# 2013 NAND Flash market annual report

January 10, 2014

## ■ 2013 global no brand tablet chip shipments will reach 130 million, to seize the tablet market share

2013, the domestic tablet chip vendors as: Allwinner, Rockchip, Amlogic and other leading on no brand tablet' sales astonishing. MediaTek due to integrate the advantages of 3G communications tablet, began full force in the tablet market. Expects 2013 global chip no brand tablet shipments will reach 130 million, in 2014 shipments are expected to rise to 160-180 million, while the surge in shipments of market competition will become more significant.

## ■ Controller Flash Chip cost down the SSD cost and the interface is transferring from SATA III to PCIe

2013 the price of SSD with SATA III interface fell by 10% to 20% and in 2014 will continue to fell, while SSD controller chip plant in 2014 increasing support for TLC NAND Flash and PCIe interface, the second half is expected to be low TLC SSD enter the consumer market applications and at the end of this year SSD PCIe interface will become the mainstream in the high-end notebook.

## ■ Market trend of NAND Flash market situation in 2013


Source:www.chinaflashmarket.com



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**Contact ：**
Tel：+86 0755-86133027
Fax：+86 0755-86185012
Email：Service@Chinaflashmarket.com
Add：Room 6/F,Building No4.,Software park keji Middle 2 Road,Hi-tech Industrial park,NanShan Distrist.ShenZhen,P.R.C

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# NAND Flash Market Price: 23% growth and 30% decline in the first/second half of 2013

## ■ Limited output from wafer supplying side, market goods quantity reduced in first half of 2013

Due to NAND Flash oversupply in 2012 first half, Samsung, Toshiba, SK-Hynix reduced production output in second half of 2013. These NAND Flash giants did not recover the output immediately at the beginning of 2013, and no procedure to increase, not only that, SK-Hynix and Micron took a further output reduction in Q1, which is the usual weak season. At the same time, comprehensive mass production of 2ynm is transfering to 1xnm. To complete the generation update and production procentage increase to 1xnm, NAND Flash production output was further restricted by the yield rate and stability.

Except the control of NAND Flash production quantity, those giants also showd power on strict counting of market sales.The main NAND Flash vendors, Toshiba,Intel, SK-Hynix all performed not well due to the oversupply of 2012. Micron even showed continued loss in the whole year, while only Samsung sales revenue growed a little bit from smart phone business. The same reason also kept the market price dropping. Learnd from 2012, flash vendors were retrenching the supply carefully to avoid further oversupply.

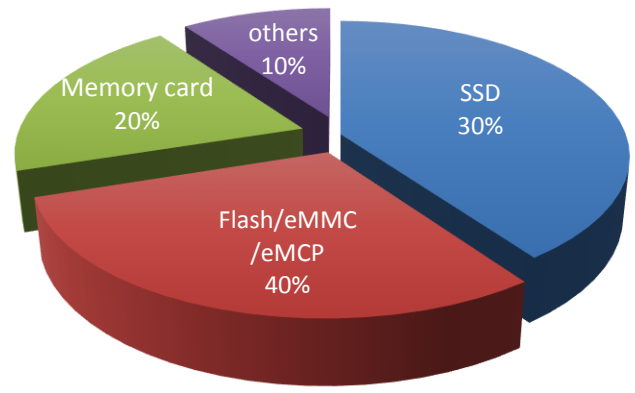
## ■ eMMC/eMCP、SSD consumed a great part of NAND Flash total share

As one of the most advanced smart phone, tablet producer, Samsung also owns the biggest share of NAND Flash market. They predicted in 2012 that they will supply 500 million pcs smart phones and 40million pcs tabltes in 2013. This huge number would definitely consume most of Samsung NAND Flash production capability.

For futher support, Samsung turned to Toshiba, SK-Hynix to purchase more flash for smart phones and tablets business. Thus Samsung was unable to supply more NAND Flash to the consuming market.

From Toshiba, SK-Hynix side, part of production to Samsung smart business, they contributed most of their share to Apple new iPhone, iPad mini/Air and MacBook Pro. The balance share was consumed by their own embeded memory and SSD products.Both Toshiba and SK-Hynix maintains

**Exhibit 1:SSD&eMMC/eMCP consumed 70% NAND Flash**




Source:www.chinaflashmarket.com for reference only.

embeded memory and SSD product lines, while Micron, also mass produced eMMC and eMCP in 2013 and put continus efforts on SSD products development. At the same, there was also product share went to other smart phone and tablet field. In this situation, flash vendors focused more attention on eMMC/eMCP, SSD and other embeded application, the flash supply for Micro SD, SD, USB and USB3.0 became insufficient.

## ■ NAND Flash price increased in the first half of 2013 due to short supply

Both Samsung and Apple were preparing new stocks smart phones in the beginning of 2013, while the other brand, Nokia,LG,Huawei,TCL,etc were also promoting new smart phones models. Not only that, non-branded single/dual-core tablets boom occoured by it low-cost and quick mass production. The last demand increase came from server SSD, which greatly improved the demand of eMMC/eMCP、SSD. These entire market situations made a progressive increasing on price and further short supply. According to Chinaflashmarket website price, in Q1 of 2013, the entire flash price index increased from 1436 to 1929,which gained 34%.

