

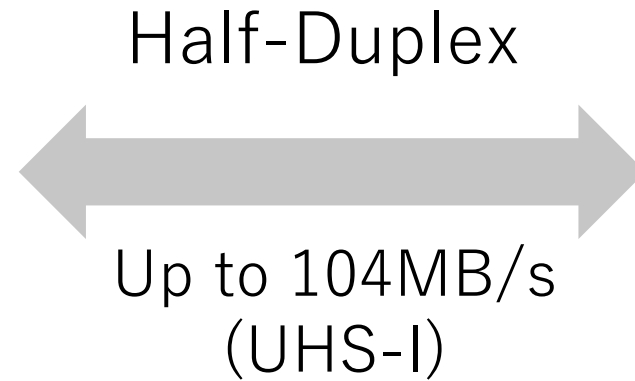


UFS Cards

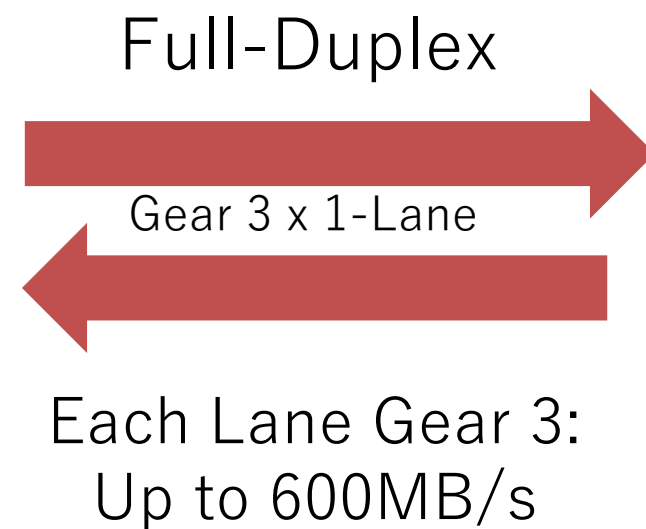
Ultra-high Performance Removable Storage

Filipe Rios & Horace Chen
Product Management, Phison Electronics
Flash Memory Summit 2018

