

# **A Comprehensive Grasp on MB810**

**ChanGoo Lee and Hyeong Ho Lee,**

**Dae Young Kim,**

**Insun Park,**

**WanKee Lee,**

**ETRI**

**CNU**

**KAIST**

**PAION**

**<http://routertech.etri.re.kr/English/Standard/>**

**<http://ccl.cnu.ac.kr/MB810/>**

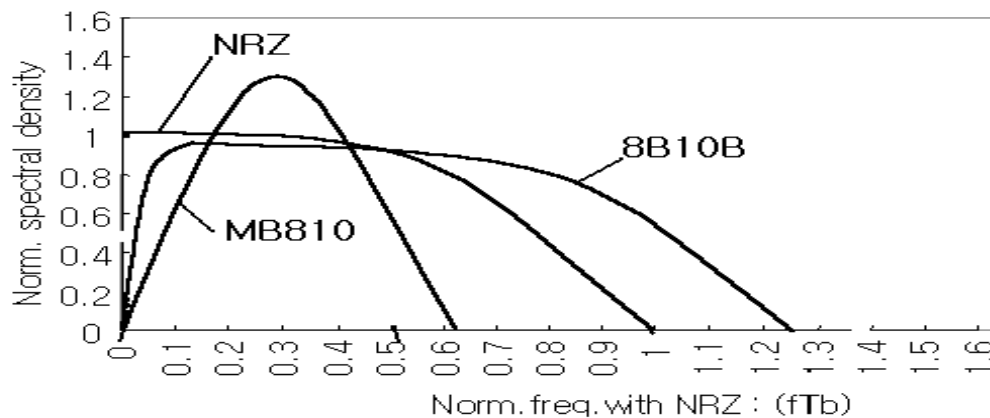
**<http://www.10gigabit-ethernet.or.kr/>**

# Goals of this Presentation

- **Summarize all materials on MB810 that is presented to IEEE 802.3ae from July 1999 to Mar. 2000.**
- **Remind that MB810 shares similar characteristics with 8B/10B but has superior to long distance than any other binary code in fiber transmission.**
- **Finally, express our thanks to this committee for supporting our idea.**

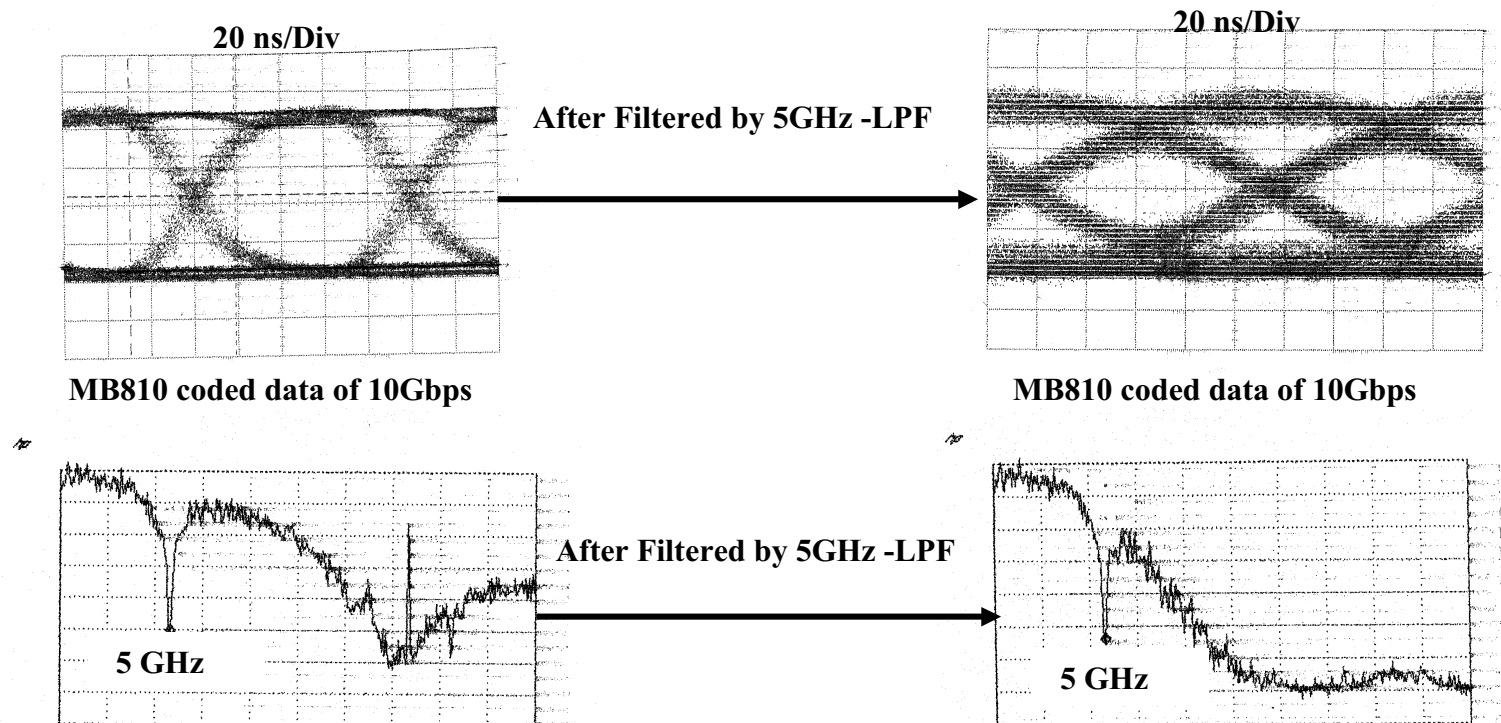
# MB810 is Minimum Bandwidth Code [1]