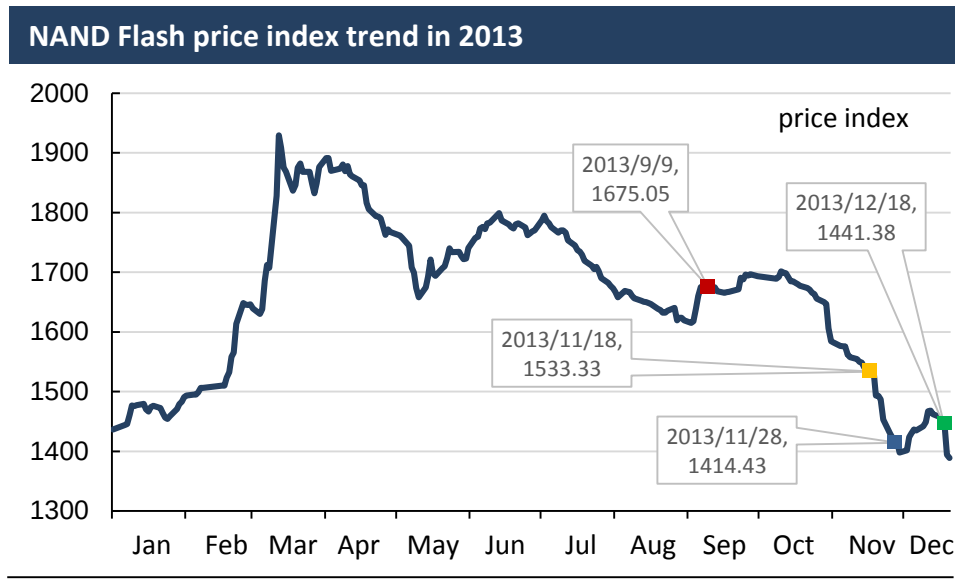
Although Production output was seasonly increased in Q2, it did not come to a relife of the short supply. Price index came down to 1657 in April as price dropped a little bit because vendors reward the market from their high profit and too high DRAM/Flash price reduced orders. From May, to keep the price stable, flash vendors come back to the control of market goods quantity. This caused the other increasing till begining of July.

### ■ 4% Price increase after SK-Hynix China Fab fire in Sep, then drop again due to Q4 weak demand

In the second half of 2013, usually considered as peak season of consumer electronics, flash giants production output gained great improvement. However, Samsung new smart phone model, Galaxy S4 sales figure did not reach expectation, high-level smart phone market was in a window period before iPhone 5s, lead the price into two-month dropping and dropped over 10%.

In September, influenced by SK-Hynix China Fab big fire, flash vendors and traders carried out panic increasing on price, hold goods and watching for chances. This made the market price increase 4% in short period of time and market orders entire NAND Flash demand decrease due to high price. The flash price index increased a little bit and then drop again until December. After Chinese Mainland National holiday, market demand recovery was quite slow, and Q4 weak season effect came earlier than expected. Only DRAM price was able to keep stable due to SK-Hynix fire. In total, NAND Flash price index increased 23% in first half of 2013, benifiting from smart phone and tablet demand boom and short supply. In second half, price decreased 30% due to over supply.

**Exhibit 2：Market trend of NAND Flash market situation in 2013**




Source:www.chinaflashmarket.com, data expiration time:Dec.20th,for reference only.

Remark: Flash products was added to the chart from Sep.9th of 2013, that day index increased to 5371.2 from 1675.05 (deviation 3696.15).Nov.18th,Dec.18th, further price adjust was done, resulted to further deviation. The above chart already removed the deviation to gain much clearer and accurate market trend.

## NAND Flash manufactory technique process and market structure

### ■ NAND Flash process technology comes into the era of 1Xnm completely

NAND Flash Nanometer process technology goes downward extension gradually and technical transformation is more difficult. In the first half of 2013 year upstream flash manufacture such as Samsung, Toshiba/SanDisk, Micron and SK-Hynix was planning transfer into 1ynm process, however, by the influence of yield rate and stable production issue each flash manufactures slow down the processing of technical transformation. In 2013 Nanometer process technology transfer from 2ynm to 1xnm level completely and promote 1xnm process technology above 50%,; In 2014 it turns into 1ynm; In 2015 it turns into 3D NAND Flash process technology.

**Exhibit 3: Nanometer Process Technology Roadmap from Major NAND Flash Manufacturers**

| Technology / Manufacturer | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| **Technology Level** | 4xnm | 3xnm | 2xnm | 2ynm | 1xnm | 1ynm |
| **Samsung** | 35nm | 32nm | 27nm | 21nm | 19nm | 16nm |
| **Toshiba/SanDisk** | 43nm | 32nm | 24nm | 19nm | 19nm | 16nm |
| **Micron** | 34nm | 25nm | 25nm | 20nm | 20nm | 18nm |
| **SK- Hynix** | 46nm | 35nm | 26nm | 20nm | 20nm | 16nm |

Source:www.chinaflashmarket.com for reference only.

