



High-Throughput LDPC Solution for Reliable and High Performance SSD

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- Flash vendors have made the call

	Redundant Area %
2D-MLC	~7%
2D-TLC	10%~11%
3D NAND TLC	10%~12%
3D NAND QLC	Even more?

- Hard-Decision (HD) DEC: LDPC surpasses BCH
- Soft-Decision (SD) DEC: LDPC can correct much more

How to Define SSD EOL?

EOL		SSD Requirement	ECC Requirement
Throughput		5% Drop	HD-DEC Throughput
Endurance	Retry Rate	1E-3	HD-DEC ECC Performance
	UECC Rate	1E-15	SD-DEC ECC Performance

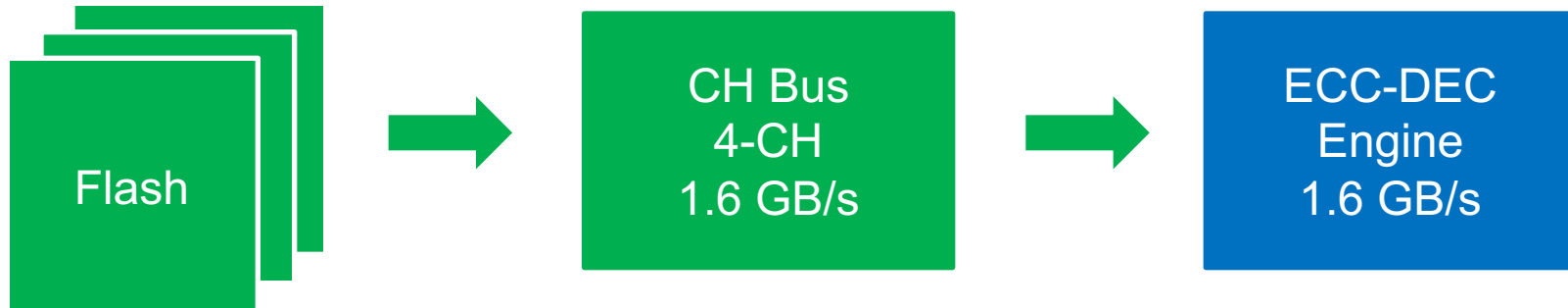
ECC Performance Throughput



