

DTMB

Technical Review of the
**Chinese Digital Terrestrial
Television Broadcasting
Standard (DTMB)**



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Outlines

- 1 Brief Historical Review
- 2 Key Technologies of DTMB
- 3 Some Measurement Results
- 4 Conclusions



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- 1 **Brief Historical Review**
- 2 **Key Technologies of DTMB**
- 3 **Some Measurement Results**
- 4 **Conclusions**

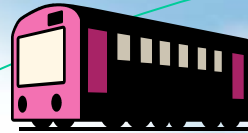


Brief Historical Review

- ❖ *In 1994*, Initial study
- ❖ *In 2001*, call for proposal and submission
 - Tsinghua University's DMB-T
 - Shanghai Jiaotong University's ADTB-T
- ❖ *In 2003*, Lab test & field trial, IP analysis;
 - TiMi proposed by ABS
- ❖ *In 2004*, three proposals started to merge together; and
- ❖ *In 2006*, Lab as well as the field test and the standard of DTMB announcement



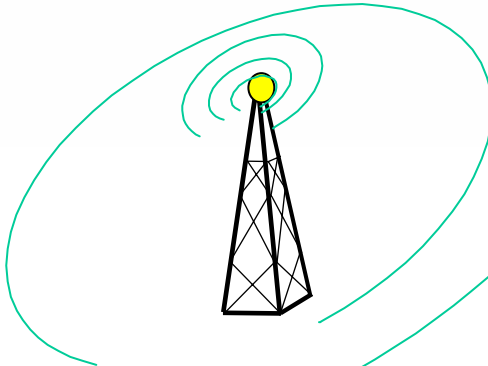
Target Applications



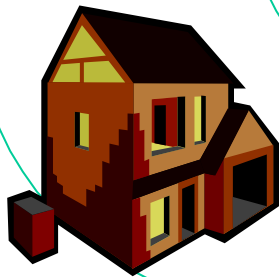
Mobile Reception



Fixed, outdoor



Handheld/Portable



Fixed, indoor





User Requirements

- ❖ Bandwidth efficiency
 - Can support >20Mbps within 8MHz

- ❖ High speed mobile reception
 - Can support mobile reception

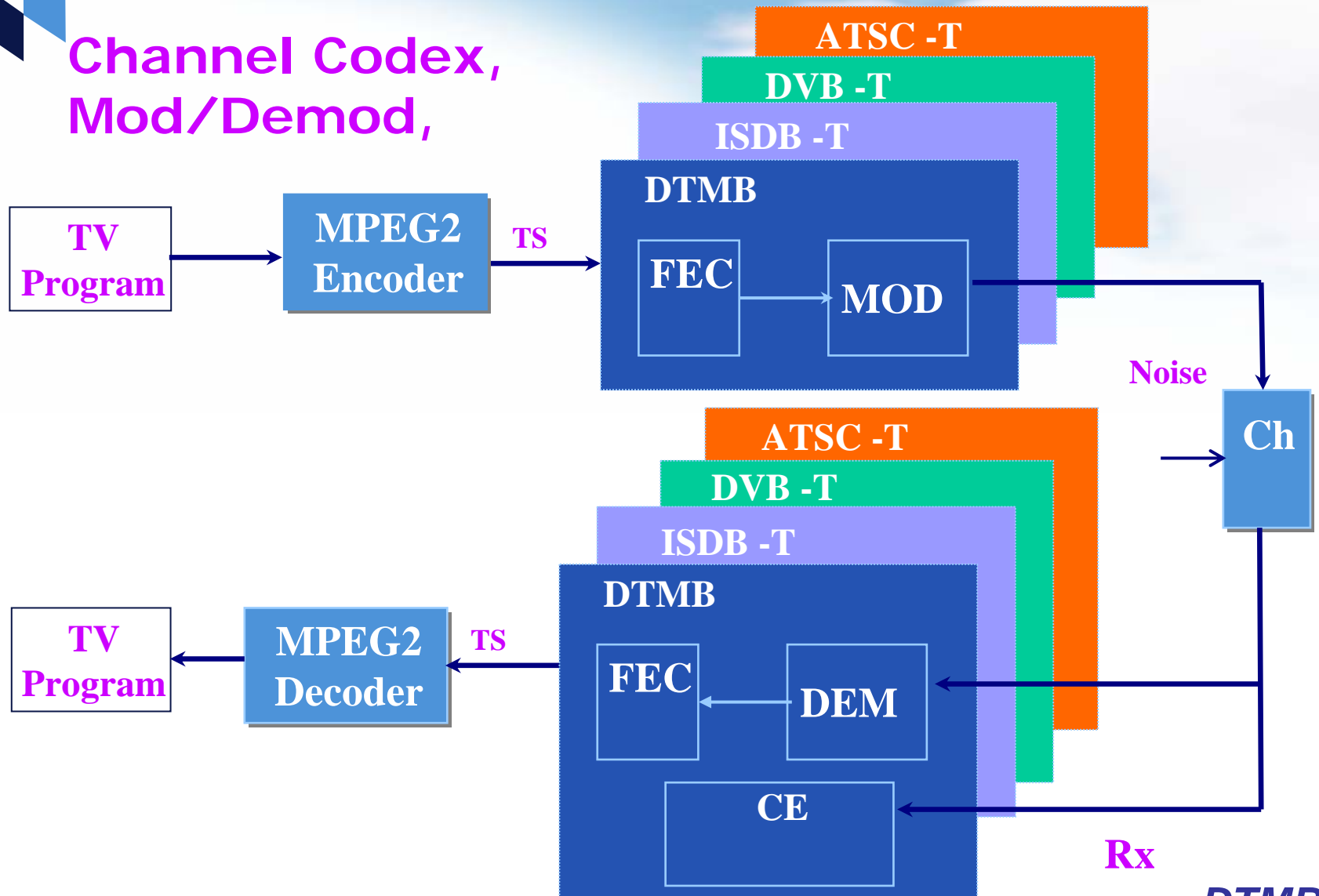
- ❖ Better coverage
 - Can cover larger area or better availability

- ❖ Portability
 - Low power consumption



What is DTMB

Channel Codex,
Mod/Demod,





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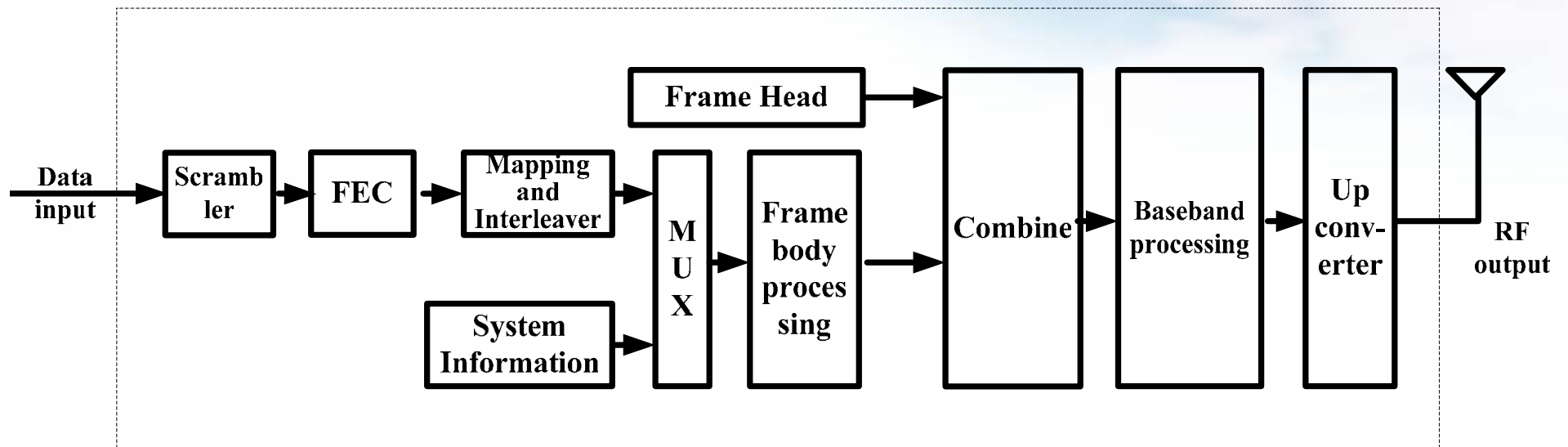