UFS – Full-Duplex Interface

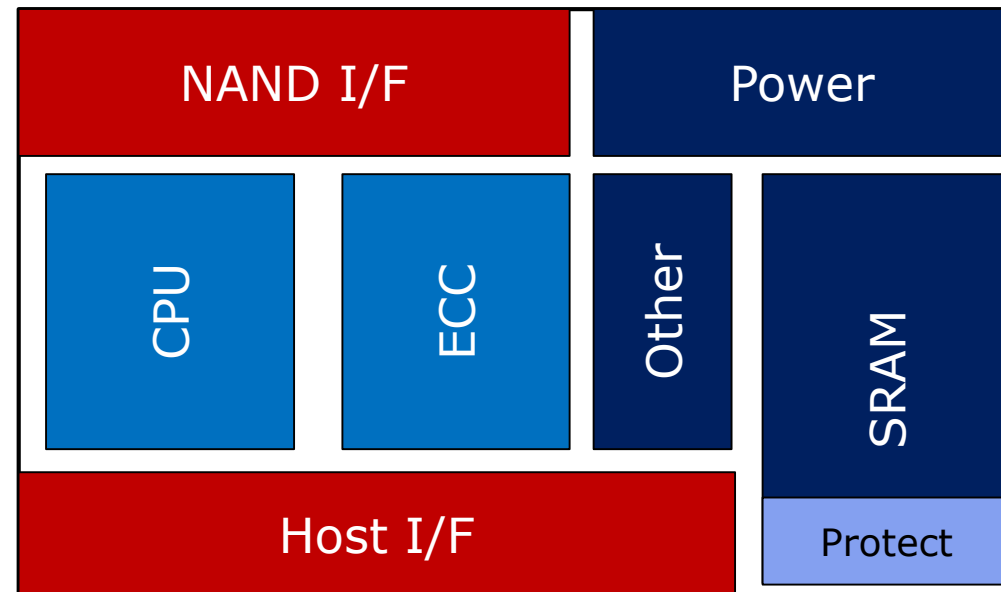


Data **only** flows in **one direction at a time.**

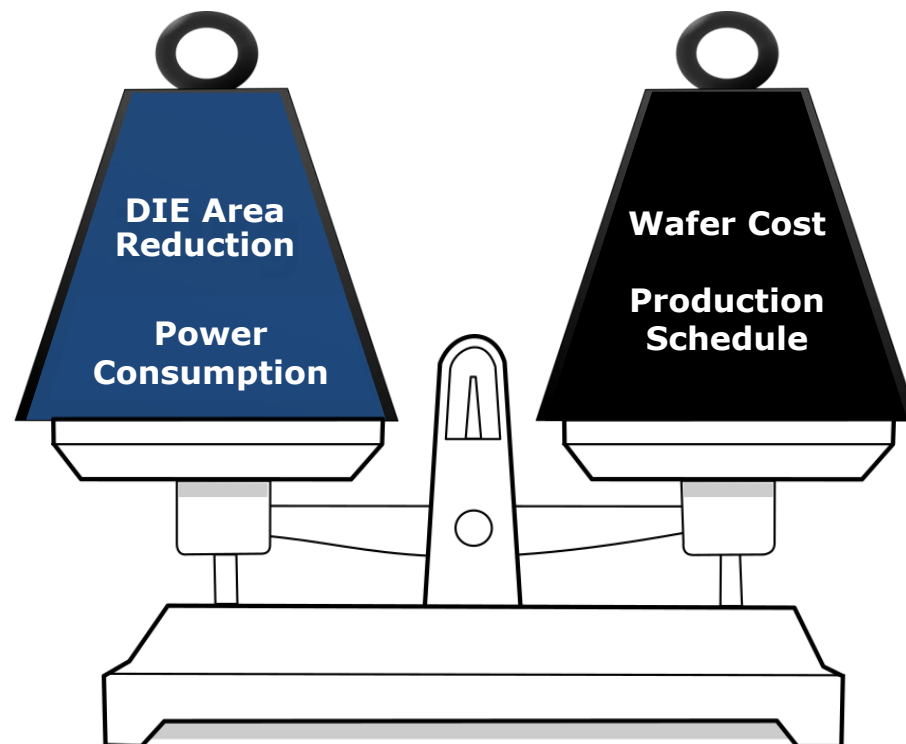


Data flows in **both directions simultaneously.**

Technology Behind the Scenes



General NAND Controller Block Diagram



**Controller Process Investment
(2xnm, 1xnm) Trade Off**

High Throughput (600MB/s) & Random Performance, Low Latencies

- 32-bit powerful processor with SSD-like architecture, more channels & SRAM, HW accelerators, FW considerations

Low Power (Active < 1.63mW, room temp) and Heat

- Regulators/Detectors, peak power, thermal management
- Low Voltage Physical Layer

NAND: Constraints of Newer 3D TLC Processes

- LDPC + RAID ECC, Large RAM, Robust FW algorithms

Quality

- Robust and Widely tested SCSI command set
- SRAM with Protection for bit-flip, End-to-End data path