- **MB810 is a Binary Code.**
- **It converts 8bits into 10 bits.**
- **DC-free and Minimum bandwidth.**
- **Max. Run-length is 7 and ASV 5, DSV 6.**
- **State dependently encoded, but decoded state independently.**



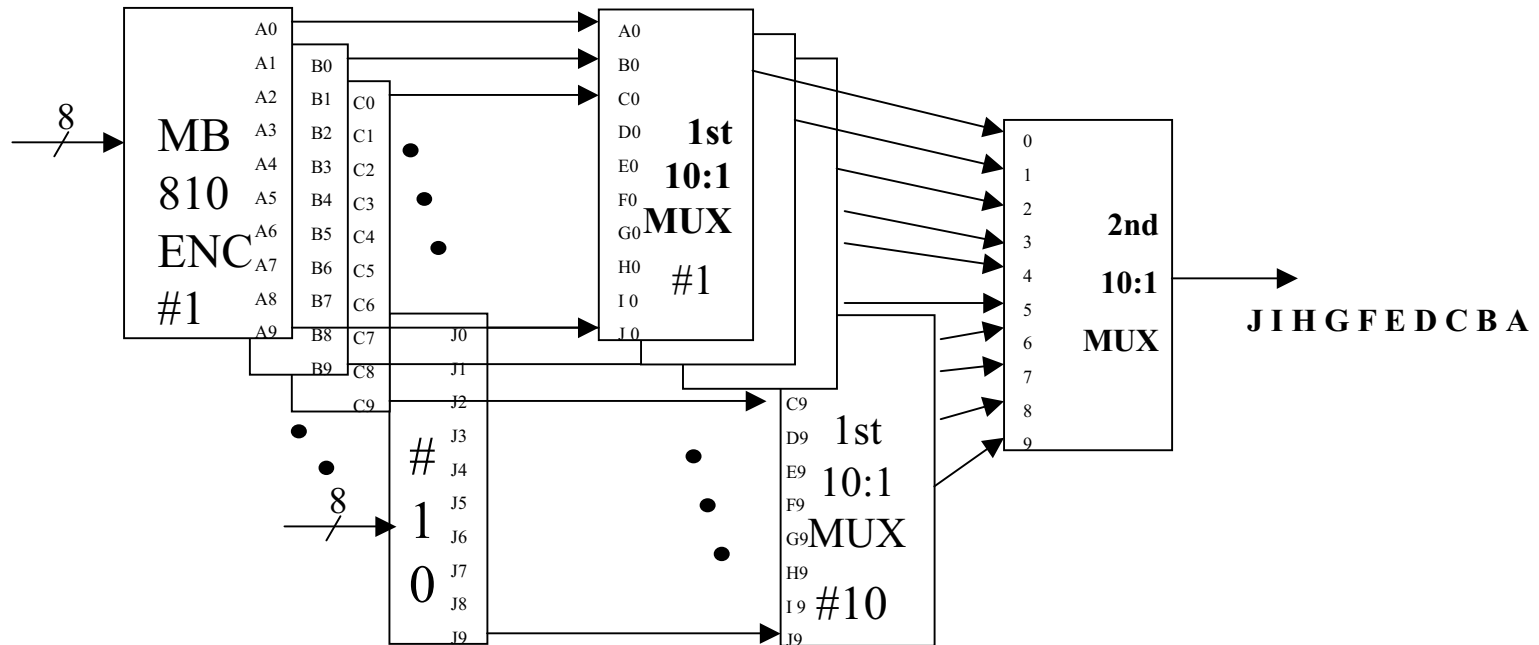
# Performance Measurement <sup>[2]</sup>

