2015 NVRAMOS

The-AIO Co., Ltd.

Oct. , 2015

Company Profile

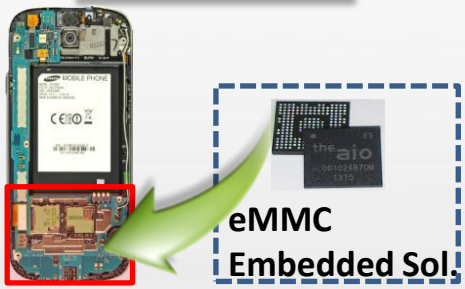
	Description
Company Name	The-AIO (The **A**dvanced **I**nput **O**utput)
Vision	Total Storage Solution Provider
Establish Day	Jun 16th 2011
CEO	Jin-Hyoung Kwon
Products	• Customized Product : F1NAND, eMMC^{Plus} controller and related S/W • Standard Product : eMMC controller and related S/W • Storage Sub-System : PCIe-SSD FPGA Platform
Employee	49 People (R&D proportion 80%, Apr. 2015)
Address	KINS Tower 17th Floor, 25-1, Jeongja-dong, Bundang-gu Sungnam-si, Gyeonggi-do, Korea
Contact	Tel : +82-31-716-0170 Fax : +82-31-716-0580 E-Mail : sales@the-aio.com Home Page : www.the-aio.com

