



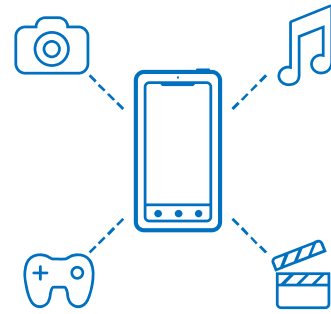
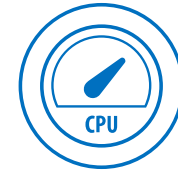
Flash Memory Summit

A Survey of Storage Products for Mobile

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Mobile Market Priorities



- Mobile market demands memory optimized for power, latency, size, and cost
- eMMC & UFS are the primary mobile storage. UFS gaining market adoption, eMMC continue to thrive in lower-tier & IoT market
- Both eMMC & UFS also provides value-added features that addresses reliability, security, and boot
 - UFS include more control/report regarding health, lifetime, and data integrity
 - Data refresh, features to improve data reliability for automotive market
- When compare with storage for computing market, SATA & NVMe/PCIe are optimized for performance, cost, and simplicity storage
- Mobile storage solution introducing features for adjacent market, i.e. automotive & IoT





Storage – Simple Features Comparison

		eMMC 5.1	UFS 2.1/3.0	SATA 3.1	NVMe 1.2
Performance	Interface	8-bit parallel	serial I/F with multi-lane	serial I/F	serial I/F with multiple lane
	Command Queue	Yes	Yes	Yes	Yes
	Command Priority	Yes	Yes	No	Yes
	Enhanced Partition	Yes	Yes	No	No
Partitioning	Boot Partition	2	2	No	No
	User Partition	4	32	No	namespace
Security	Write Protection	Yes	Yes	No	Yes
	Secure Write Protection	Yes	Yes	No	No
	Inline Encryption	Ver5.2	Yes	No	No
	RPMB	Yes	Yes	No	Yes
Reliability	Reliable Write	Yes	Yes	No	No
	Refresh	No	Yes	No	No
	Error Log Report	No	Yes	No	No

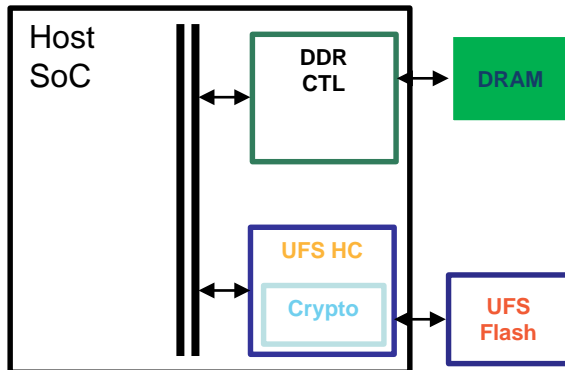


Security

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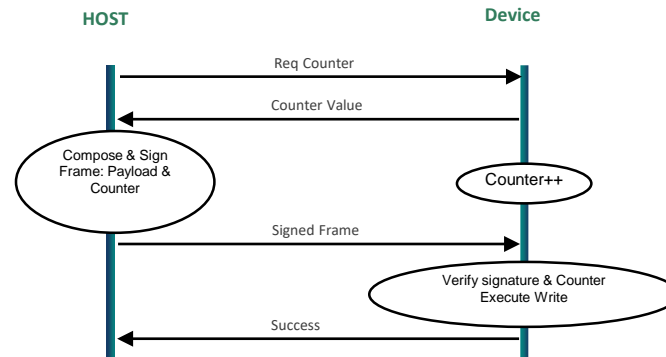
Host Inline Crypto Engine

- Encryption/Decryption at line rate
- Inline execution: minimal Power and CPU utilization
- Identical software interface for eMMC and UFS
- Supports Up to 256 keys (implementation parameter)
- Supports AES-CBC, AES-XTS, AES-ECB



Replay Protected Memory Block (RPMB)

- Partition only receives authenticated, replay-protected transactions
- Using HMAC SHA-256 with Hash key (Unique, one-time-programmable) programmed at OEM plant
- Internal transaction counter
- Transactions must be signed, include counter
- Similar architecture for eMMC and UFS





Storage Performance & Power Comparison

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- UFS2.1 performance is comparable to NVMe, 1-2gen behind
- eMMC/UFS optimized for power, while continue to improve performance. Examples include
 - Improving standby power in UFS3.x, ~300mW
 - Migration to lower voltages, 2.5V VCC & 1.2V IO

	eMMC5.1	UFS2.1/3.0	SATA3.1	NVMe2.1
Max bandwidth	400MB/s	1.2GB/s (Gear3-2L) 2.4GB/s (Gear4-2L)	600MB/s	2GB/s (Gen3-2L)
Read IOPs	~10K	~50-70K	>100K	>100K
Write IOPs	~5K	~40-50K	>20K	>20K
Standby Power	~200uW	~500uW	<5mW	1-2mW
Voltages	1.8V/3.3V	1.2V/1.8V/3.3(2.5)V	3.3V/5V/12V	1.8V/3.3V



Memory Card

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- Overview
 - Mobile market continue to use SD card, in uSD form factor.
 - Market continue to stay with UHS-I, have not migrate to higher performance interface
- Solutions
 - SD Card – continue to driver higher data rate. Some developments
 - SD-PCIe card. Only available in full size, work is underway on uSD form factor
 - Low-Voltage card definition - Eliminate 3.3V signaling, currently only used at initialization
 - Random IOP improvement
 - UFS Card – a new alternative solution to the market, driven by Samsung
 - Based on UFS2.1, with MIPI M-PHY Gear3-1L
 - Jedec published UFS Card spec in 03/2016