- 5th order Chebyshev filter used



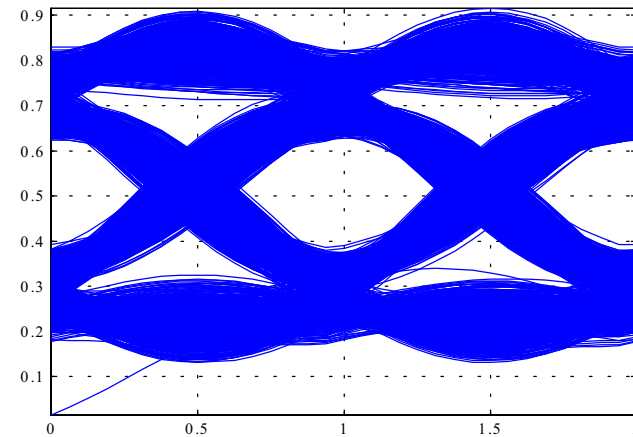
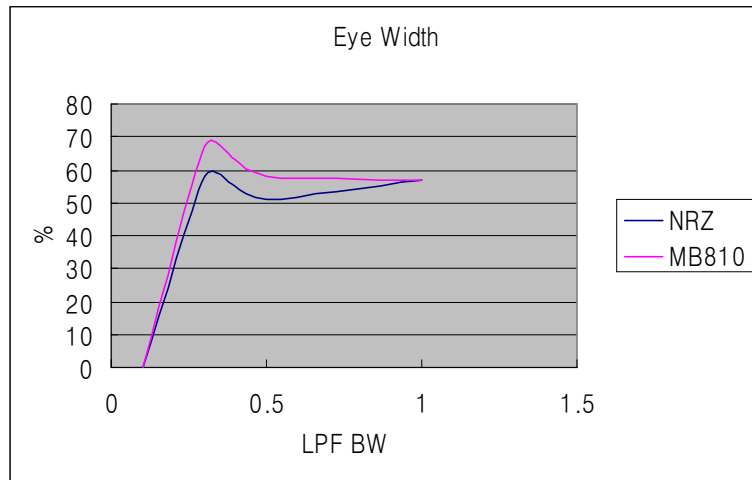
***MB810 is error free when cut off set at the Nyquist frequency; 50% of the line rate and 60% of the data rate. A wide eye opening***

# Implementation: Double Multiplexing [3]



- Estimated gate number is under 20K in VHDL simulation

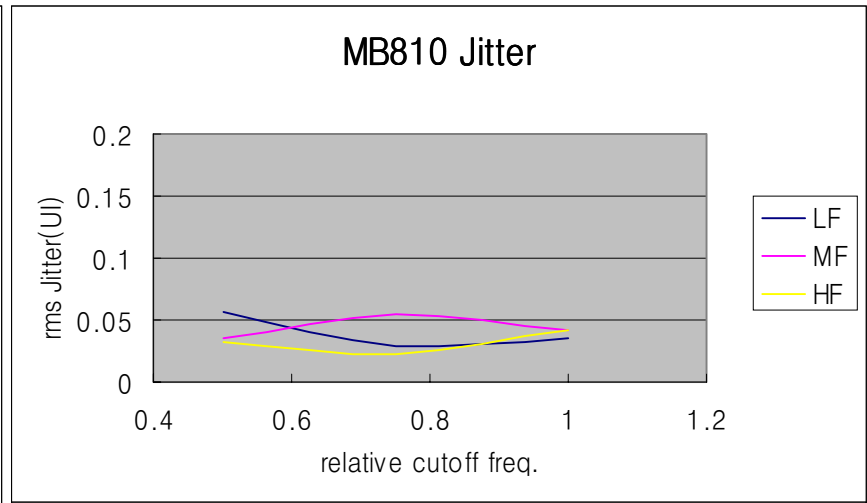
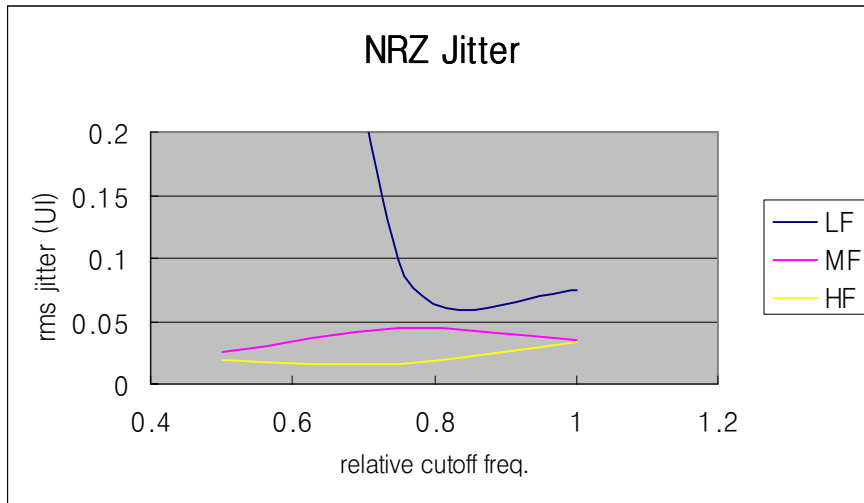
# Simulation Results (1) [2]



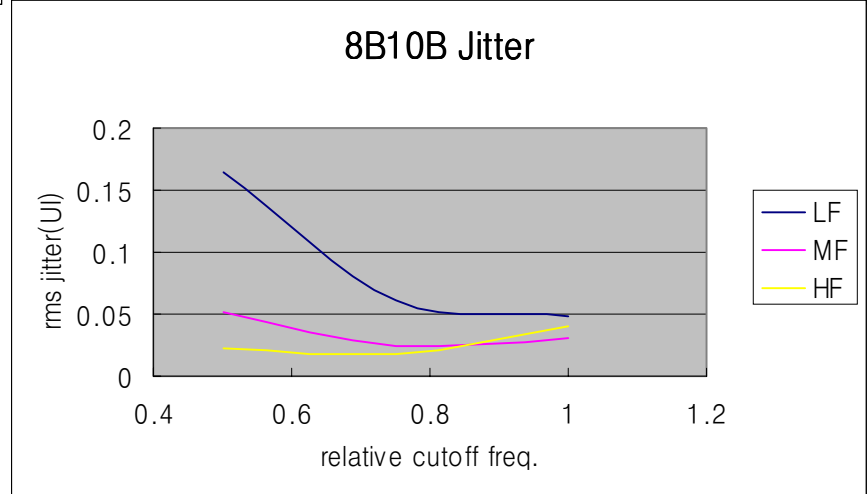
Measured at frequency of  $0.35 \cdot 1/T$