Vision of AIO

Storage solution Innovation from embedded storage to storage system

Embedded Solution

Embedded



Full Components

SSD

PCIe-SSD

Card

uSD, SD
Removable Card

Server BOX

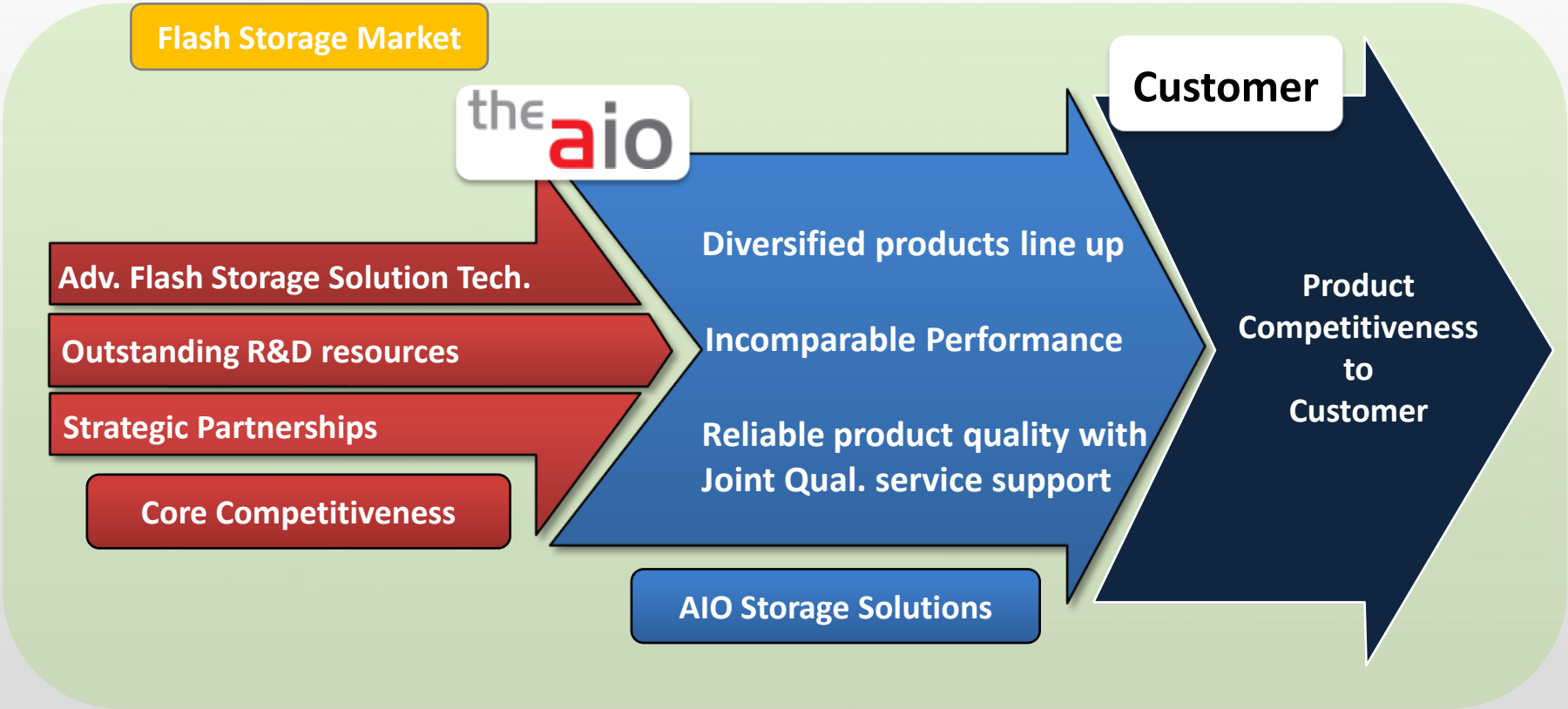
Phase I 2015~

Phase II 2017~

Phase III 2020~

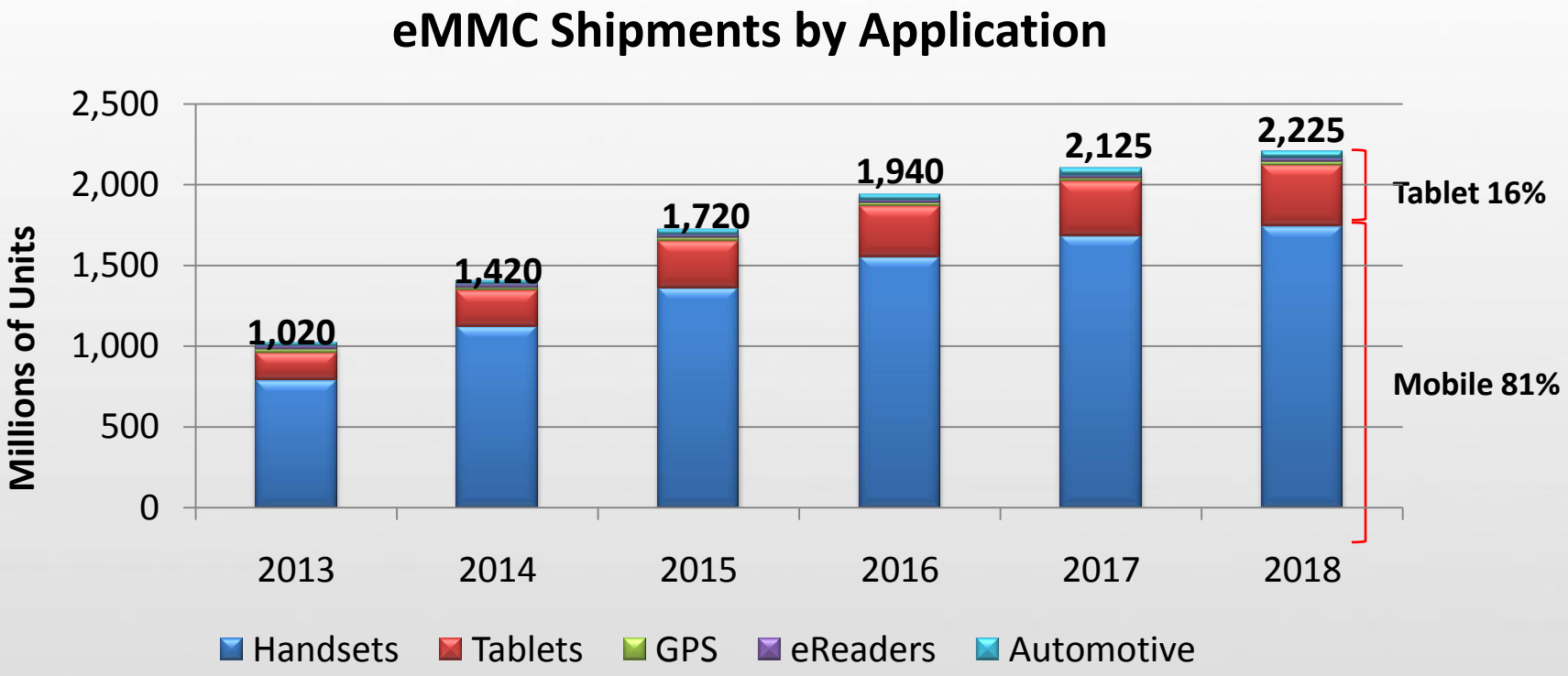
Value Chain of AIO storage solution

- **The AIO delivers our core competitiveness for customer satisfaction**
  - The AIO, the best storage solution partner, provides incomparable performance, highly reliable quality based on technology innovation
  - The AIO values loyalty to customers as well as customer satisfaction



Market Trend (eMMC Shipments)