Validation

- Collaboration with host chipsets and customer

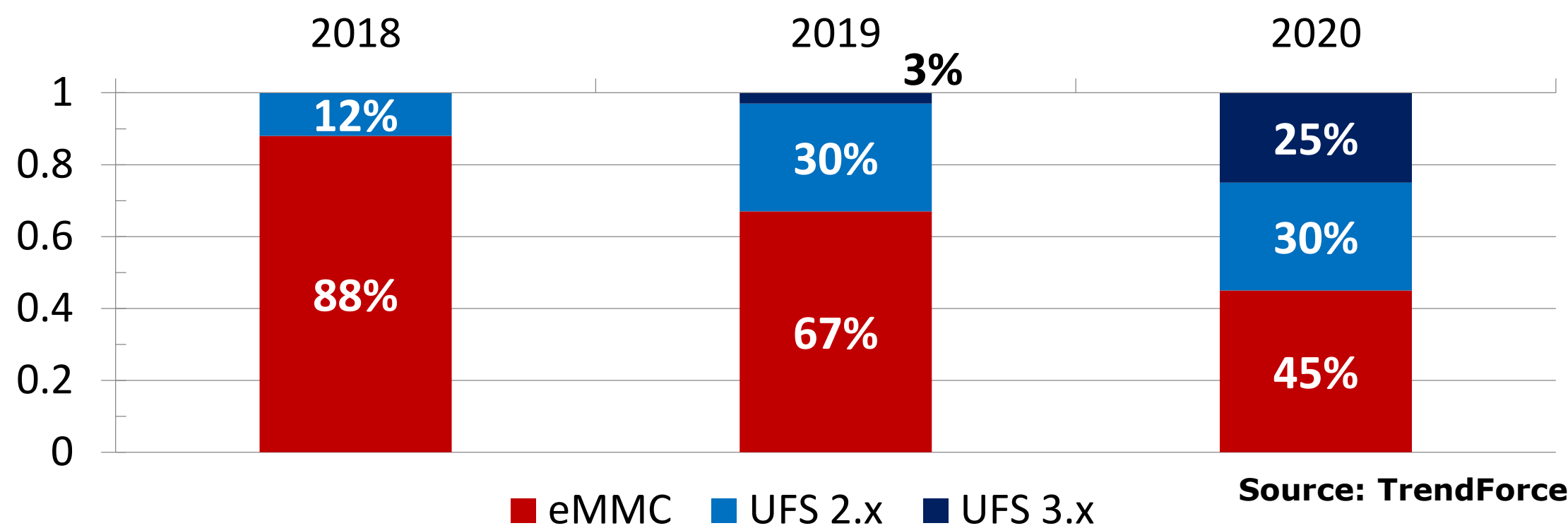
Major Challenge: Mobile Market Consolidation

- Global phone sales hitting saturation