- ***Eye is more wider than NRZ while decreasing channel bandwidth.***

# Simulation Results (2) [4]



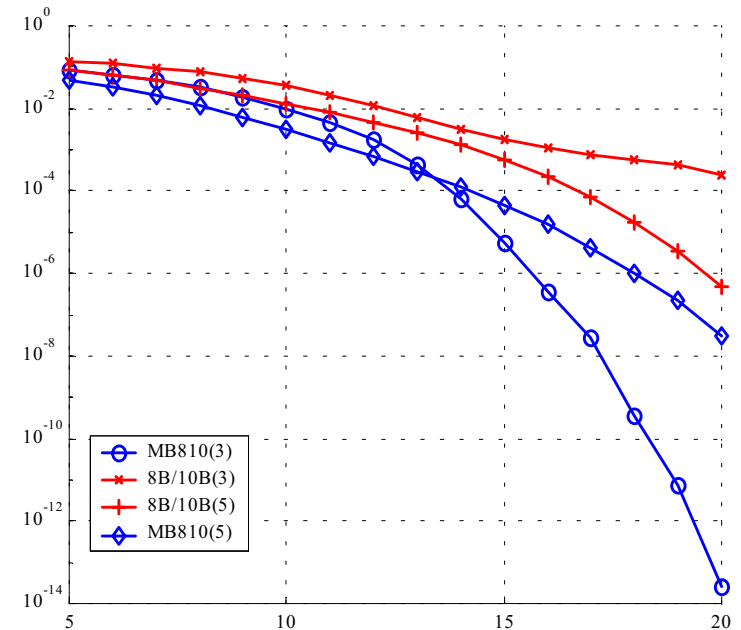
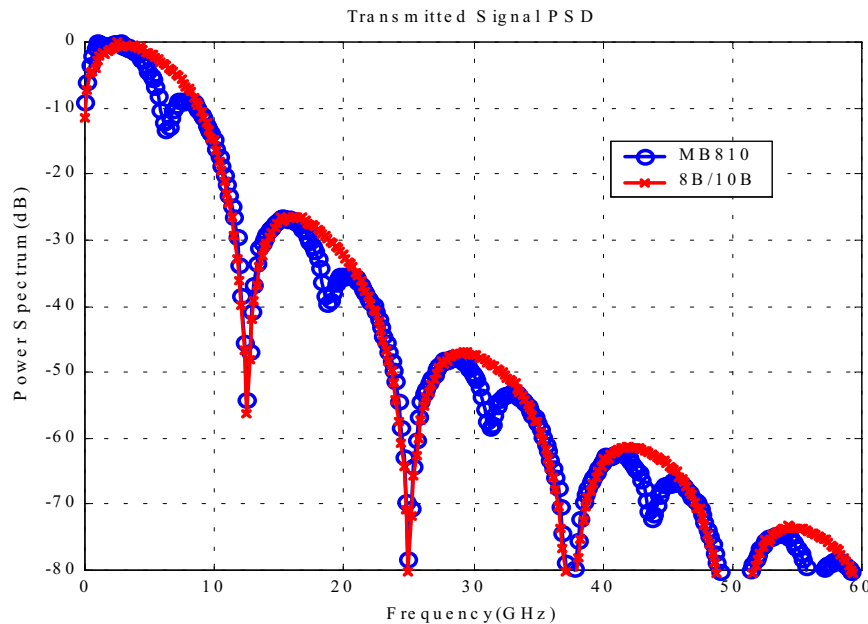
- **As the channel bandwidth decreases further, the jitter of NRZ and 8B/10B explode whereas that of MB810 stays relatively constant.**