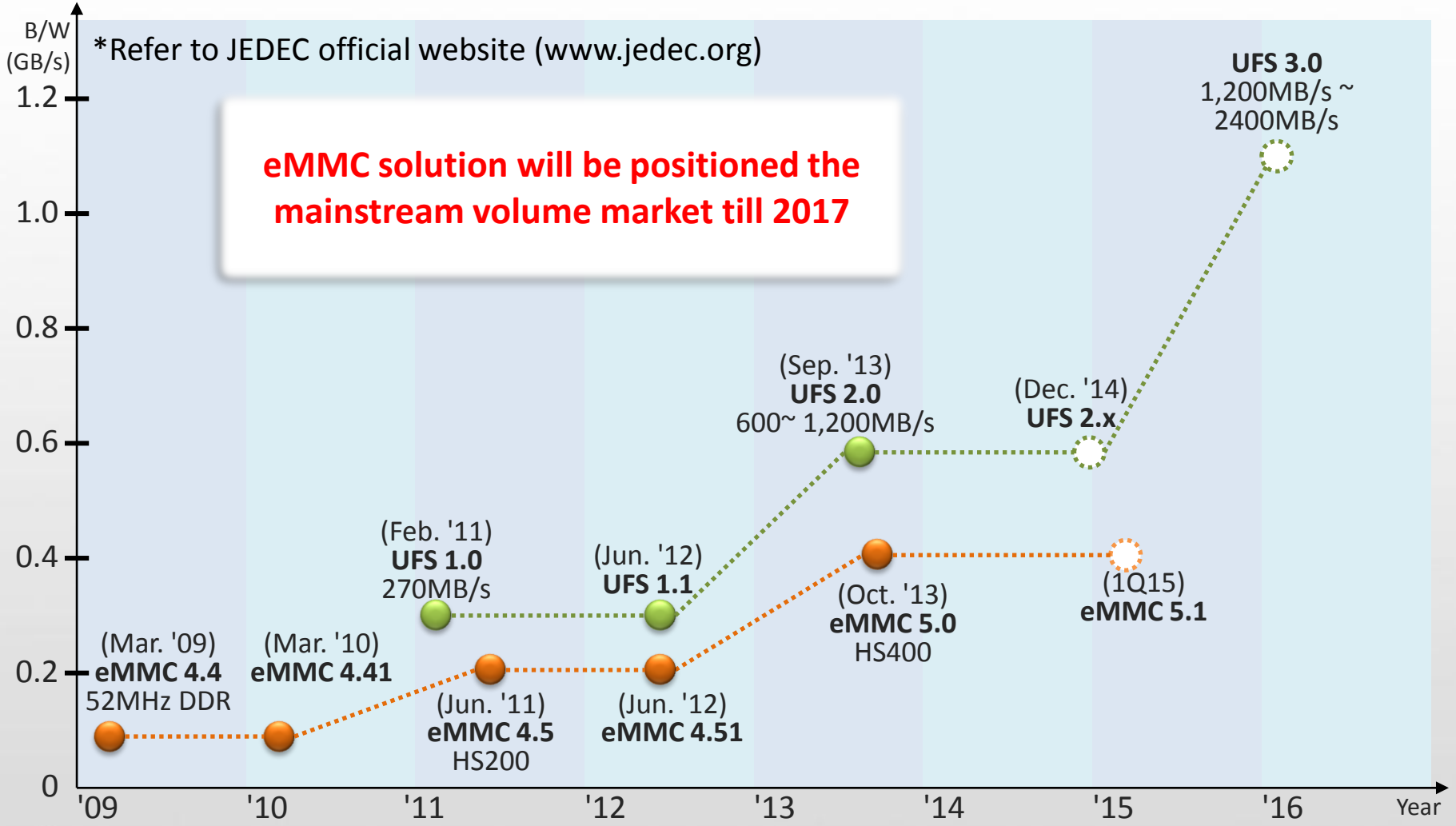
- **eMMC market is still increasing**
  - eMMC market(Unit) CAGR from Year `13 to `16 will be over 18%
  - eMMC market(Unit) is focused on smartphone application over 80%



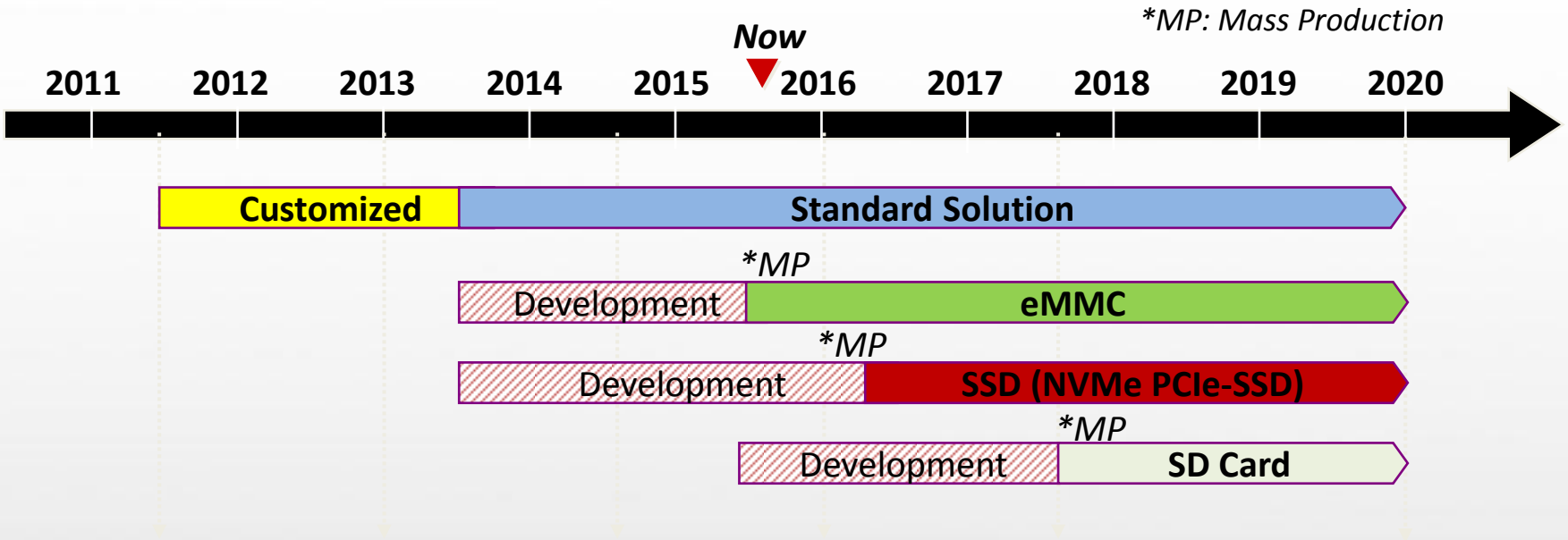
[Source: Mobile and Embedded Memory Market Tracker, IHS 2014]