UFS Controllers: Very High Entry Barrier

Smartphones: Storage Trend and Expectations

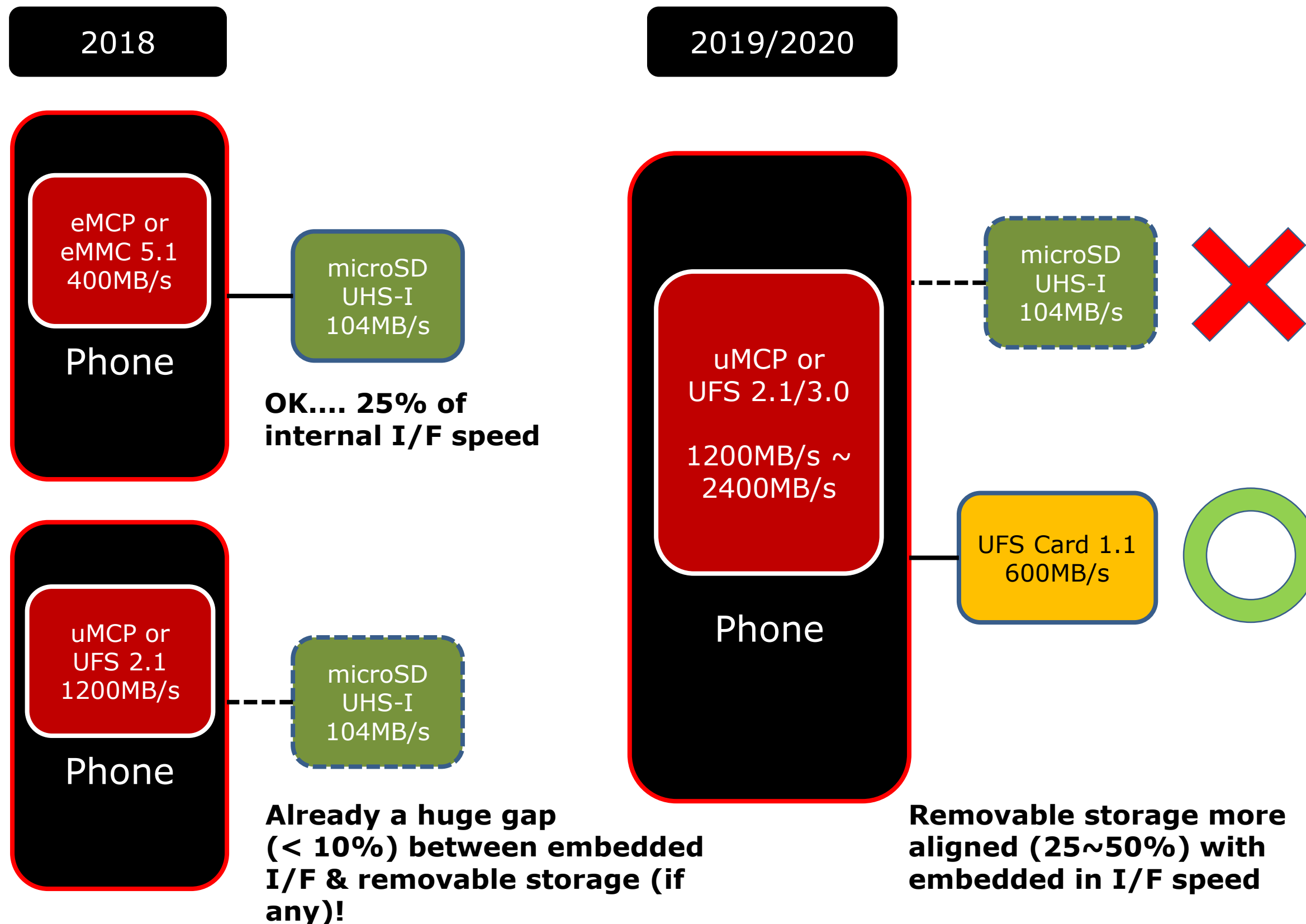
Assuming market size of 1.5b smartphones....