# Simulation Results (3) [18]

- Linear channel transmission

## Transmitted signal PSD in channel

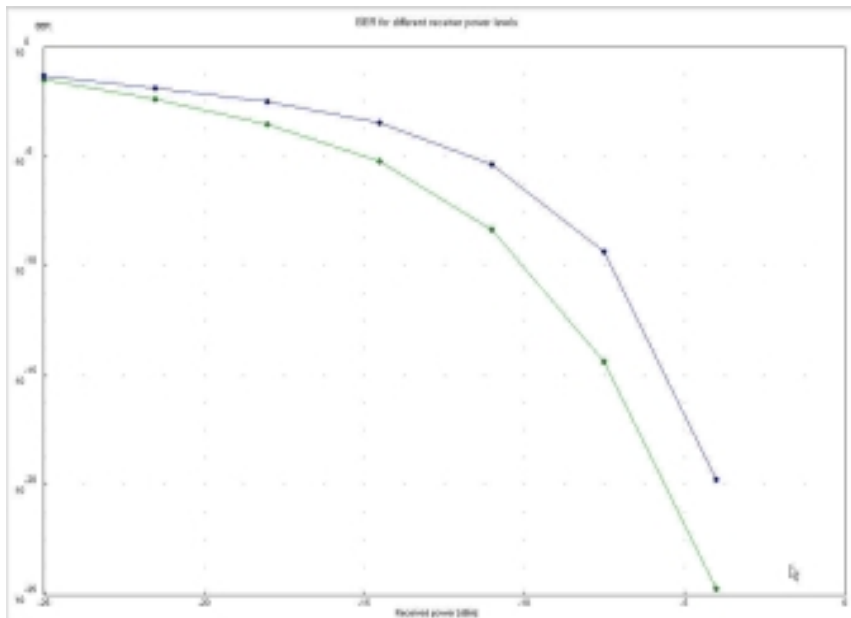


***When channel bandwidth is 5GHz, MB810 shows better performance than that of 8B/10B***

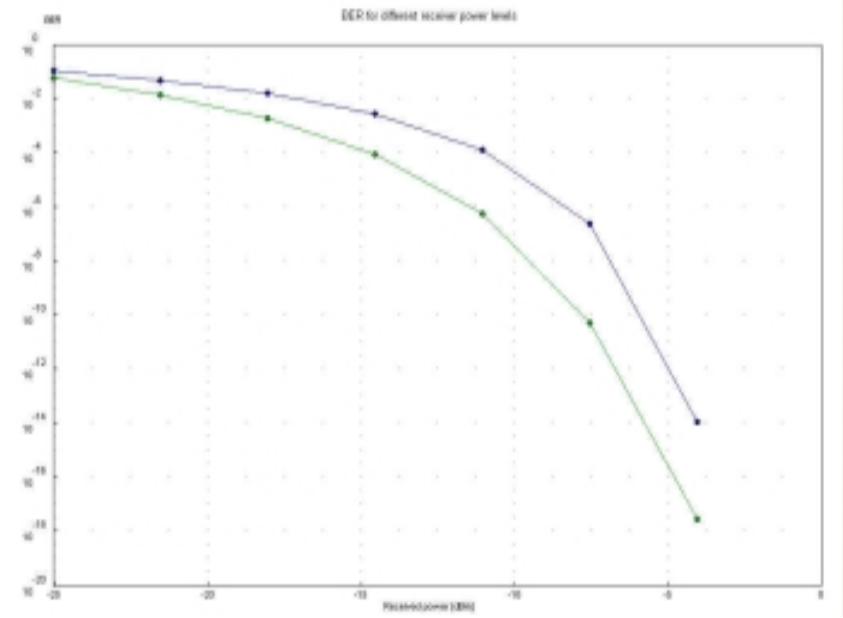


# Simulation Results (4) [18]

- **Fiber Channel Simulation - Distance 60km to 120km**



**MB810, Blue: fc=10GHz,  
Green: fc= 5GHz**



**8B10B, Blue: fc=10GHz,  
Green: fc= 5GHz**

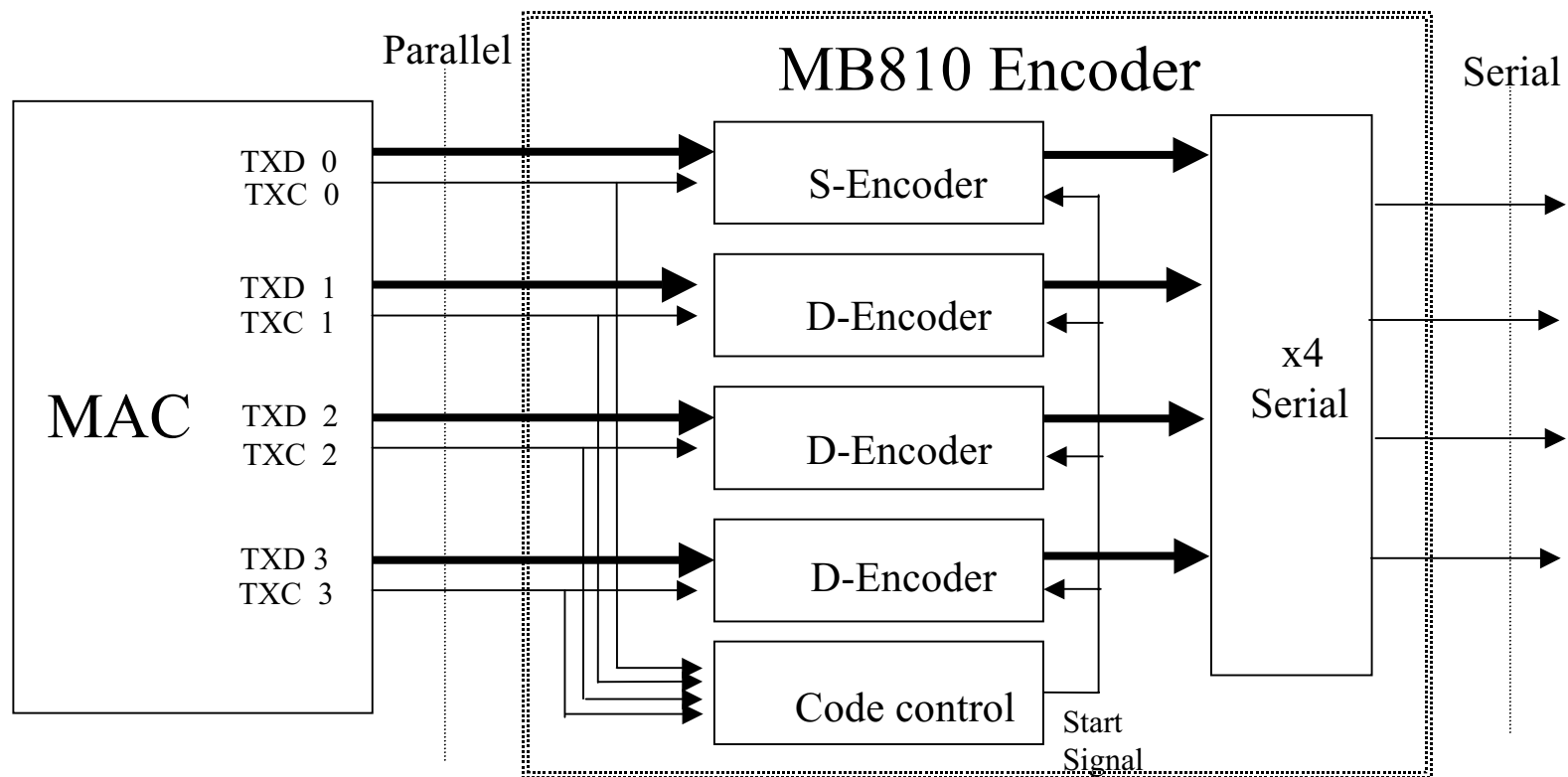
# MB810 Control Codes for 10GbE Serial Interface <sup>[8]</sup>