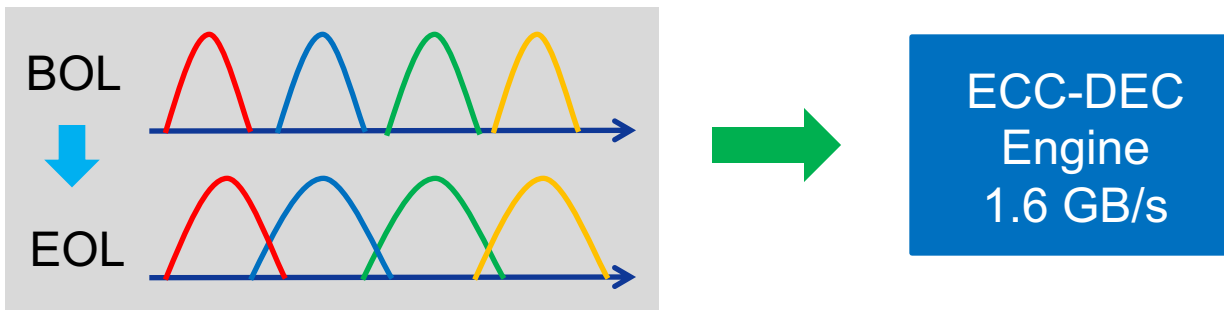
Area/Power

Algorithm
HW Architecture

HD-DEC: Overview

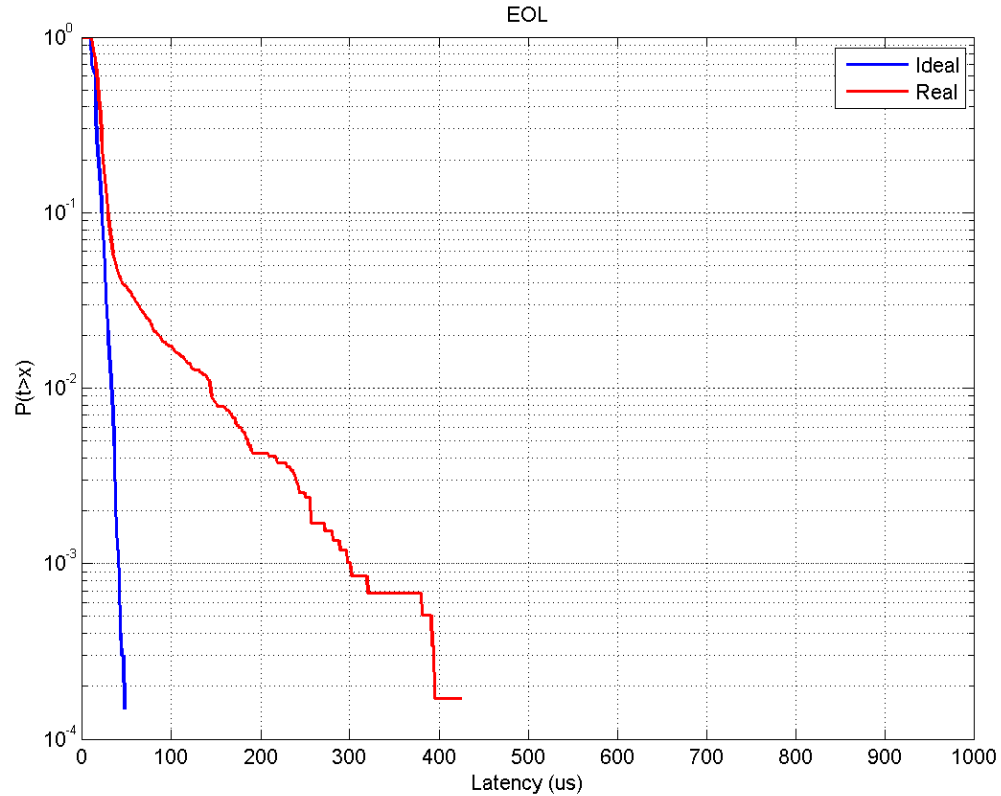


HD-DEC: Throughput

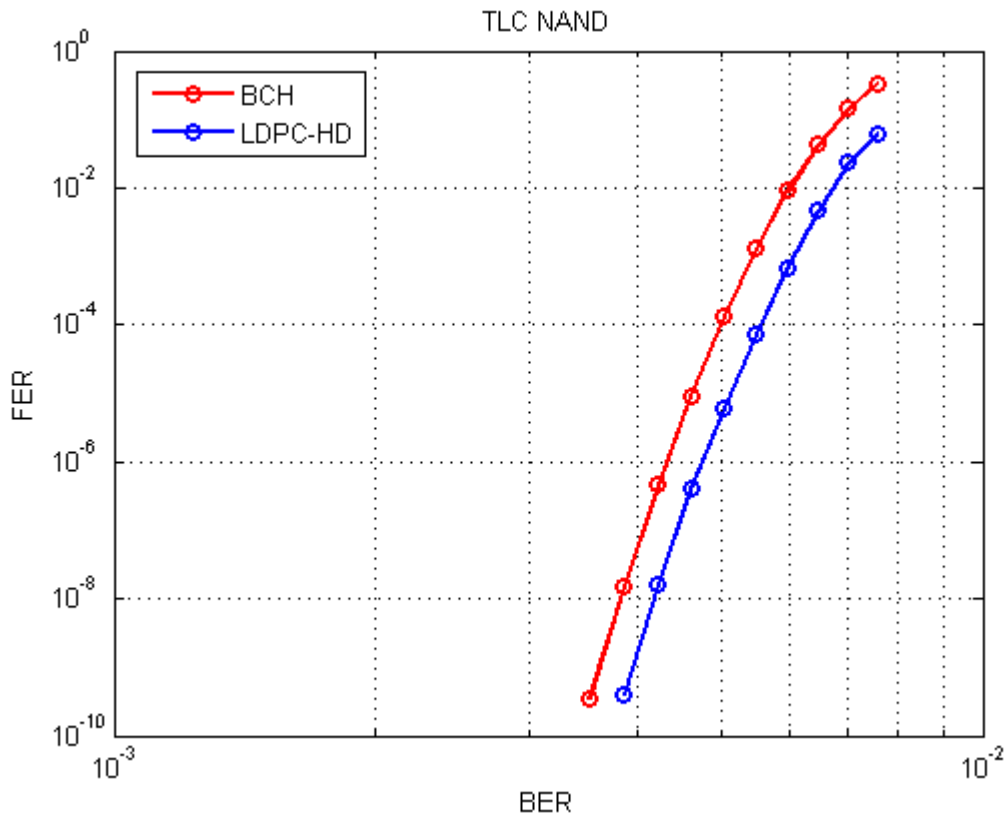


	BOL	MOL	EOL	Post EOL
Normalized Throughput	100%	100%	96%	82%

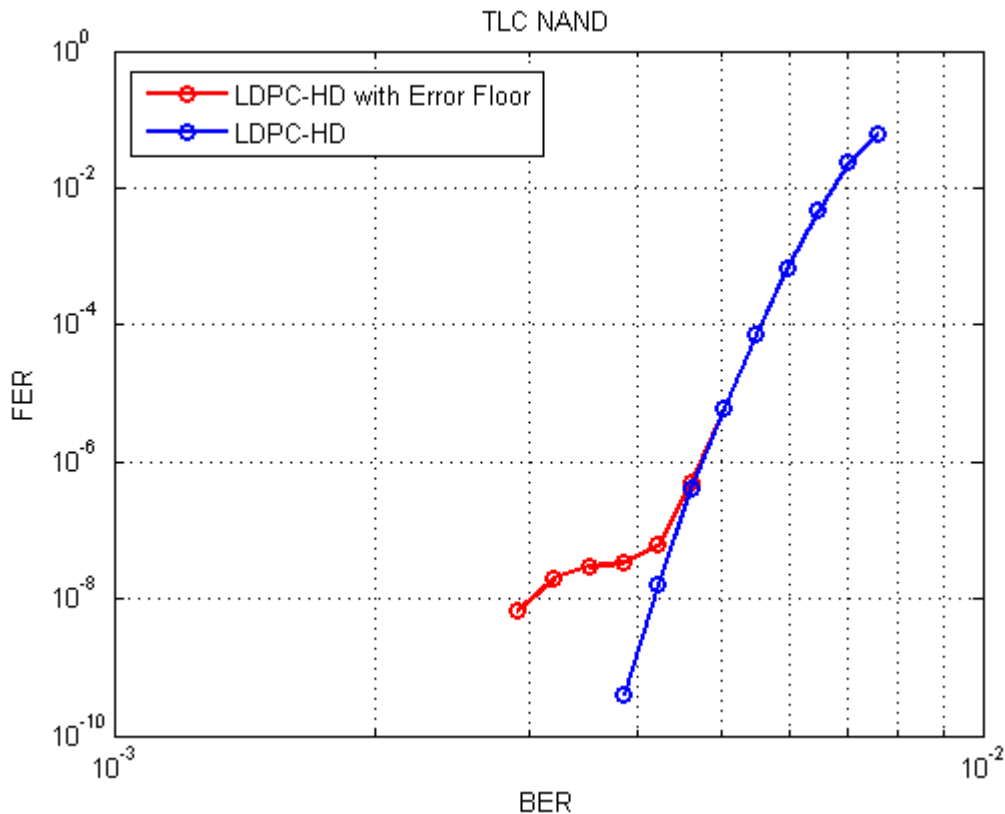
HD-DEC: QoS