To making mass production smoothly, Samsung uses 19nm as technology and downwards extension after stable mass production, also plans to do 16nm mass production gradually in the beginning of 2014 and Samsung begins to produce 3D NAND Flash technology in Xi'an factory specially in 2014 Q1; Toshiba/SanDisk raise the production percentage of 19x24nm process technology and transfer into 19x19nm in the end of 2013, mass production in 2014 Q1; Micron transfer from 25nm(L7 series) to 20nm (L8 series), as the transformation was not smooth it only can turns int 18nm process technology (L9 series) in the middle of 2014; SK-Hynix mainly produce with 20nm technology and will plan to produce 18nm process technology in the middle of 2014.

## ■ The upstream chip factory promote advanced Nanometer Process technology, demands of high capacity NAND Flash increased

In 2013 the demands of main flash memory products such as eMMC/eMCP, SSD continue to rise, except a small part products use TLC Flash by Samsung in the market, other manufactures supply MLC Flash only which cause lots of MLC NAND Flash production capability use up. To fulfill market demands, upstream chip factory decrease TLC/SLC NAND Flash production percentage and improve MLC NAND Flash production capability, MLC NAND Flash estimate more than 85% of total production capability. TLC/SLC NAND Flash production capability keeps 15% to meet memory card, USB drive and SLC SSD market demands.

In 2012 Samsung 840 series TLC SSD was recognized by consumers gradually, in the beginning of 2013 Samsung begins to mass production 19nm ADG 128Gb TLC NAND Flash which speed up SSD capacity improvement; Toshiba did 19nm 128Gb TLC NAND Flash mass production in 2012 and then launch mini version 2nd generation 19nm 64Gb MLC NAND Flash which write speed up to 25MB/s in 2013; Micron begin to mass produce 20nm B85 128Gb TLC NAND Flash which don't use on SSD but on the memory card and USB drive only. At the same time Micron produce small batch of L95 16nm 128Gb MLC NAND Flash which plan to use on the new SSD launched in 2014; SK-Hynix adopt the newest 16nm process technology mass production L95 16nm 128Gb MLC NAND Flash and plan to mass production 16nm 128Gb MLC NAND Flash in the beginning of 2014.

**Exhibit 4: The most advanced Nanometer process technology MP status of NAND Flash chip factory in 2013**

| Manufacturer | Structure | Technology | Max Capacity | Application |
|---|---|---|---|---|
| Samsung | TLC | 1xnm | 128Gb | SSD，eMMC/eMCP |
| | MLC | 1xnm | 64Gb | SSD，eMMC/eMCP |
| Toshiba /SanDisk | TLC | 19nm | 128Gb | Memory card，USB Drive |
| | MLC | 19nm | 64Gb | SSD，eMMC/eMCP |
| Micron | TLC | 20nm | 128Gb | Memory card，USB Drive |
| | MLC | 16nm | 128Gb | SSD，eMMC/eMCP |
| SK- Hynix | TLC | NO | NO | |
| | MLC | 16nm | 64Gb | SSD，eMMC/eMCP |

Source:www.chinaflashmarket.com for reference only.

## ■ 3D NAND Flash technology time table announced, may to be main market trend in 2016

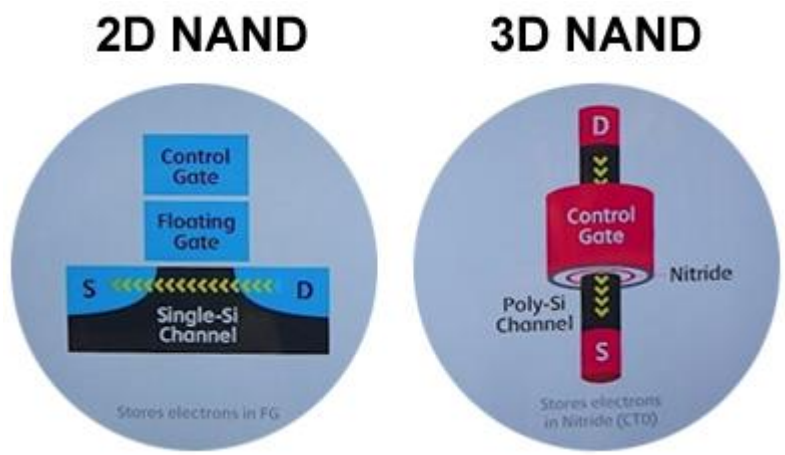
3D NAND Flash technology was talked by chip manufacturers such as Samsung/ Toshiba 3-4 years before but never saw it launched. Along with Nanometer process technology continues to shrink, the technical bottleneck is more and more prominent. It finally surfaced after several years of sedimentation. Samsung is the first one to launch 3D NAND Flash, other manufacturers such as Toshiba, Micron and SK-Hynix announced 3D NAND Flash sample and mass production time schedule, and it officially opened the prelude to the new technology of NAND Flash.