- Internal eMMC form factors:
 - Discrete eMMC / eMCP
- Internal UFS form factors:
 - Discrete UFS / uMCP

Year	Flagship Most powerful devices for a given generation.	Mid and High-End Very powerful devices. Some are comparable to the flagship.	Low-End /Entry level Cost-oriented devices. Features performance just above minimum recommended to run the OS ver. & apps of current gen.
2018	Internal Storage only UFS 2.1 x 2L	Internal: eMMC / UFS 2.1 - 2L Removable Storage: microSD UHS-I	Internal: eMMC Removable Storage: microSD UHS-I
2019	Internal Storage only UFS 3.0 x 2L	Internal: UFS 2.1 - 2L Removable Storage: UFS Card 1.1 / microSD UHS-1	Internal: eMMC / UFS 2.1 - 2L Removable Storage: microSD UHS-I
2020	Internal Storage only UFS 3.x or superior	Internal: UFS 2.1 - 2L / UFS 3.0 – 1L or superior Removable Storage: UFS Card 1.1 or superior	Internal: UFS 2.1 - 2L / UFS 3.0 – 1L / eMMC Removable Storage: UFS Card 1.1 or superior

Mobile Storage: Embedded vs Removable Trend

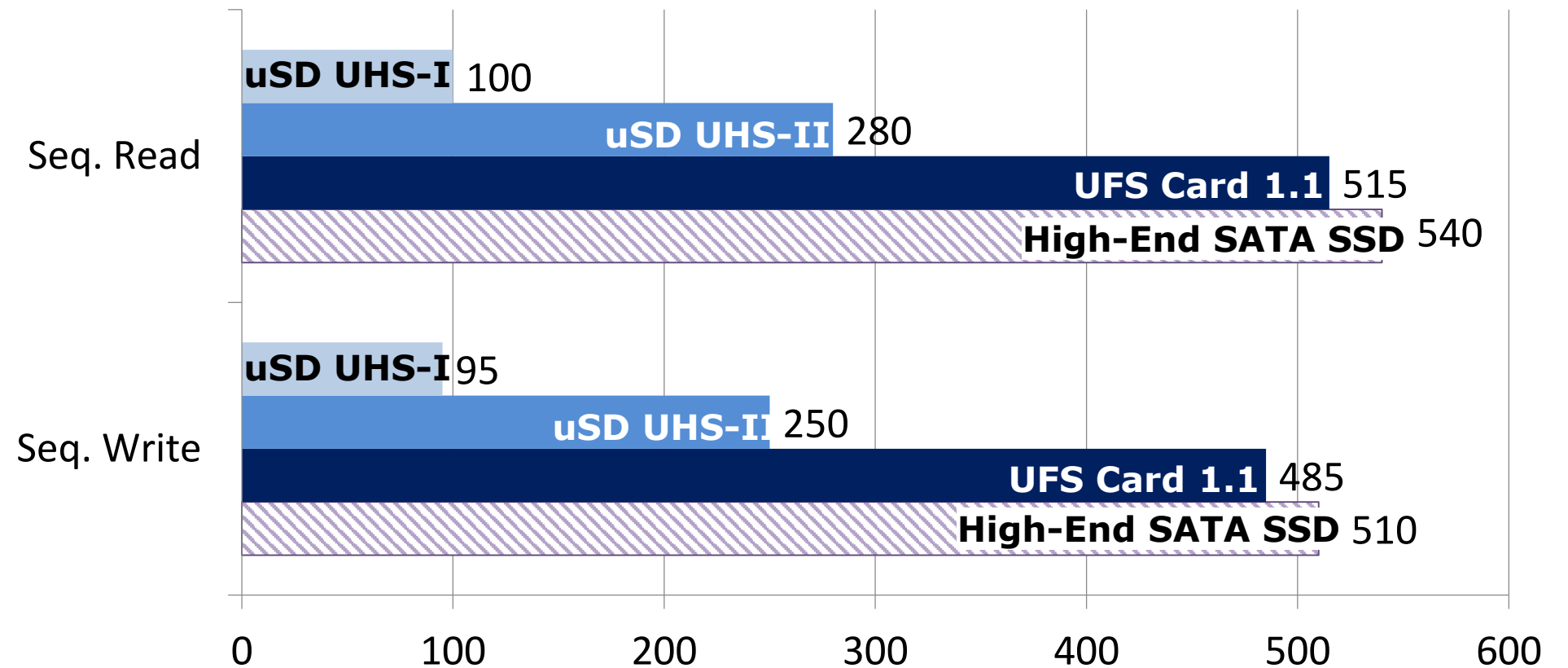


- **Android's Adoptable Storage Device means growing need for card seq. & random performance (IOPS)**
- **UFS Card's high speeds eliminate the need to bring up various application level logos to guarantee seq. and random performances**
- **Result: Great 8K video, 5G speed and APP compatibility. True expansion of internal storage possibility**