- *Same control codes are defined and used as those of 8B/10B*

8B10B Code			MB810 Code			
Symbol	Code	Description	Symbol	Code	Description	
K	K+	0011111010	K	K+	0011111010	Idle/even cycles
	K-	1100000101		K-	1100000101	
R	R+	0011110100	R	R+	0011000011	Idle/odd cycles
	R-	1100001011		R-	1100111100	
S	S+	1101101000	S	S+	1001000111	Start of Packet
	S-	0010010111		S-	1010000111	
T	T+	1011101000	T	T1+	1000011101	End of Packet
	T-	0100010111		T1-	0111100010	
T2+				0111100011		
T2-	1000011100					
E	E+	0111101000	E	E+	1001110001	Error
	E-	1000010111		E-	0110001110	

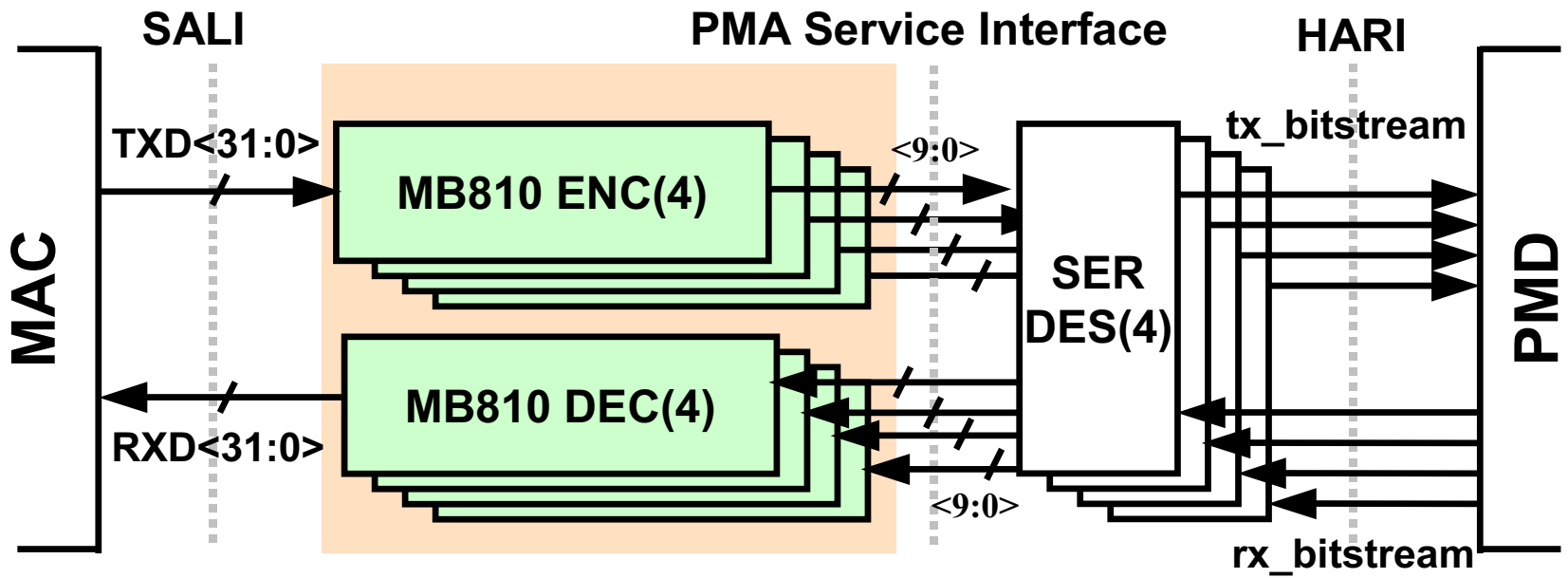
# MB810 Encoder architecture <sup>[8]</sup>