3D NAND technology is completely different with current 2D NAND, 2D NAND is plane structure but 3D NAND is three-dimensional structure. 3D structure is with vertical semiconductor channel, Multilayer spiral gate (GAA) structure is formed more electric gate memory cell transistor, it can reduce the interference between the effective stack. 3D technology not only raises product performance 20% at least and also reduces consumption above 40%.

Samsung has started first mass production of 35nm 3D V-NAND products in August 2013 and launched the first SSD based on 3D V-NAND technology, Toshiba/SanDisk plan to adopt P-BiCS(Pipe-shaped Bit Cost Scalable) technology to produce 3D NAND Flash products, sample will be ready in 2014 Q1 and it may begin mass production in the second half year of 2015; Micron 3D NAND Flash sample assume to be ready in 2014 Q2, and mass production time is pending; SK-Hynix adopt VSAT(Vertical Stacked Array Transistor) technology to produce 3D NAND Flash, plans to finish research in 2013, sample afford in 2014 Q4, mass production in 2015.

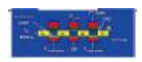
Although each chip manufacturers afford 3D technology time schedule, except Samsung began mass production, all other chip manufacturers only can mass production in 2015, they mainly adopt 2D technology for production in the coming year and would be changed technology at least 2 times. With further analysis 3D technology adopt the newest structure, upstream chip manufacturers should transfer 2D NAND to 3D NAND technology, all the production equipment need to be changed which not only spend lots of capital investment, but with more complicated structure, production difficulty is greatly increased and hard to control the stability.

**Exhibit 5: 2D NAND Flash and 3D NAND Flash schematic diagram**




Source:www.chinaflashmarket.com for reference only.

**Exhibit 6: 3D NAND Flash technology time table of the upstream chip manufactures**

| Manufacturer | Structure | Technology | Picture | Sample Time (estimate) | MP Time (estimate) |
|---|---|---|---|---|---|
| **Samsung** | 3D | TCAT/VG technology |  | - | 2014 Q1 |
| **Toshiba /SanDisk** | 3D | P-BiCS technology |  | 2014 Q1 | The 2nd half of 2015 |
| **Micron** | 3D | DG TFT technology |  | 2014 Q2 | pending |
| **SK- Hynix** | 3D | SMArt technology |  | 2014 Q3 | 2015 |

Source:www.chinaflashmarket.com for reference only.

In addition, Samsung launched 3D products but price didn't confirmed yet, compared with 1ynmand and the coming 1xnm process technology, the production cost of 3D will be higher than 2D products. Currently market don't have great demands of 3D product, the application of new products also need time to digest and verify, 3D NAND Flash maybe becomes major market trend in 2016.

## ■ NAND Flash chip output increased season by season, the supply shortage of excess by variable

After production line adjustment, the biggest NAND Flash manufacture Samsung, Fab 9 only do mass production small batch of NAND Flash; Fab 12 goes with stable production capability; Fab 16 is with the max output and regards as a flexible adjustment of NAND Flash product factory, it is located at Xi'an, china and will begin mass production in the beginning of 2014, and Fab 12, Fab 16, Xi'an factory will be the main NAND Flash production line of Samsung in future.

Toshiba, No. 2 manufacturer of NAND Flash, Fab 4,Fab 5 and Fab 6 is main production line for NAND Flash. After Fab 4 decrease production capability in 2012, its output improve gradually in 2013 and resume production capability same as before in the second of 2013. Fab 5 is the joint factory of Toshiba and SanDisk, so it always keeps certain output and expects to begin small batch NAND Flash production in the beginning of 2014. Meanwhile, Toshiba begins to build No. 3 new NAND Flash factory. Toshiba and SanDisk production capability allocation as below: Toshiba share 70% of Fab 4, SanDisk share 30%, during the finance crisis in 2008, Toshiba rent 1 billion USD to SanDisk through the crisis to avoid takeover by Samsung, SanDisk decrease 49% to 30%, but the production capability allocation is 50% each own by Toshiba and SanDisk. In 2011 SanDisk capital turns better and adds factory investment into NAND Flash market, Fab 5 shareholder structure is 51% Toshiba, 49% SanDisk, productivity allocation is 50% each, SanDisk is not original manufacturer but module manufacturer, Toshiba produce Flash Wafer and then sell to SanDisk to do branded product sales, so it won't mention SanDisk in the ranking of original manufacturers.

Micron own 3 NAND Flash production lines, in 2012 Micron acquired Elpida and became Inotera shareholder. Refer to productivity adjustment, Japan Elpida is production base of Mobile DRAM, Taiwan Rexchip and Inotera Memories became standard DRAM production base, Micron transfer USA and Singapore DRAM to Japan and TW in 2013 also change DRAM production capability to Flash, which greatly enhance the production scale, the effect can be reflected in 2014.

**Exhibit 7: Toshiba SanDisk NAND Flash Allocation in Fab 4 and Fab 5 factories**

| Factory | | Toshiba | SanDisk |
|---|---|---|---|
| Fab 4 | Share | 70% | 30% |
| | Production capability | 50% | 50% |
| Fab 5 | Share | 51% | 49% |
| | Production capability | 50% | 50% |

Source:www.chinaflashmarket.com for reference only.