HD-DEC: ECC Performance



HD-DEC: Low Error Floor

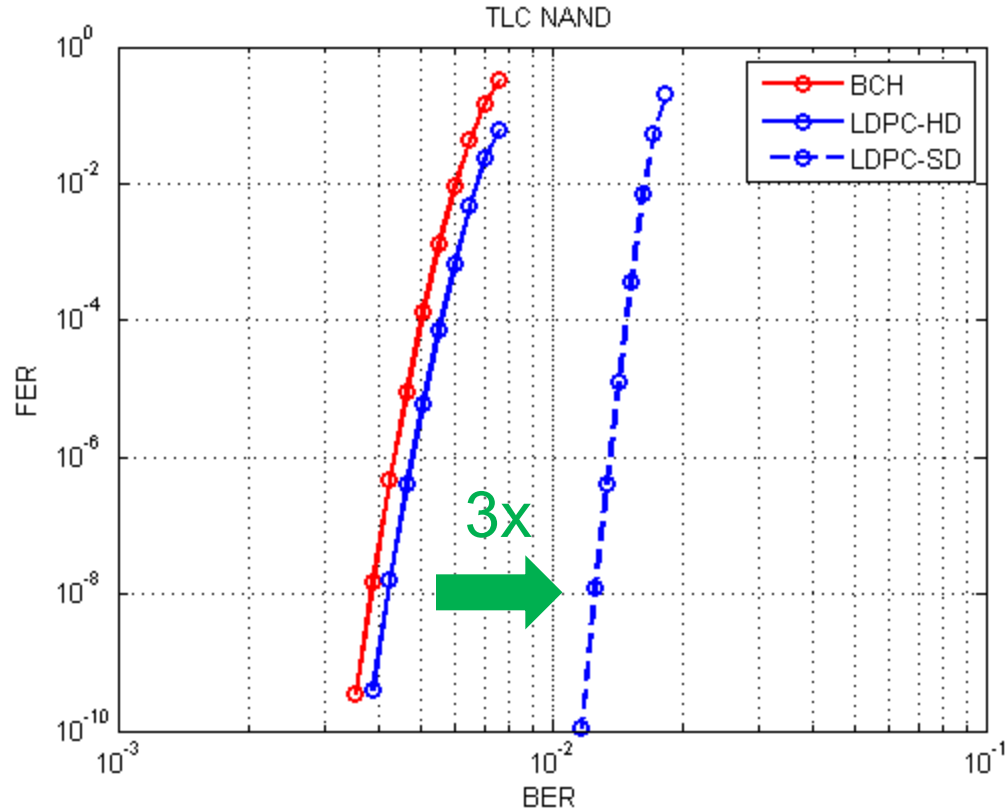


HD-DEC: Feature Summary

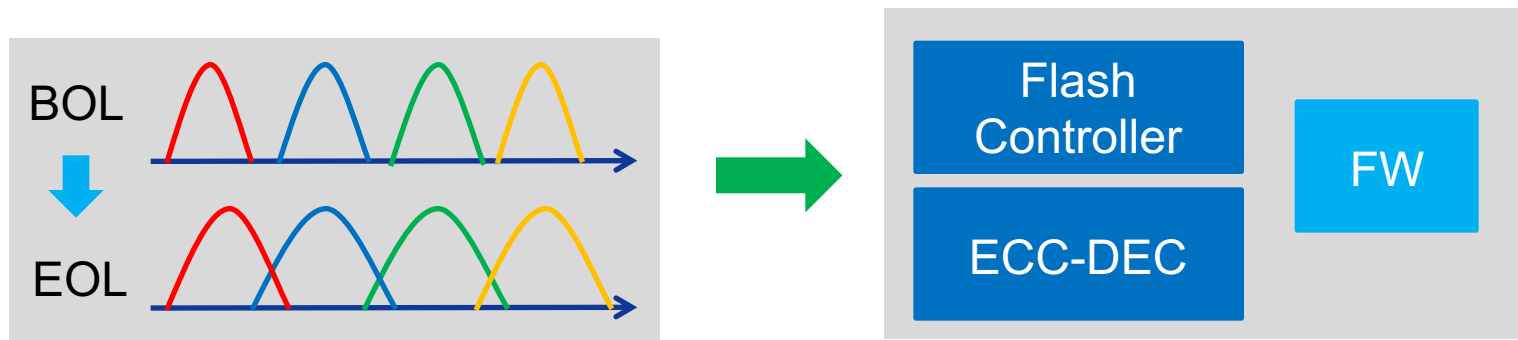
Item	Features
Code Rate	Configurable
Error Floor	Low
Code Pool	Programmable
Code Switch	Dynamic
Gate Count	Low
Throughput	Saturating Flash Bus

