036.7 Mbps

** Spreading factors (SFs) are 2/1

Conclusions

- 40 MCSs has been reduced to 10+2 through “HARD WORK”
- The new set of MCS should meet market requirements
- This may contribute to speed up the standardization process: less number of comments expected

Appendix 1
MCS table confirmed in Atlanta

SC mode (CR, MLR, MR)

MCS Class	MCS Identifier	Data Rate (Mbps)	Symbol /Chip Rate (Mcps)	Modulation Scheme	Spreading factor	FEC Type	FEC Rate	Pilot Word Length (Symbols /chips)	Burst Length (Symbols /chips)
CR	CR (LR1)	50.2	1728	π2-BPSK/(G)MSK	32	RS(255,239)	0.937	0	256
MLR	MLR(LR13)	1506.6	1728	π/2-BPSK/(G)MSK	1	RS(255,239)	0.937	16	256
LR	LR1 (CR)	50.2	1728	π/2-BPSK/(G)MSK	32	RS(255,239)	0.937	0	256
	LR2	188.3	1728	π/2-BPSK/(G)MSK	8	RS(255,239)	0.937	16	256
	LR3	376.6	1728	π/2-BPSK/(G)MSK	4	RS(255,239)	0.937	16	256
	LR4	401.9	1728	π/2-BPSK/(G)MSK	2	LDPC(576,288)	0.500	16	256
	LR5	401.9	1728	π/2-BPSK/(G)MSK	2	CC(R=1/2,K=5)	0.500	16	256
	LR6	602.8	1728	π/2-BPSK/(G)MSK	2	LDPC(576,432)	0.750	16	256
	LR7	703.3	1728	π/2-BPSK/(G)MSK	2	LDPC(576,504)	0.875	16	256
	LR8	753.3	1728	π/2-BPSK/(G)MSK	2	RS(255,239)	0.937	16	256
	LR9	803.7	1728	π/2-BPSK/(G)MSK	1	LDPC(576,288)	0.500	16	256
	LR10	1071.6	1728	π/2-BPSK/(G)MSK	1	CC(R=2/3,K=5)	0.667	16	256
	LR11	1205.6	1728	π/2-BPSK/(G)MSK	1	LDPC(576,432)	0.750	16	256
	LR12	1406.5	1728	π/2-BPSK/(G)MSK	1	LDPC(576,504)	0.875	16	256
	LR13 (MLR)	1506.6	1728	π/2-BPSK/(G)MSK	1	RS(255,239)	0.937	16	256
	LR14	1506.6	1728	Dual Rail Bipolar	2	RS(255,239)	0.937	16	256
	LR15	1607.4	1728	π/2-QPSK	1	LDPC(576,288)	0.500	16	256
	LR16	376.6	864	π/2-BPSK/(G)MSK	2	RS(255,239)	0.937	16	256
	LR17	1506.6	864	π/2-QPSK	1	RS(255,239)	0.937	16	256
MR	MR1	2143.3	1728	π/2-QPSK	1	CC(R=2/3,K=5)	0.667	16	256
	MR2	2411.2	1728	π/2-QPSK	1	LDPC(576,432)	0.750	16	256
	MR3	2806.6	1728	π/2-star 8QAM	1	CC(R=2/3,K=4) & RS(63,55)	0.582	16	256
	MR4	2813.0	1728	π/2-QPSK	1	LDPC(576,504)	0.875	16	256

SC mode (HR,SC-OOK)

MCS Class	MCS Identifier	Data Rate (Mbps)	Symbol /Chip Rate (Mcps)	Modulation Scheme	Spreading factor	FEC Type	FEC Rate	Pilot Word Length (Symbols /chips)	Burst Length (Symbols /chips)
HR	HR1	3000.6	1728	π/2-QPSK	1	LDPC(1440,1344)	0.933	16	256
	HR2	3013.2	1728	π/2-QPSK	1	RS(255,239)	0.937	16	256
	HR3	3013.2	1728	Dual Rail Bipolar	1	RS(255,239)	0.937	16	256
	HR4	3214.9	1728	π/2-NS8QAM	1	TCM(R=1/2,K=5)	0.667	16	256
	HR5	3214.9	1728	Dual Rail Bipolar	1	Uncoded	1.000	16	256
	HR6	3616.7	1728	π/2-8PSK	1	LDPC(576,432)	0.750	16	256
	HR7	4210.0	1728	π/2-star 8QAM	1	RS(63,55)	0.873	16	256
	HR8	4219.5	1728	π/2-8PSK	1	LDPC(576,504)	0.875	16	256
	HR9	4500.8	1728	π/2-8PSK	1	LDPC(1440,1344)	0.933	16	256
	HR10	4519.7	1728	π/2-8PSK	1	RS(255,239)	0.937	16	256
	HR11	4519.7	1728	π/2-NS8QAM	1	RS(255,239)	0.937	16	256
	HR12	4822.3	1728	π/2-16QAM	1	TCM(R=2/3,K=5)	0.750	16	256
	HR13	4822.3	1728	π/2-16QAM	1	LDPC(576,432)	0.750	16	256
	HR14	5626.0	1728	π/2-16QAM	1	LDPC(576,504)	0.875	16	256
	HR15	6026.3	1728	π/2-16QAM	1	RS(255,239)	0.937	16	256
SC-OOK	SCOOK1	50.2	1728	OOK	32	RS(255,239)	0.937	0	256
	SCOOK2	376.6	1728	OOK	4	RS(255,239)	0.937	16	256
	SCOOK3	753.3	1728	OOK	2	RS(255,239)	0.937	16	256
	SCOOK4	1506.6	1728	OOK	1	RS(255,239)	0.937	16	256

Appendix 2
Updated MCS table

Class 1 and 2

MCS Class	MCS Identifier	PHY-SAP rate Mbs	Modulation Scheme	Spreading factor	FEC Type	FEC Rate
Class 1	LR1	**50.6**(CR)/379.6/ 759.2/**1518.4**(MLR)	π/2-BPSK/(G)MSK	32/4/2/1	RS(255,239)	0.937
	LR2	607.5/1215.0	π/2-BPSK/(G)MSK	2/1	LDPC(576,432)	0.750
	LR3	810.0	π/2-BPSK/(G)MSK	1	LDPC(576,288)	0.500
Class 2	MR1	1620.0	π/2-QPSK	1	LPDC(576,288)	0.500
	MR2	2430.0	π/2-QPSK	1	LPDC(576,432)	0.750
	MR3	2835.0	π/2-QPSK	1	LDPC(576,504)	0.875
	MR4	3024.0	π/2-QPSK	1	LDPC(1440,1344)	0.933
	MR5	3036.7	π/2-QPSK	1	RS(255,239)	0.937

Class 3 and 4

MCS Class	MCS Identifier	PHY-SAP rate Mbs	Modulation Scheme	Spreading factor	FEC Type	FEC Rate
Class 3	HR1	4555.1	π/2–Star 8QAM	1	RS(255,239)	0.937
	HR2	6073.4	π/2-16QAM	1	RS(255,239)	0.937
Class 4	OOK1	1518.4/759.2	OOK	1/2	RS(255,239)	0.937
	DRB1	3036.7	Dual Rail Bipolar	1	RS(255,239)	0.937