Market Trend (Embedded Storage Industry Trend)

eMMC & UFS standard Spec. release and expected launching time



Long Term Product Roadmap



- Incorporation The-AIO
- (Advanced IO)
- Angel Fund : $1.7M

- E2NAND Host SW
- F1NAND Project (world Best performance Solution) for LGE

- Finished 1st Round Investment $10.24 M (LB, SVIC, IBK, KDB and others)
- Post Valuation $ 28.63 M

(1$:1172 Won,2015.8.5 FX Rate)

- eMMC5.0 Ready to *MP
- PCIe SSD will be launched '16 ,1Q

- consummate Full line up
- Penetrate SSD Controller Market & SD Card

- IPO
- Penetrate Server Box Market

Innovating in Storage Solution, We are perusing enhancement of the system.

eMMC (Specification and Current Status)

Product Features

Product Spec.

- ✓ Fully compatible with JEDEC eMMC 5.0 / 4.5 / 4.41
- ✓ Enhanced Strobe, Packed command, Cache handling
- ✓ Special Features
  - → Sanitize, Extended Security Commands
  - → Context ID, Discard, Sanitize, Data tag, Partition attribute, RTC, Security

Performance

- ✓ Seq. R/W = 250/37 MB/s
- ✓ Ran. R/W = 7.5K/8.9K IOPS (for 16GB device)

*** Random performance is 2X~3X higher than Competitor**

Support NAND vendors

(MLC : SK Hynix 16nm 64Gb, Micron 20nm 32Gb & 64Gb)

- ✓ Configurable BCH ECC engine: 40/50/57 bit per 1KB
- ✓ Support ONFI 2.x/3.0 & Toggle DDR 2.0 interfaces

Current Status

On a Stage of AP(AVL)/ Customer Validation

AP, AVL Valuation

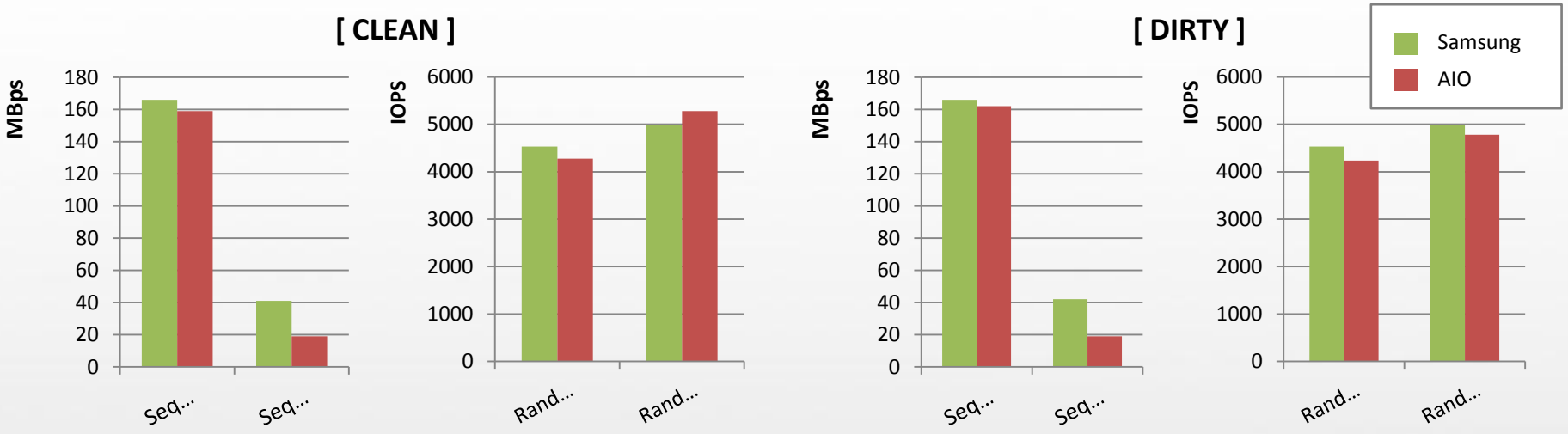
- ✓ Rockchip (On going) : OTT(Over the Top) & White Box Application
- ✓ MediaTek (Ready) : Smartphone/ Tablet Solution
- ✓ Spreadtrum (Ready) : Smartphone Solution
- ✓ Qualcomm(Ready) : Smartphone Solution