- *Same architecture is used as that of 8B/10B*



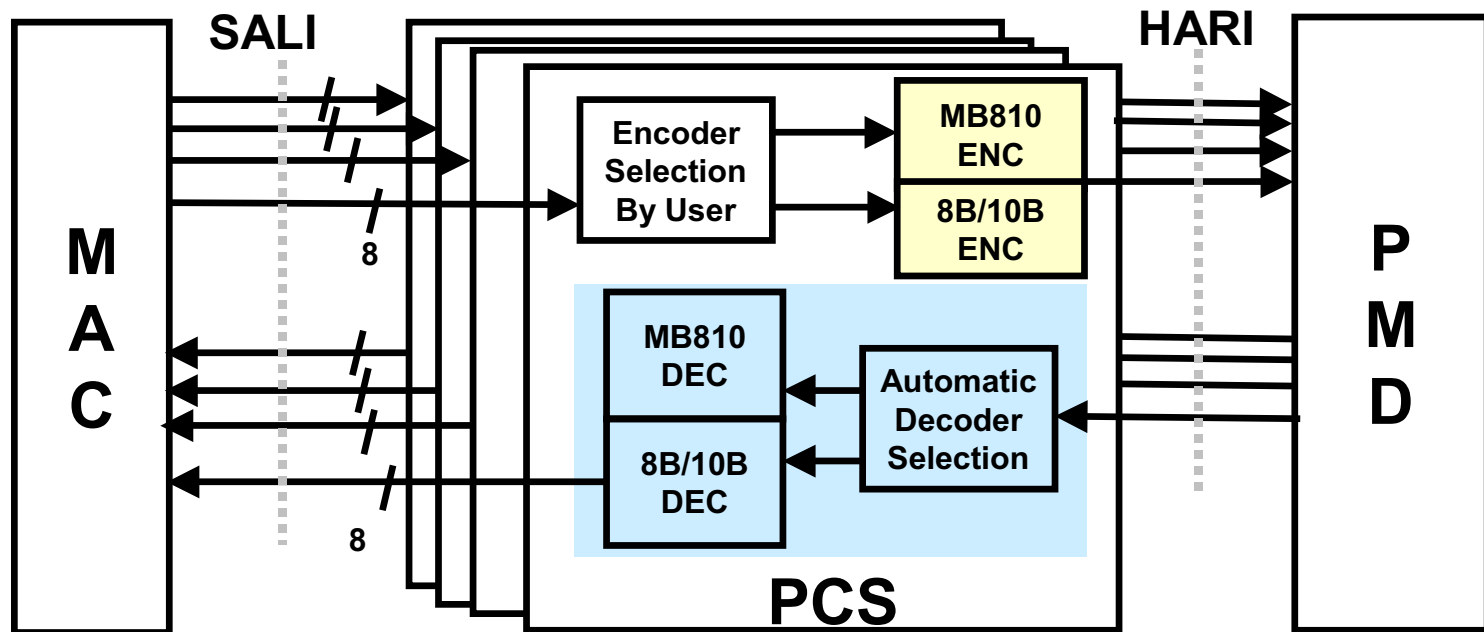
## MB810 is applicable to 4- $\lambda$ Architecture [19]

- MB810 ENDEC sits between the same SALI(XGMII) and HARI(XAUI) interfaces as 8B/10B ENDEC does.



# Dual Mode PCS <sup>[19]</sup>

- **Adoption of MB810 together with 8B/10B in PCS is free from system architecture.**



# Conclusion and Future Plan

- **MB810 offers better performance; less bandwidth, less jitter, longer transmission distance, less emission.**
- **MB810 can be considered as an alternative 8B/10B coding and thus implemented in dual mode PCS.**
- **With less bandwidth, MB810 can also be applied successfully to fibers; e.g., VCSEL over MMF/SMF.**
- **We are designing dual mode PCS chip and will evaluate it in 10GbE system in this year.**
- **We hope to announce the evaluation results in soon.**