- SD-DEC
 - ECC Performance: High
 - Throughput: Low (Usage %: $\leq 1E-2$)
- Wrapper
 - Input Buffer Management
 - LLR Mapping
- Firmware Interaction
 - Prepare Multi-Read Data
 - Submit Jobs / Obtain Results

SD-DEC: ECC Performance

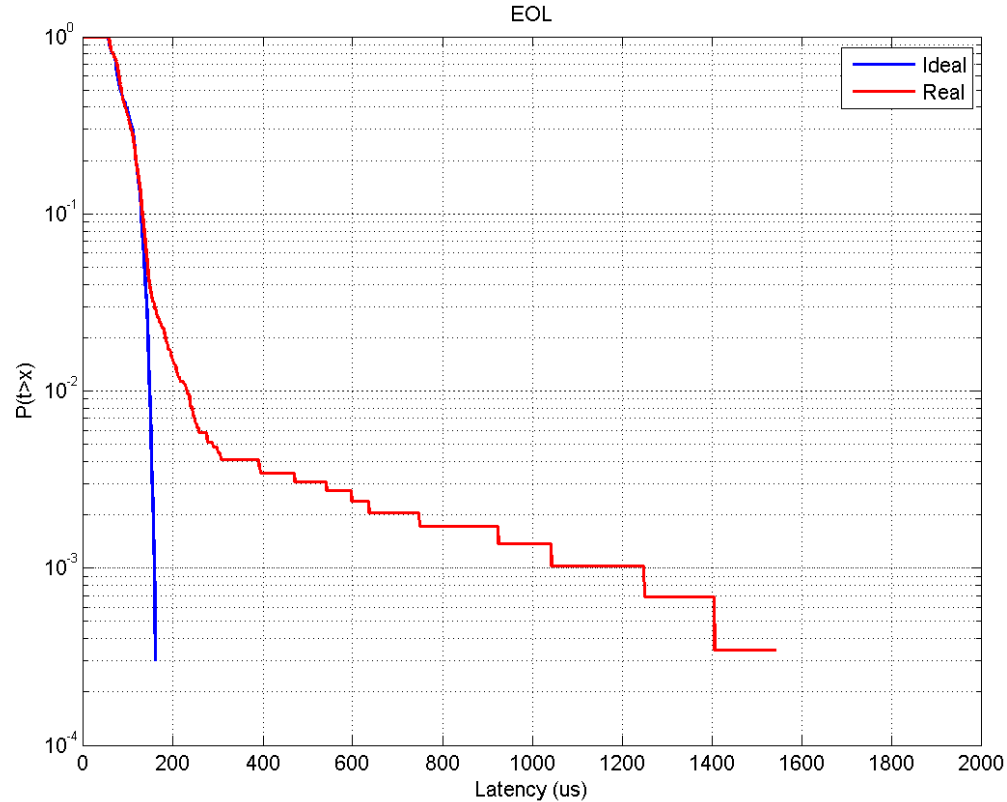


- Yes, Soft Decoding looks great.
Will it hurt the system performance?
- Consume System Bandwidth
 - Flash Bus: Shift Read
 - Internal Data Transfer: Data Transfer
 - DEC Engine: Soft Decoding



	BOL	MOL	EOL	Post EOL
Soft Decoding %	0	1E-4	1E-2	3E-2
Read Throughput	100%	100%	95%	81%