Key Technologies of DTMB

- ❖ FEC/Constellation mapping
- ❖ Interleaving (frequency/time domains)
- ❖ Frame structure & baseband Processing



Schematic Diagram





Two Modes for No. of Carriers

- ❖ Multi-Carrier with No. of Carrier parameter $C=3780$ at 2KHz spacing
- ❖ Single-Carrier $C=1$ with optional pilot insertion (-16dBc) at the frequency of \pm half symbol rate
- ❖ All these two modes have the same
 - frame structure,
 - symbol rate/data rate,
 - system bandwidth,
 - system clock/information definition, and etc.



Scrambling & FEC

- ❖ Scrambler $2^{15}-1$ bit long for randomization
- ❖ Using BCH and LDPC as FEC
 - BCH(762, 752) derived from BCH(1023, 1013) as the outer code
 - LDPC with 3 code rates as the inner code

Code Rate	Block Length (bits)	Information Bits
0.4	7488	3008
0.6	7488	4512
0.8	7488	6016

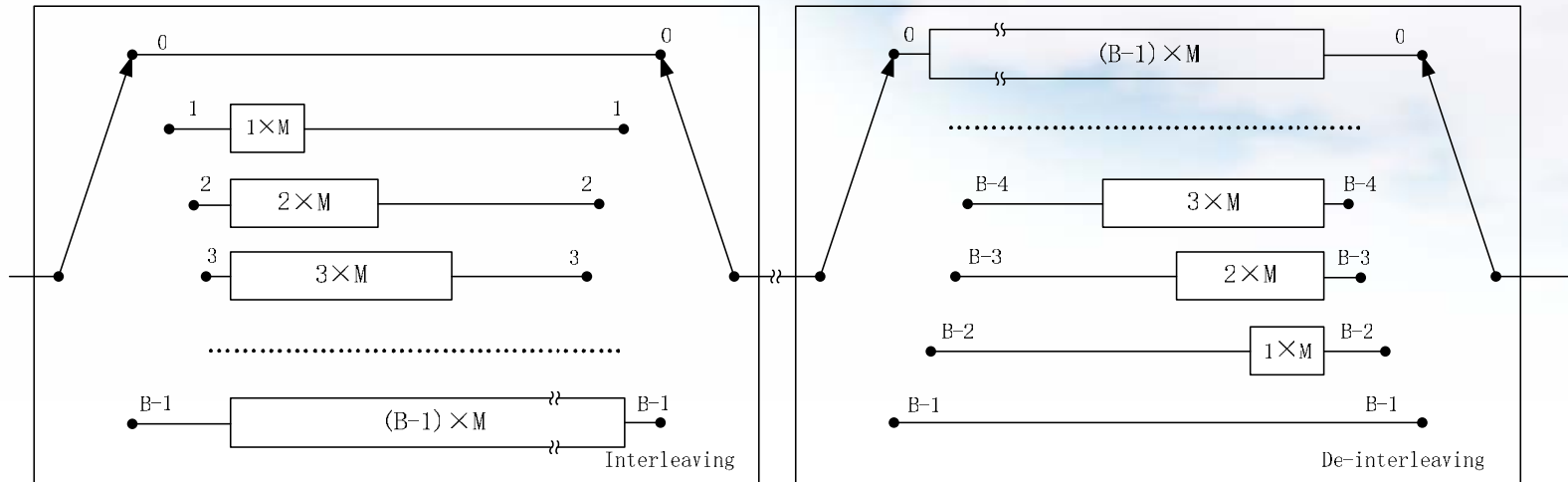


Constellation Mapping

- ❖ Altogether 5 mappings are adopted with power normalization
 - 64 QAM
 - 32 QAM
 - 16 QAM
 - 4 QAM
 - 4 QAM-NR



Time-domain Convolutional Interleaver



- ❖ Two modes: B-branch No., M-depth
 - B/M: 52/240 with delay of 170 Signal Frames
 - B/M: 52/720 with delay of 510 Signal Frames