Biz(Customer)

- ✓ Micron (On going) : Performance & Reliability Test
  - Samsung IM / LG MC Biz. opportunity
- ✓ SK Hynix (On going) : 3D NAND(V2/V3) Enabling Test
- ✓ Essencore (On going) : OEM(White Box) Biz. Test
- ✓ BARUN (On going) : eMCP(for Jeju-Semiconductor co.) and eMMC (Domestic & China) Biz. Test

Performance Comparison (OS: Tiobench, 8GB)

AM1214B0 can also show competitive performance even on OS environment.



Items	AIO		Samsung	
	AM1214B0 + SKH F16 B-die 64Gb MLC x 1		Samsung own CTRL + Samsung F1y 64Gb MLC x 1	
	Filled	Dirty	Filled	Dirty
Seq. Read (MB/s)	159	162	166	166
Seq. Write (MB/s)	19	19	41	42
Ran. Read (IOPS)	4274	4237	4532	4532
Ran. Write (IOPS)	5282	4780	4983	4983

Performance Comparison (OS-less, 16GB)

- **The performance for SKH 3D-V2 will be further improved.**
  - First, NAND tPROG time will be optimized on CS level.
  - Second, NAND I/O speed will be optimized after the package is assembled.

Items		AIO		Samsung		SK Hynix (Mercury+)		Micron		SK Hynix + AIO	
		AM1214B0 + SKH F16 B-die 64Gb **MLC x 2**		Samsung own CTRL + Samsung F1y 64Gb **MLC x 2**		SMI 2716 + SKH F16 B-die 64Gb **MLC x 2**		Phison ???? + Micron L84D 64Gb **MLC x 2**		AM1214B0 + SKH 3D-V2 **MLC x 1**	
		Filled	Dirty	Filled	Dirty	Filled	Dirty	Filled	Dirty	Filled	Dirty
Seq.	Read	243.6	237.2	253.0	253.4	248.8	247.5	226.6	223.2	201.2	On progress
	Write (w/ cache)	38.9	6.5	83.5	3.5	52.4	4.8	32.4	2.6	53.7	
Ran.	Read	7261	5279	6081	6094	5569	5572	4116	4892	7811	
	Write (w/ cache)	8852	1253	9392	562	4321	1015	4302	1450	7909	

Performance Comparison (OS-less, 8GB)

- **AM1214B0 can show the best random write performance among devices.**
  - Ran. WR performance depends on FTL mapping algorithm, while Seq. WR performance depends on NAND program time.
  - If P'ISPP scheme for SKH F16 MLC was adopted, seq. WR can be improved.

Items		AIO		Samsung		SK Hynix (Old 5.0)		Micron	
		AM1214B0 + SKH F16 B-die 64G MLC x 1		Samsung own CTRL + Samsung F1y 64G MLC x 1		SMI 2716 + SKH F16 B-die 64G MLC x 1		Phison ???? + Micron L83A 32G MLC x 2	
		Filled	Dirty	Filled	Dirty	Filled	Dirty	Filled	Dirty
Seq.	Read	229.7	229.2	193.8	193.6	202.2	209.7	177.5	177.4
	Write (w/ cache)	19.1	6.4	41.0	5.3	21.0	6.3	22.9	4.2
Ran.	Read	7762	6430	6095	6092	8048	8049	6447	6458
	Write (w/ cache)	7432	1166	7258	738	899	300	4440	763

Value Proposition1

Can treat low quality NAND as High Quality w/ AIO's HW & SW

1 **Low Quality NAND = Lower Price**

– Low Quality NAND is quite cheaper than High Quality NAND

2 **Low Quality NAND to High Quality**

– Low Quality NAND + AIO CTRL.