**Exhibit 8: NAND Flash factory Estimated Average output in 2013**

| Manufacturer | Factory | Technology | Monthly Output | Remark |
|---|---|---|---|---|
| Samsung | Fab 12 | 21nm | 8 | |
| | Fab 16 | 1xnm | 30 | Flexible adjustment |
| | Fab 9 | 2xnm | 2 | |
| | China Xi'an | 3D VNAND | 10 | Output in 2014 |
| Toshiba | Fab 4 | 19nm | 10 | |
| | Fab 5 | 19nm | 20 | Flexible adjustment |
| | Fab 6 | - | - | Output in 2014 |
| Micron | MTV | 20nm | 4 | |
| | IMFT | 20nm | 7 | |
| | IMFS | 20/16nm | 8 | Flexible adjustment |
| SK-Hynix | M11 | 20/16nm | 13 | |
| | M12 | 20/16nm | 2 | Flexible adjustment |
| | China Wuxi | 20nm | 1 | Adjust by demands |

Source: www.chinaflashmarket.com for reference only. Unit:10 thousands 12" wafer.

SK-Hynix M11 NAND Flash production line always keeps certain output, M12 adjust DRAM and NAND Flash production percentage more flexibly according to market demands. The factory located at Wuxi china and expanded 2.5 billion usd to add advanced technology investment of DRAM and NAND Flash in the end of 2013.

## ■ The Mutual Conversion between DRAM and NAND Flash Affects memory chip capacity change

Due to little differences on NAND Flash and DRAM production equipment, it is common that the upstream DRAM and NAND Flash chip manufacturers change the policy on production line conversion, production capacity conversion and output adjustment. Global Mobile DRAM major suppliers are Samsung, Elpida and SK-Hynix only, Elpida's production capacity needs to meet Micron embedded memory eMCP/eMMC applications in mobile phones, Samsung's capacity need meet its own smart Mobile phone demands, so the supply of Mobile DRAM market is always in shortage. In 2013 smart mobile phone began to enter quad-core mobile processor generations, which push the average capacity upgrading from 1/2GB to 2/4GB, the consumption for Mobile DRAM production capacity is doubled, while the sales profit of Mobile DRAM is much higher than NAND Flash, Samsung, SK-Hynix, etc. tend to change the NAND Flash production lines to produce Mobile DRAM.

SK-Hynix's china Wuxi factory happened fire explosion in the beginning of Sep, 2013, the factory capacity is around 150k pcs/month, about 100k of them is PC DRAM, 30K Mobile DRAM and MCP, total takes around 15% of worldwide supply. The resume time predicts extend to Jan, 2014. The 4-5 months productivity loss of Wuxi factory increase DRAM supply shortage, each upstream chip manufacturers may get balanced supply through production line conversion.

Further analysis, upstream chip manufacturer transfer part of PC DRAM to Mobile DRAM, and then the market supply of PC DRAM is not so much. Now the PC DRAM production capability of Wuxi factory loss heavily, it not only stimulate PC DRAM prices rising, but make market supply extremely tight, meanwhile NAND Flash price keep going down in the second half of 2013. Under the driven of PC DRAM profit, upstream chip manufacturers may adjust part of NAND Flash production line to producing DRAM or Mobile DRAM.

**Exhibit 9: Comparison between NAND Flash and DRAM**

| Manufacturer | | Toshiba | Samsung | Elpida |
|---|---|---|---|---|
| Product | | 1ynm 64G ED3 | K9ACGD8U0B | 30nm 4Gb ECB440ABACN-Y3 |
| Dimension | X | 6276 | 11695 | 10460 |
| | Y | 10922 | 6684 | 7100 |
| | unit | um | um | um |
| Technology | | 1ynm | 19nm | 30nm |
| Qty per wafer(pcs) | | 713 | 804 | 859 |
| price | | USD2.5 | USD2.5 | USD3.3 |
| Total price (90% yield) | | USD1605 | USD1809 | USD2551 |

Source:www.chinaflashmarket.com for reference only.

According to report, SK-Hynix improve 30% of Icheon in Gyeonggi Province DRAM factory to fill the lost productivity of Wuxi factory, part of Qingzhou NAND Flash device transfer to Lichuan as DRAM production line device, At the same time Samsung improve DRAM supply, The upstream chip factory adjustment of production line will affect the memory chip production changes, or have a certain influence on market prices.

# NAND Flash related product application market- - The mainstream embedded storage products

## ■ The development of mainstream eMMC products

### 1.1, the new eMMC specification interface transfer speeds will up to 400MB/s

eMMC specification from 2008 JEDEC V4.2 to JEDEC V4.5, the theoretical write speeds has been up to 200MB / s On Oct,2013.JEDEC Solid State Technology Association has released V5.0 specification (JESD84-B50), the new standard by introduced HS400 mode, the interface has improved theoretical writing speed doubled from 200MB/s rose to 400MB/s, while in response to user needs design improvements to simplify the system development, effectively reducing the cost of production, and accelerate new products to market and upgrade the speed, V5.0 specification significant improvements greatly enhance the marketing of the high-end mobile devices.