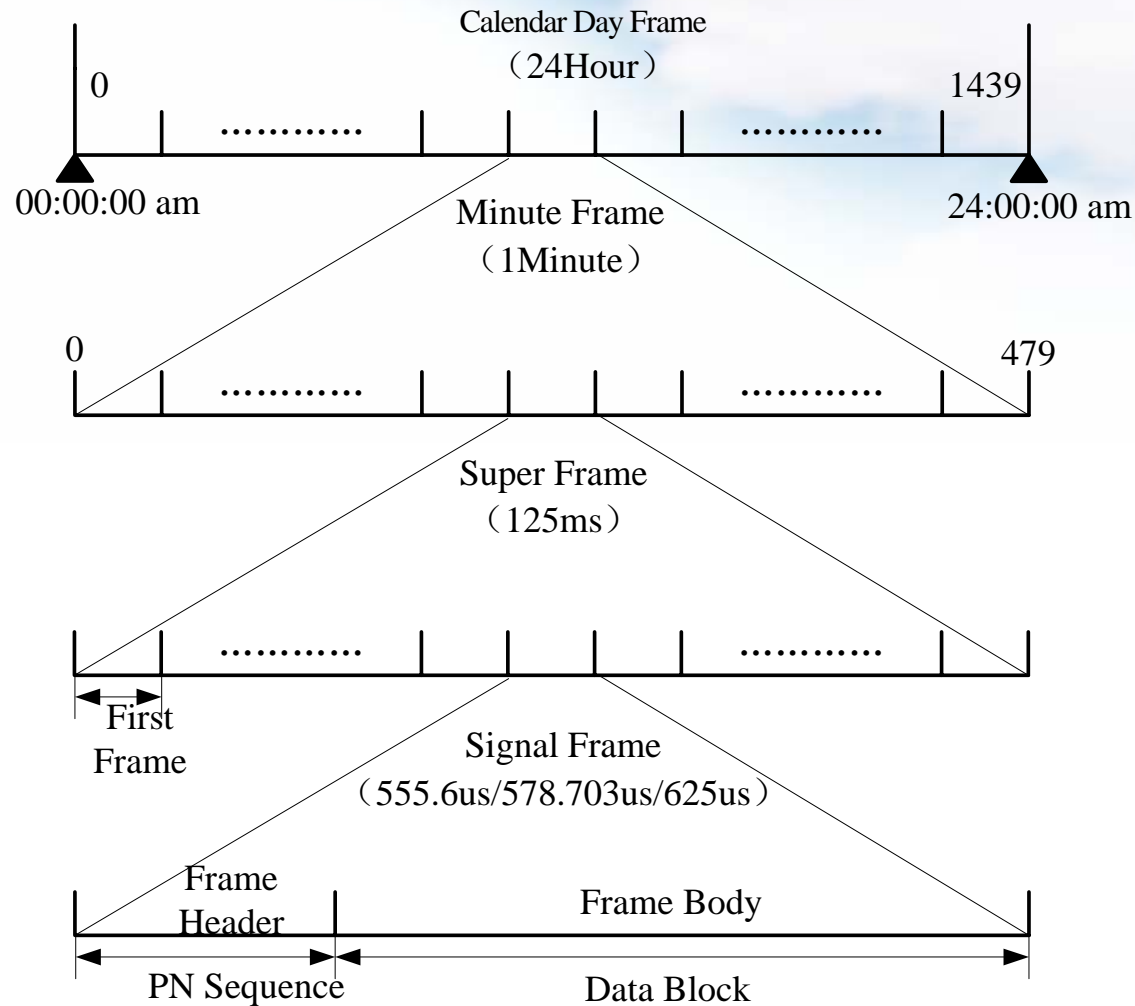


Frequency-domain Interleaver

- ❖ Within each Signal Frame and is only for the multi-carrier mode



Hierarchical Frame Structure



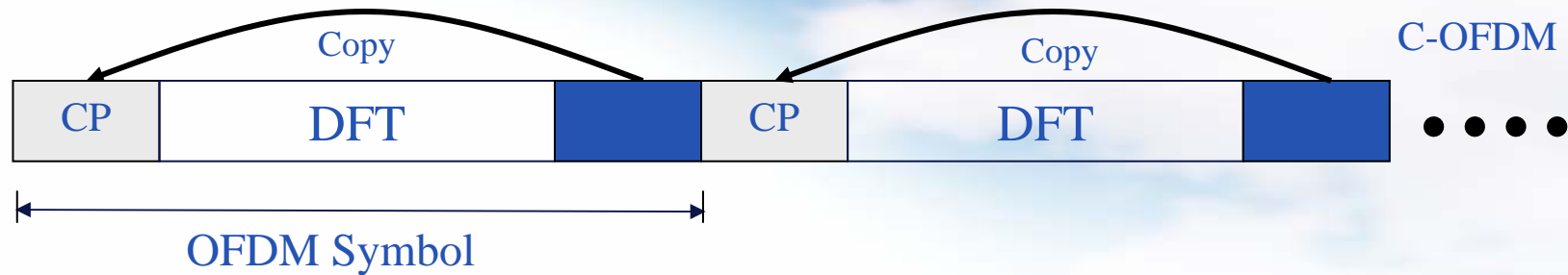


The basic Element: Signal Frame

- ❖ Symbol rate: 7.56Mps
- ❖ Fixed frame body length of 3780 symbols
 - 3744 symbols of information
 - 36 symbols of system information
 - Fixed duration of 500 μ s
- ❖ Three different length of frame header
 - 420-symbol long
 - 595-symbol long
 - 945-symbol long
- ❖ Signal frame doesn't have constant duration

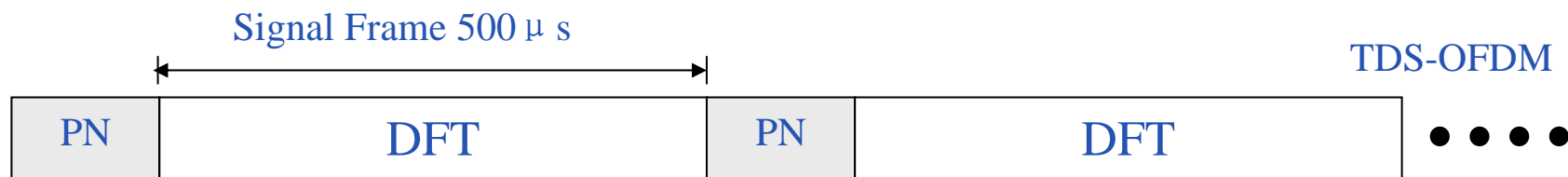


Time-domain Synchronous OFDM



C-OFDM: Process in Frequency domain

Parameter refresh:1ms; Signal lock:100ms



TDS-OFDM: Process in Time/Frequency domains

Channel estimation:0.56ms; Signal lock: 5ms

Synchronization gain : >20dB



PN in TDS-OFDM

- ❖ As guard interval similar to CP in OFDM
- ❖ For synchronization in time domain
 - No need for the continuous pilot insertion
 - Make the process faster
- ❖ For channel estimation
 - No need for the scatter pilot insertion
- ❖ Has better spectrum efficiency
- ❖ Can even provide unique address for the OFDM symbol



Unique Method for PN Protection

pre-amble 82symbols	PN255, M- sequence of 255	post-amble 83symbols
FH of 420		
pre-amble 217 symbols	PN511, M- sequence of 511	post-amble 217 symbols
FH of 945		

PN can be either fixed or rotated, the rotate PN provides unique address for the signal frame within super frame



Baseband Data Processing

Frame forming with $C=3780$

$$F_{Body}(k) = \frac{1}{\sqrt{C}} \sum_{n=1}^C X(n) e^{j2\pi n \frac{k}{C}} \quad k = 0, 1, \dots, 3779$$