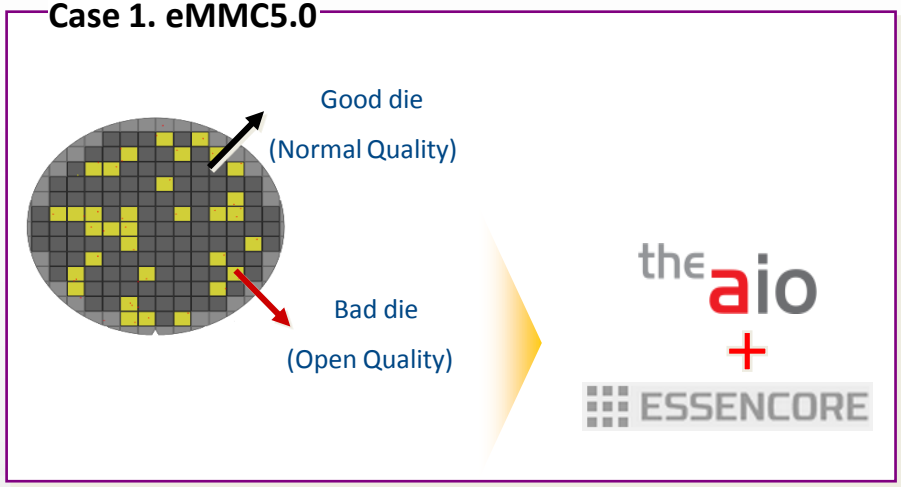
→ Enable to recycle the defect NAND

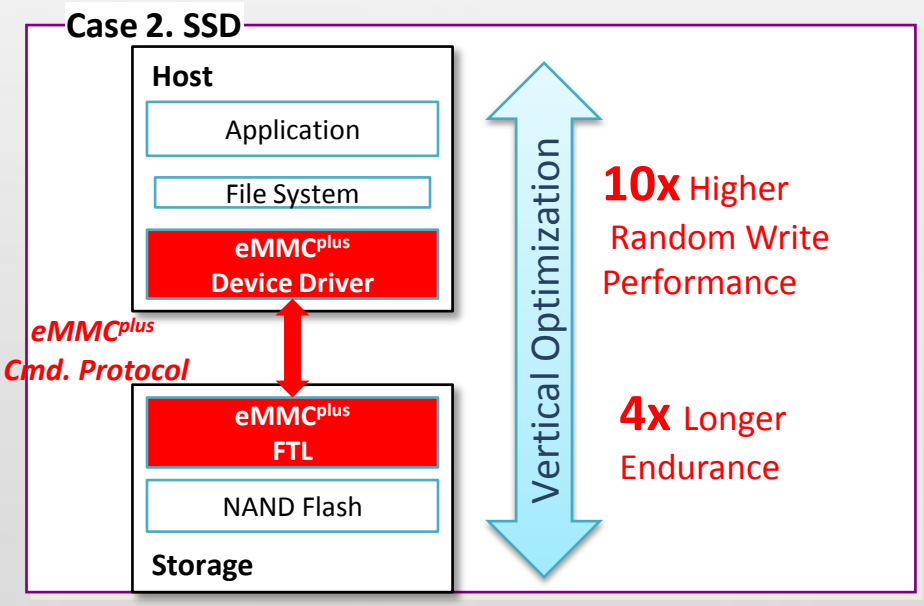
3 **Lower Cost SSD based on Low Quality NAND**

– Fast SSD adoption expansion

– SSD price is critical in Client area

→ Its Biz is up to Reliability solution : eMMC^{plus} technology





Value Proposition2

Performance of AIO CTRL can make All SET makers satisfied

1 **Several major NAND Makers can supply eMCP for all segments**

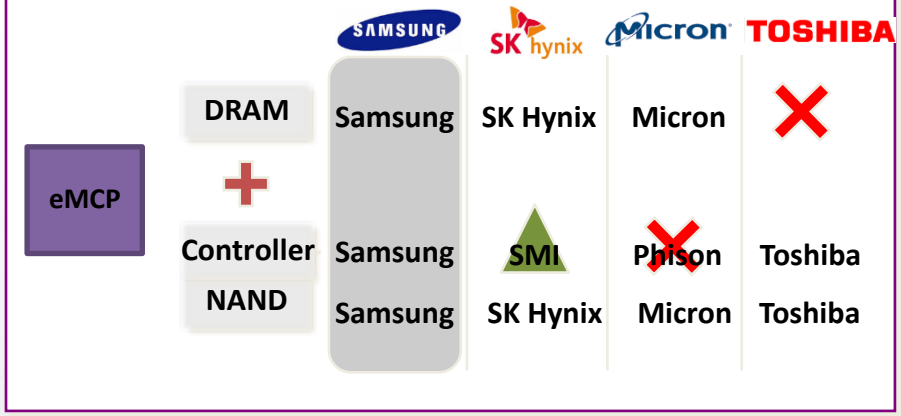
2 **Several storage solutions can not meet Tier1 SET maker requirement**