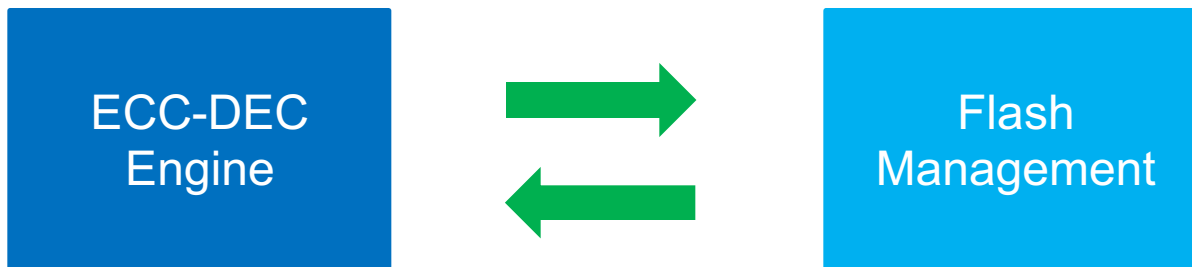
SD-DEC: Read QoS



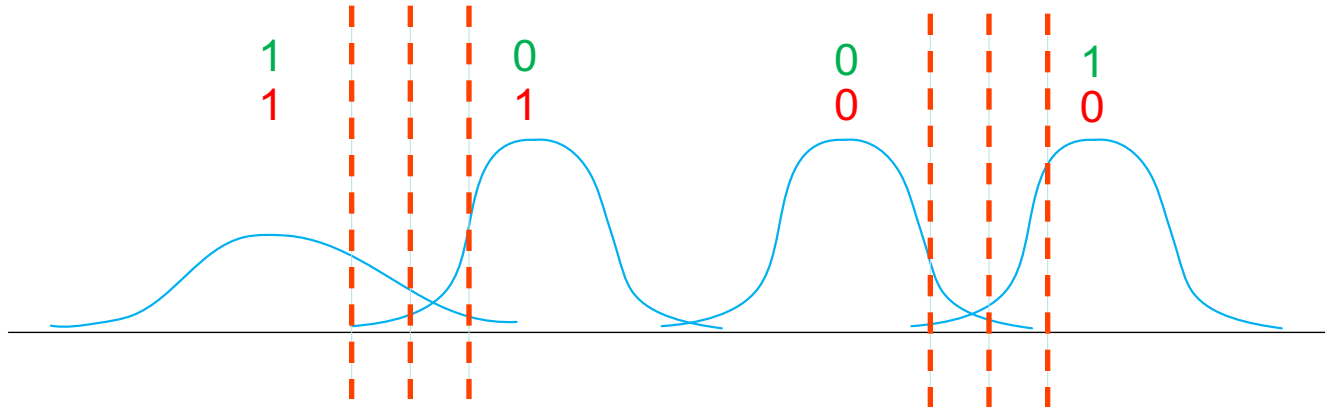
Good ECC Engine == Expected System Performance?

No, without Flash Management

Flash Management: Scheme



- For Hard Decoding
 - Vth Management
 - Retention, Read Disturb
 - Flash Physical Variation
- For Soft Decoding
 - Sensing Points
 - LLR Setting



- Propose LDPC DEC Solution (Hardware + Firmware)
 - HD-DEC
 - SD-DEC
- Achieve the following goals:
 - Provide Sustainable Throughput
 - Extend SSD Lifetime
- VIA VT6745/6735 Controllers are equipped with LDPC Plus Technology targeting for 2D/3D TLC NAND Flash

Product	VT6745	VT6735	VT6740	VT6742	VT6730
Interface	PCIe Gen3 2L	SATA Gen3	PCIe Gen3 2L	PCIe Gen2 2L	SATA Gen3
DRAM	DDR3L; LPDDR2/3-1066	DDR3L; LPDDR2/3-1066	LP/DDR3-1066	DDR3L-1066	DDR3L-1066
Channel #	X4, 8CE/Channel	X4, 8CE/Channel	X4, 8CE/Channel	X4, 8CE/Channel	X4, 8CE/Channel
MLC NAND			●	●	●
TLC NAND	●	●			
3D NAND	●	●	●	●	●
ECC	LDPC PLUS	LDPC PLUS	BCH-72b	BCH-72b	BCH-72b
XOR	●	●			
End-to-End CRC	●	●			
AES	256	256	256	256	256
TCG/OPAL	●	●	●		●

VIA Technologies @ Flash Memory Summit

Time

Presentation

Forum E-21
Wed, Aug. 10
8:30 ~ 10:50am

High-Throughput LDPC
Solution for Reliable and High
Performance SSD

Forum M-22
Wed, Aug. 10
3:50 ~ 6:15pm

SSD Flash Management for 3D
NAND Flash Memory

Session 302-D
Thurs, Aug. 11
9:45 ~ 10:50am

High Performance FTL
Architecture for PCIe/NVMe
SSDs