UFS Card - Very High Performance

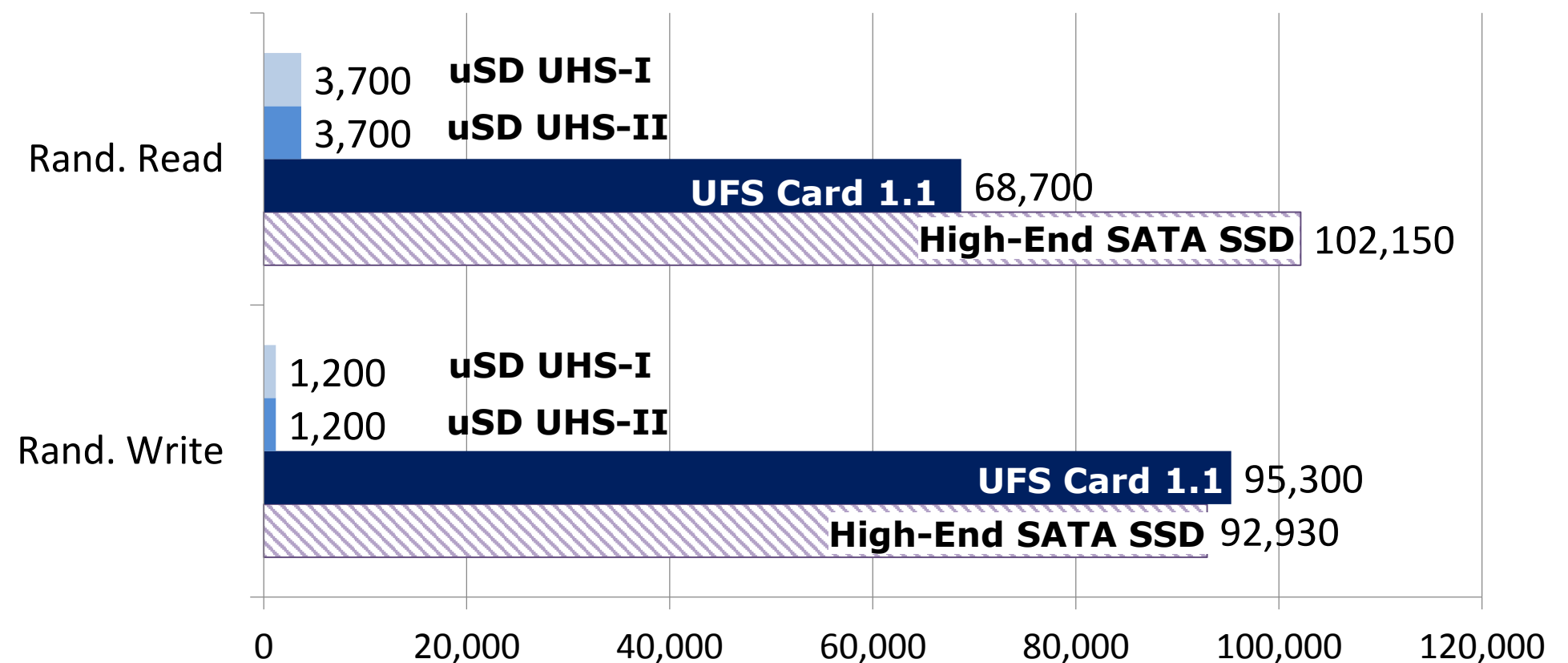
Sequential Read/Write (MB/s)

- **5 Times Faster** than the fastest cards used by current smartphones (UHS-I)
- **Similar to High-End SATA SSDs**



Random 4KB Read/Write (IOPS)

- **Over 15 Times Faster Read** than the cards used by current smartphones (UHS-I)
- **Over 70 Times Faster Write** than the cards used by current smartphones (UHS-I)
- **Similar random write performance to High-End SATA SSDs**



Next Mobile Controller Directions

Embedded Controllers

- **For Tier-1 flagship phones**
- **Performance is top priority**
- Boost Random Read Performance from system
- Increase burst write performance
- Reduce standby power to increase battery life



Removable Controllers

- **For expansion cards**
- **Cost will be prioritized**
- Performance can be inherited from embedded controllers
- Therefore, using controllers one generation behind would be ideal



PS8313 - UFS 2.1 Performance (Measured)

UFS HS-Gear 3B x 1-Lane and 2-Lanes at Phison UFS Host

Performance (LBA Range: 1GB)	PS8313* 3D TLC	PS8313 3D TLC
Host Interface Mode	HS-Gear 3B x1 Lane (eUFS / UFS Card)	HS-Gear 3B x2 Lanes (eUFS only)
NAND Flash Configuration	2ch, 4CE @667MT/s	2ch, 4CE @667MT/s
Seq Read	510 MB/s	920 MB/s
Seq Write	430 MB/s	520 MB/s
4KB Random Read QD8	48,500 IOPS	48,500 IOPS
4KB Random Read QD32	68,700 IOPS	68,700 IOPS
4KB Random Write	95,300 IOPS	95,300 IOPS

Platform: Phison UFS Tester (no OS, no overhead)

**Note: For performance data in specific platforms, please contact Phison technical support.*



THANK YOU

PHISON
Knows What You Need