- controller maker capability dependency

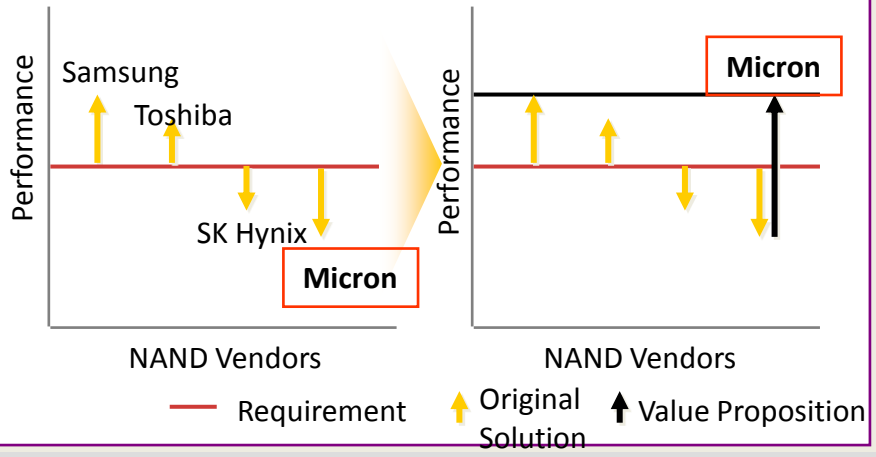
3 **Performance/Reliability Normalization**

- AIO can make all eMMC be normalized

Case 1. eMCP Supply



Case 2. Micron NAND



What is a right solution of mobile storage?

가격?
신뢰성?

성능?
용량?

eMMC or UFS?

MLC or TLC?

Market Trend – SSD Hierarchy

2018 Datacenter Storage Device Hierarchy

SATA/SAS SSD

PCIe SSD

Increasing Performance

Increasing Cost (device & System)

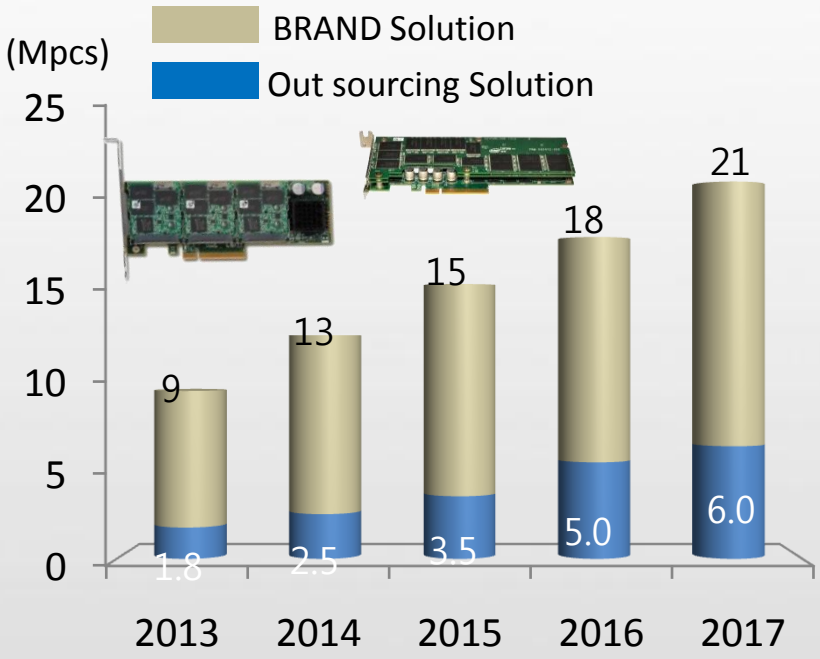
Decreasing Volume

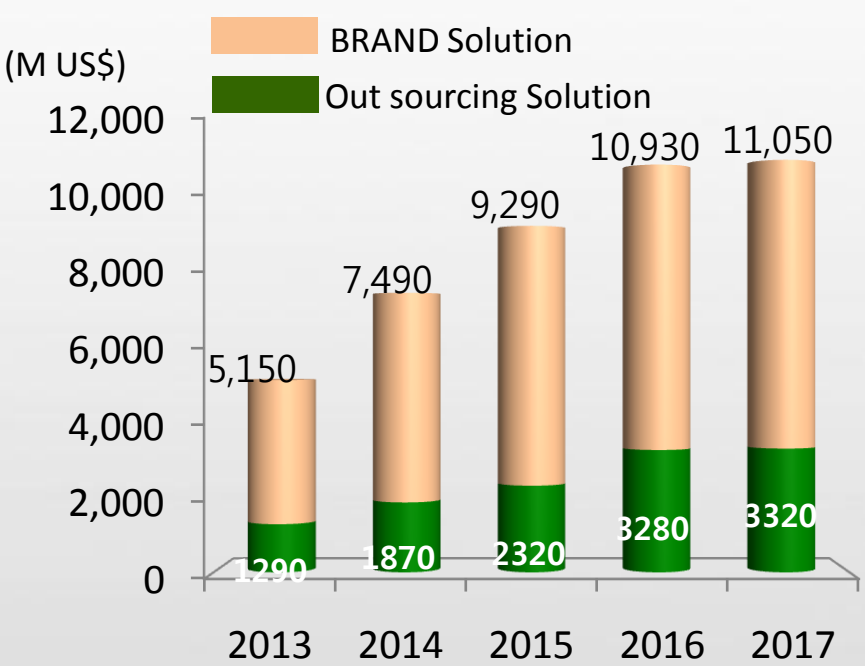
- Break-through performance in a serviceable bay for latency sensitive applications
- Highest performance SSD in a standard SFF-8680 story bay
- Lowest cost SSD in a standard SFF-8680 Storage bay until SATA Express emerges
- Rotating media remains capacity workhorse@75%+ devices shipped