Pulse shaping with $\alpha=0.05$

$$H(f) = \begin{cases} 1 & |f| \leq (1 - \alpha) / 2T_s \\ \left\{ \frac{1}{2} + \frac{1}{2} \cos \left(\frac{\pi[(2T_s |f|) - 1 + \alpha]}{2\alpha} \right) \right\}^{\frac{1}{2}} & (1 - \alpha) / 2T_s < |f| \leq (1 + \alpha) / 2T_s \\ 0 & |f| > (1 + \alpha) / 2T_s \end{cases}$$



Data Throughput (mbps)

	Frame length of 4200/4375/4725 symbols		
Code Rate	0.4	0.6	0.8
4QAM-NR			5.414/5.198 <i><u>/4.813</u></i>
4QAM	5.414/5.198 /4.813	8.122/7.797 /7.219	10.829/10.396 /9.626
16QAM	10.829/10.39 6/9.626	16.243/15.593 /14.438	21.658/20.791 /19.251
32QAM			27.072/25.989 /24.064
64QAM	16.243/15.59 3/14.438	24.365/23.390 /21.658	<i><u>32.486</u></i> /31.187 /28.877



Summary on DTMB vs DVB-T

- ❖ TDS-OFDM vs C-OFDM, Using PN brings
 - Higher spectrum efficiency
 - Faster channel synchronization
- ❖ BCH+LDPC vs RS+Convolutional code for better coding gain, therefore, lower E_b/N_0 required for the same BER
 - Larger coverage
 - Better availability
- ❖ Long time-domain interleaver
 - Better immunization to impulsive noise



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Sensitivity and C/N (AWGN)

PN	Mapping	Code Rate	Sensitivity (dBm)		C/N (dB)	
			S	M	S	M
420	4QAM	0.4	-97	-97	2.2	1.9
		0.6	-95	-95	3.9	3.7
		0.8	-92	-93	6.0	5.7
	16QAM	0.4	-91	-92	8.0	7.4
		0.6	-89	-89	10.0	9.9
		0.8	-85	-86	12.7	12.5
	64QAM	0.4	-85	-87	13.0	12.5
		0.6	-83	-83	15.3	15.2
		0.8	-80	-80	18.8	18.3



Sensitivity and C/N (AWGN) (cont'd)

PN	Mapping	Code Rate	Sensitivity (dBm)		C/N (dB)	
			S	M	S	M
945	4QAM	0.4	-97	-97	2.4	2.1
		0.6	-95	-95	4.1	4.0
		0.8	-92	-93	6.6	6.1
	16QAM	0.4	-91	-91	8.0	8.0
		0.6	-89	-89	10.0	10.0
		0.8	-85	-86	12.9	12.5
	64QAM	0.4	-84	-86	13.3	12.5
		0.6	-82	-83	15.5	15.3
		0.8	-80	-79	19.8	18.9



C/N under Fading Channels

Channel	C/N in dB			
	64QAM + FEC of 0.6		4QAM + FEC of 0.4	
	S	M	S	M
Brazil A	18.1	16.3	3.7	2.7
Brazil B	22.2	18.3	4.9	3.5
Brazil C	21.5	17.6	5.0	3.4
Brazil D	23.3	18.4	6.1	4.1
UK long paths	20.4	16.8	3.3	2.5
Short paths	25.4	19.5	6.9	4.5



PAPR Issue at TX w/o Pilots

Percentile	64QAM + FEC of 0.6		4QAM + FEC of 0.4	
	S	M	S	M
99%	5.9	6.7	5.7	6.6
99.9%	8.2	8.5	8.3	8.5
99.99%	9.5	9.7	9.6	9.8

Under the current design, there is no significant difference in PAPR between single- and multi-carrier modes



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Conclusion

- ❖ DTMB uses TDS-OFDM as well as other latest technologies to achieve
 - Higher spectrum efficiency
 - Faster channel synchronization
 - Larger FEC coding gain
 - Better capability handling impulsive noise
- ❖ From now to 08/01/2007—Probation period
- ❖ Starting from 08/01/2007, it becomes mandatory as ATSC in USA.



ACKNOWLEDGEMENT

Thanks to all the contributions
from different individuals and
groups to this standard!

DTMB

Thank You !

Tips:

You can buy the standard (GB20600-2006) at
http://www.bzcbs.com/about/about_us.asp

(You need to learn Chinese first)