Nowadays, the CPU processing's speed is running faster and faster, NAND Flash interface transfer rate theory has reached 400MB / s, plus upgrade eMMC interface speed, the mobile terminal devices will be faster to execute the multitasking, web browsing, downloading software, transfer files shooting HD video, as well as carrying the big game and office software, mobile devices lead the terminal enters the era of high-speed transmission.

### 1.2, eMMC applications have been developed to more deep penetrate from the noble products to the civilian one

2013 was the actual first year of eMMC's outbreak in market demand applications. Before 2013, eMMC's application is limited to a small number of high-end smart phones, tablet PCs and high-end industrial applications such as automotive GPS. The eMMC price has been high, compared with the price of the TSOP MLC NAND Flash, at least 15-20% of the price difference space. 2013 With the rapidly growing popularity of the Android system, especially over Android 4.0 operating system, the rapid spread of the minimum operating system requirements for Flash memory has risen to at least 2GB of space, but also take into account the storage of data, backup data, etc., Android 4.0 above the product requires at least 4GB of storage space, while the use of traditional TSOP SLC NAND Flash has

**Exhibit 10:The evolution of eMMC standard features list**

| Feature | eMMC4.4 | eMMC4.41 | eMMC4.5 | eMMC5.0 |
|---|---|---|---|---|
| Mass Storage | √ | √ | √ | √ |
| Boot Support | √ | √ | √ | √ |
| Sleep Mode | √ | √ | √ | √ |
| Reliable Write | √ | √ | √ | √ |
| DDR I/F | √ | √ | √ | √ |
| Partitioning | √ | √ | √ | √ |
| Protection Modes (RPMB) | √ | √ | √ | √ |
| Secure Write (Reliable Write) | √ | √ | √ | √ |
| H/W reset HW Flash Lock(Reset pin) | √ | √ | √ | √ |
| 1.2v IO | √ | √ | √ | √ |
| High Priority Interrupt | x | √ | √ | √ |
| Background Operations | x | √ | √ | √ |
| Higher Speed 200MB/s throughput | x | x | √ | HS400 |
| Packed Command | x | x | √ | √ |
| Context ID | x | x | √ | √ |
| Large sector 4KB size | x | x | √ | √ |
| Power off notification | x | x | √ | √ (add sleep notification) |
| Package case temperature | x | x | √ | √ |
| RTC(Real Time clock) info | x | x | √ | √ |
| Dynamic device capacity | x | x | √ | √ |
| HS400 | x | x | x | √ |
| Discard | x | x | √ | √ |
| Cache | x | x | x | √ |
| Sanitize | x | x | √ | √ |
| Data tag | x | x | √ | √ |

Source:www.chinaflashmarket.com for reference only.

been completely unable to meet the capacity requirements and cost requirements, so more eMMC applications quickly began to spread.

In the low-end tablet PCs and network player OTT boxes, the very price sensitive market, due to the use of domestic chip as the main chip, Allwinner, Rockchip, Amlogic, Actions and other platforms are supported by default TSOP MLC NAND, most of the customers based on cost considerations, preferred the TSOP MLC NAND, but TSOP NAND resource market is uneven, the problem appeared Flash quality of a number of manufacturers in 2013, also gave birth to some customers began more willingness to consider eMMC and product reference designs eMMC compatible design. In order to MediaTek based communications tablet market, car GPS, intelligent digital television, industrial control, gaming consoles, EBOOK books, including the high-end quad-core tablet PCs and custom operators OTT boxes and other industries, more and more customers want to have a better performance, cost-effective solutions to better stability, more customers are choosing eMMC storage solutions.

In eMMC vendors, the market from 2012 SanDisk and Samsung dominated situation becomes more than balanced competitive landscape. In the high-capacity MLC eMMC market, SanDisk, Samsung and Toshiba continue to maintain comprehensive advantages, and in the low-end capacity eMMC market, Samsung, Toshiba and other industry-focused customer oriented, while module plant, such as Kingston, Netcom have started the consumer market and occupy more and more market share. SK-Hynix and Micron eMCP due more focused on other markets, the market share in eMMC is limited.