## References

- [1] ChanGoo Lee, Dae Young Kim, Hae Won Jung, and Hyeong Ho Lee, "A new line code MB810 for 10 GbE," *IEEE 802.3 HSSG plenary meeting*, Montreal, Canada, July 6-7, 1999.
  - [2] ChanGoo Lee, Dae Young Kim, Chun Sik Shin, Hae Won Jung, and Hyeong Ho Lee, "Performance and Implementation Updates to MB810," *IEEE 802.3 HSSG Interim meeting*, York, UK, Sept. 27-29, 1999.
  - [3] ChanGoo Lee, Dae Young Kim, Chun Sik Shin, Hae Won Jung, and Hyeong Ho Lee, "White paper on the MB810 Line Code for 10GbE," *IEEE 802.3 HSSG Interim meeting*, York, UK, Sept. 27-29, 1999.
  - [4] ChanGoo Lee, Dae Young Kim, Kyung Gyu Chun, Hae Won Jung, and Hyeong Ho Lee, "Jitter Consideration of MB810," *IEEE 802.3 HSSG Plenary meeting*, Kauai, Hawaii, Nov. 9-10, 1999.
  - [5] Dae Young Kim, Tae Kyu Kang, Sang Seob Song, Moo Jung Chu, Sang Soo Lee, and Hyeong Ho Lee, "MB810 Applications for HARI Interface," *IEEE 802.3 HSSG Interim meeting*, Dallas Texas, Jan. 18-20, 2000.
  - [6] Dae Young Kim, Tae Kyu Kang, Sang Seob Song, Moo Jung Chu, Sang Soo Lee, and Hyeong Ho Lee, "MB810 Applications for HARI Interface," *IEEE 802.3 HSSG Interim meeting*, Dallas Texas, Jan. 18-20, 2000.
  - [7] ChanGoo Lee, Yong Woo Chae, Dae Young Kim, Hae Won Jung, and Hyeong Ho Lee, "Considerations on MB810 Decoder for 10 GbE," *IEEE 802.3 HSSG Interim meeting*, Dallas Texas, Jan. 18-20, 2000.
  - [8] Heyung Sub Lee, ChanGoo Lee, Dae Young Kim, and Hyeong Ho Lee, "MB810 Encoding Method with Control Codes," *IEEE 802.3 HSSG Interim meeting*, Dallas Texas, Jan. 18-20, 2000.
- IEEE 802.3 Website: <http://grouper.ieee.org/groups/802/3/ae/index.html>

## References (Con't)

- [9] Han Chul Do, ChanGoo Lee, and Hyeong Ho Lee, "Error Detectability of MB810," *IEEE 802.3 HSSG Interim meeting*, Dallas Texas, Jan. 18-20, 2000.
- [10] C. G. Lee, D. I. Lee, and D. Y. Kim, "An evaluation for high speed optical line code: Minimum Bandwidth (MB) Line code MB34," *proc. of ICT'98*, vol. 1, pp. 81-85, Porto Carras, Greece, June 1998.
- [11] D. Y. Kim, and J. -k. Kim, "A condition for stable minimum-bandwidth line codes," *IEEE Trans. Commun.*, vol. COM-33, no. 2, pp. 152-157, Feb. 1985.
- [12] D. Y. Kim, J. I. Baek, J. -k. Kim, S. K. Hyun, and Y. K. Park, "Run-Length-Limited Variants of Duobinary and Modified Duobinary," *IEEE Trans. on Commun.*, vol. COM-33, no. 2, pp. 142-150, Feb. 1987.
- [13] D. Y. Kim, "Lower-bound eye widths of minimum-bandwidth systems," *IEEE Trans. on Commun.*, vol. 43, no. 2/3/4, pp. 1235-1249, Feb./Mar./Apr. 1995.
- [14] ChanGoo Lee, Jae Il Cho, Chulhyung Zchung, Jeong Hoon Ko, and Dae Young Kim, "A Test Results of Minimum-Bandwidth Line Code MB34 in 10Gbps Optical Transmission System," *Proc. of ICICS'97*, pp. 1148-1152, Singapore, Sept. 1997
- [15] ChanGoo Lee, Dae Young Kim, Byungjun Ahn, Hae Won Jung, and Hyeong Ho Lee, Chu Hwan Yim, "A LINE CODE FOR HIGH-CAPACITY OPTICAL TRANSMISSION SYSTEMS: MB810," *proc. of ISS2000*, May 2000.
- [16] ChanGoo Lee, Hyeong Ho Lee, Dae Young Kim, Jung Whan Kim, and Hae Won Jung, "A new Line Code for 10-Gigabit Ethernet: MB810," *proc. of ICC2000*, vol. 3, pp.1774-1777, June 2000.
- [17] J.H.Kim, "A study on designing line codes of minimum bandwidth," Ph.D. *Dissertation*, CNU, Taejon, 1992.
- IEEE 802.3 Website: <http://grouper.ieee.org/groups/802/3/ae/index.html>



## References ( Con' t )

- [17] ChanGoo Lee, Dae Young Kim, Byungjun Ahn, Hae Won Jung, Hyeong Ho Lee, and Chu Hwan Yim, "A line code for high capacity optical transmission systems: MB810," Proc. of ISS2000, Access technologies1, Birmingham UK, 7-12 May 2000.
- [18] ChanGoo Lee, Dae Young Kim, Tae kyu Kang, Insun Park, and Hyeong Ho Lee, "Transmission performance of MB810," <http://ccl.cnu.ac.kr/MB810>, May 2000.
- [19] ChanGoo Lee, Tae Kyu Kang, Hyeong Ho Lee, and Dae Young Kim, " MB810 implementation for HARI," *IEEE p802.3ae plenary meeting*, Alberquerque NM, Mar. 6-10, 2000.