Market Trend (PCIe SSD Market)

Market growing of High-end PCIe SSD : ’13 9Mpcs → ’17 21Mpcs (2.5 times)

- Global Portal & Mobile carrier have their own solution with OEM/ODM
- OEM/ODM Market is expected to grow up to 3.3 Billion at 2017, with above $500 of ASP





※ Combined Data from iSuppli, Gartner forecast

SSD (Specification and Current Status)

Product Features

Product Spec.

- ✓ Adopting PMC's Controller
- ✓ NVMe Protocol Support
- ✓ Max Capacity : 4TB
- ✓ PCI Express Gen3.0, 4-Lane

Performance & Reliability

- ✓ Seq. R/W : 3.0/2.2GB/s
- ✓ Ran. R/W : 750/130 K IOPS
- ✓ Enhanced Reliability scheme, 10 DWPD

Support NAND vendors

(MLC : SK Hynix 16nm 64Gb, Micron 20nm 32Gb & 64Gb)

- ✓ SKH 3D-V2 128Gb MLC
- ✓ 16 Channel support
- ✓ LDPC ECC support
- ✓ Separate NAND Flash B/D (Capacity flexibility)

Current Status

3rd Gen. Development with PMC Chip

3rd Generation Development (`15)

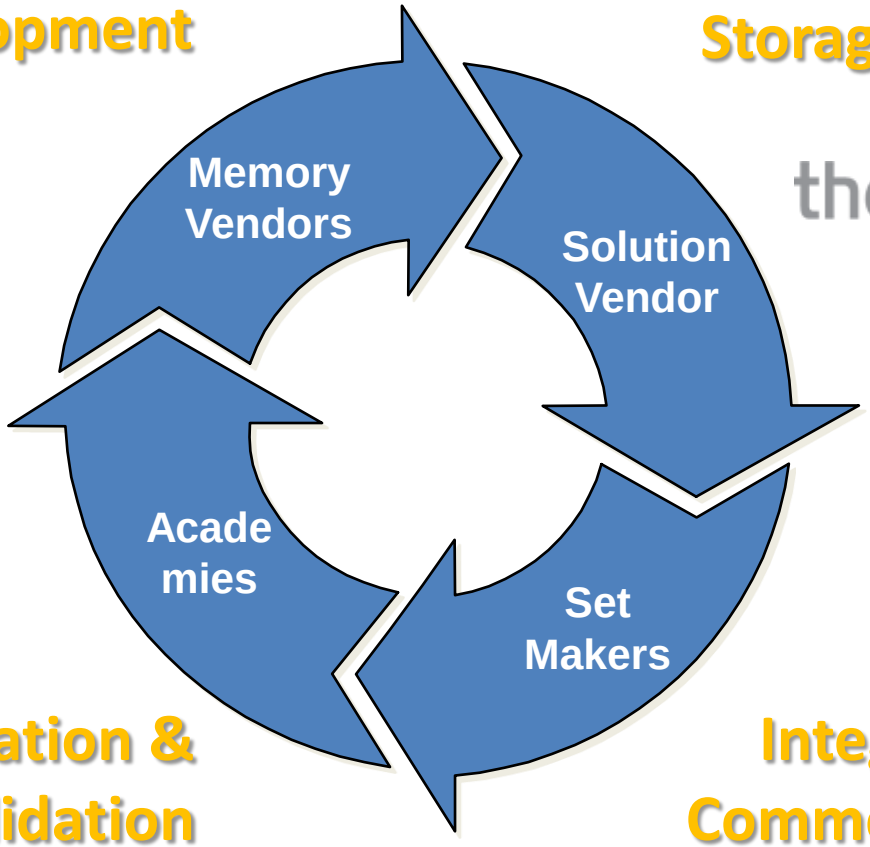
- Adopting PMC's NVMe Controller
- PCI Express Endpoint connectivity (Gen3.0 4-lane)
- Enabling SK Hynix V2 128Gb MLC **3D-NAND**

  * Schedule : ES ('16. 1Q)

1st/2nd Generation Development (`13~`14)

- FPGA (Xilinx Zynq-7000 XC7Z045 AP)
- PCI Express Endpoint connectivity (Gen2.0 8-lane)
- Enabling SK Hynix 16nm 64Gb MLC NAND

Ecosystem setup for Effective Storage Development



SSD Development

SAMSUNG

SK hynix

Storage Solution

the aio

Arch. Exploration & Concept Validation

HANYANG UNIVERSITY 1939

SUNGKYUNKWAN UNIVERSITY 1398

VERI LUX TAS MEA

Integration & Commercialization

SAMSUNG

LG