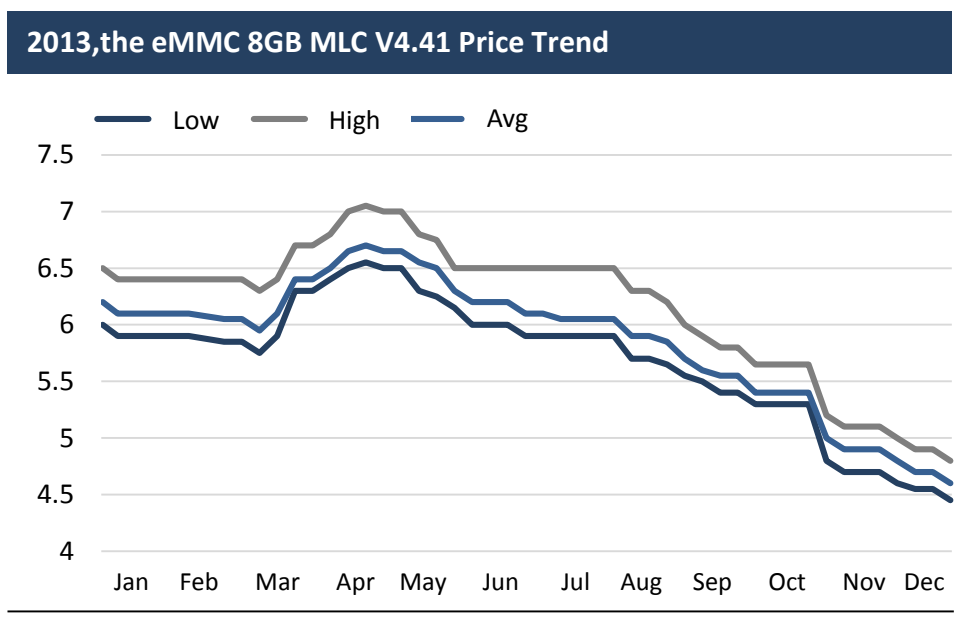
In 2014, with blowout development of the large screen of the smartphone, tablet universal communication, OTT boxes and popularization of smart digital TV, eMMC market will further expand the range of applications and market share as well.

**Exhibit 11, 2013, the key vendors on latest eMMC products**

| Manufacturer | Brand | eMMC SPEC | Technology | Max Capacity | Flash | Main Package SPEC |
|---|---|---|---|---|---|---|
| **Samsung** | Samsung | eMMC 5.0 | 19nm | 64GB | MLC/TLC | |
| **Toshiba** | Toshiba | eMMC 5.0 | 19nm | 64GB | MLC | FBGA 11.5*13 |
| **SanDisk** | SanDisk | eMMC4.5 | 19nm | 64GB | MLC | |
| **Micron** | Micron | eMMC4.5 | 20nm | 64GB | MLC | FBGA 12*16 |
| **SK-Hynix** | SK-Hynix | eMMC4.5 | 20nm | 64GB | MLC | |
| **Netcom** | FORESEE | eMMC4.5 | 21nm | 32GB | MLC/TLC | |
| **Kingston** | KSI | eMMC4.5 | 21nm | 32GB | MLC | |

Source:www.chinaflashmarket.com for reference only.

**Exhibit 12, 2013 eMMC 8GB Price Quotes Chart**




Source:www.chinaflashmarket.com, data expiration time:Dec.20th, for reference only,Unit:USD

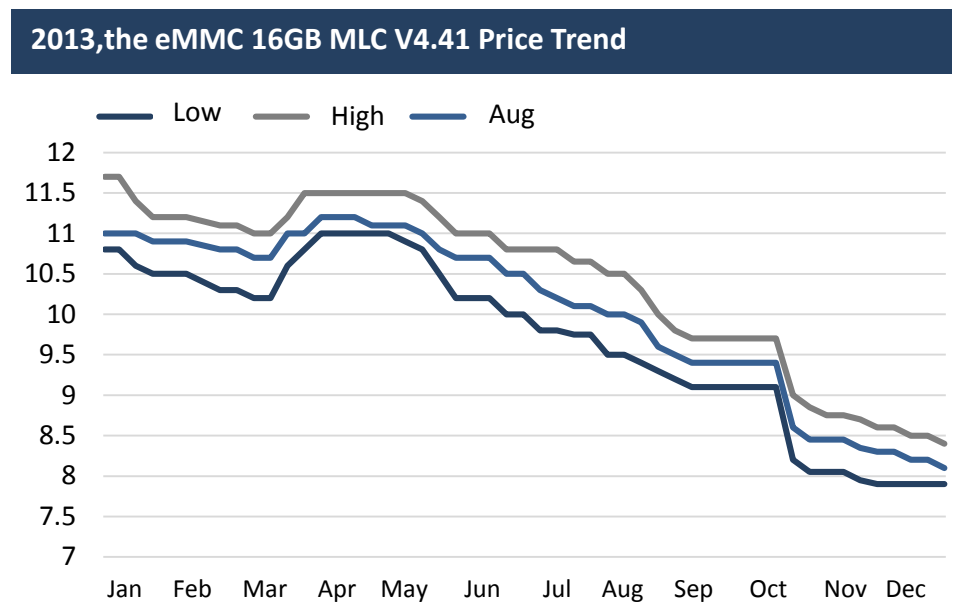
**1.3,2013 eMMC price's market trend**

The first half of 2013.the V4.41 specification MLC eMMC is still the mainstream of the market, with increased market demand for high-capacity, 2GB V4.41 MLC eMMC began to withdraw from the mainstream market, and prices were relatively stable in the first half, the second half by the market demand for light impact, price fell about 5%. 4GB V4.41 MLC eMMC benefit from low-cost smart phone eMCP shipment lead, as well as increased smart TVs, set-top boxes and other embedded demand, prices rose 12 percent in the first half, the second half of year, the price continued to decline, has fallen to about 3 dollars.

8GB, 16GB V4.41 MLC eMMC is the mainstream demand of smart phone, tablet PC, Q1 2013 by the upstream supply shortages and the impact of increasing demand, prices edged performance.Since the 8GB and 16GB are the main production capacity in the upstream suppliers, the price was going down in the trend from the beginning of Q2, the annual declines were more than 20%. The high-end smart phone and tablet products are mainly used 32GB price, relatively limited demand, prices fell about 15% throughout the year. (Note: eMMC prices at an average price basis).

The second half of 2013, V4.5 specification eMMC mainstream trend gradually formed, mainstream capacity from 16GB-64GB, but the equivalent capacity eMMC slightly higher price than V4.41 specification. V4.41 specification TLC eMMC prices slightly lower than V4.41 specification MLC eMMC, mainly concentrated in the low-capacity 4GB, 8GB.

**Exhibit 13, 2013 eMMC 16GB Price Quotes Chart**




Source:www.chinaflashmarket.com, data expiration time:Dec.20th, for reference only,Unit:USD.

## ■ The mainstream embedded storage products in the smart phone market

### 2.1, eMMC embedded storage eMCP mainstream development

The main chip platform has determined the support of the embedded application programs in the smart phone, its capacity depends on customer's needs, the development of multi-core chips, and the main customer needs and capacity changes directly affect the cost embedded memory solutions. Currently mainstream smart phone embedded storage solutions have NAND MCP, eMCP, POP (Package on Package) Mobile DRAM+eMMC etc..

The middle&high end smart phones use more eMCP, POP(Package on Package)+eMMC embedded storage solutions. eMCP and POP+eMMC has some advantages compared to the price, is in the end as well as part of the mainstream of embedded storage solutions used in high-end smart phone, its main storage specifications are 4+4(eMMC:4GB,LPDDR1/2:4 Gb),4+8(eMMC:4GB,LPDDR2:8Gb),16+8(eMMC:16GB,LPDDR2:8Gb)and so on.

POP LPDDR and CPU processor package, plus an eMMC chip, this embedded storage solution has been adopted by Samsung, Nokia, Lenovo and other high-end smart phones. This program currently supports high-end main chip platform: MTK 659X, Qualcomm 8064,89 XX, Samsung Exynos 4412, nVidia Tegera 4 and so on.

### 2.2,Smart phone shipments will continue to increase, driven by growing demand for eMMC

2013,smart phone market momentum flourishing, is still the Samsung Galaxy and Apple iPhone series to lead the high-end smart phone market, while the domestic mobile phone brand factory Huawei, Lenovo, ZTE and other shipments grew rapidly and began to lead the low-end market has become new smart phone growth momentum. According to IDC expects 2013 global smart phone shipments will be over 1 billion, representing an increase of 39 percent over the same period in 2012 to 2017 to reach 1.7 billion in shipments of scale.

**Exhibit 14：The mainstream smart phone embedded storage solutions**

| | Storage Profiles | main chip platform |
|---|---|---|
| **eMCP** | eMMC:4GB,LPDDR1/2:4Gb<br>eMMC:4GB,LPDDR2:8Gb<br>eMMC:16GB,LPDDR2:8Gb | MTK 657X,658X，Qualcomm 8X2X,8X60，spreadtrum 6825/8825，Marvell 98X，leadcore LC1815/1820，Broadcom 281XX etc |
| **eMMC** | POP Mobile DRAM ,8GB/16GB/32GB eMMC | MTK 659X，Qualcomm 8064,89XX，Samsung Exynos 4412，nVidia Tegera 4 etc |

Source:www.chinaflashmarket.com for reference only.

**Exhibit 15：2013 global smart phone shipments forecast**

| Area | 2013 output | 2013,Market share | 2017 output | 2017,Market share |
|---|---|---|---|---|
| **Asia-Pacific** | 528.2 | 52.3% | 986.0 | 58.5% |
| **Euro** | 182.1 | 18.0% | 261.0 | 15.5% |
| **North America** | 151.0 | 15.0% | 189.0 | 11.2% |
| **Latin America** | 91.1 | 9.0% | 154.7 | 9.2% |
| **Middle East and Africa** | 57.6 | 5.7% | 95.0 | 5.6% |
| **Total** | 1010.1 | 100% | 1685.8 | 100% |

Source:IDC,Unit:Million

#### 2.2.1,2013 Apple, Samsung smartphone market share may more than 50%

High-end market, Samsung Galaxy series with hot sales, smart phone in 2013 has been among the top quarter sales. September 2013 began selling Apple's iPhone 5s, 64bit A7 processor, fingerprint recognition and fashion design for the new plus expected Q4 overall iPhone shipments more than 50 million, in 2014 Q1 shipments will reach 45-50 million . Samsung, Apple's smart phone shipments in 2013 are expected to exceed 50% market share. In addition to the Apple iPhone, Samsung Galaxy S4 / Note 3 to lead the high-end market, other mobile phone brand factory also has its own high-end smart phones is one of the active force eMMC demand continued to drive growth.

**2.2.2,High-end smart phone market demand slowdown, demand for low-end smart phones into a new force**

Because the decline in demand for high-end smart phone, the Samsung originally in 2014 is estimated to be 360 million smart phone sales down to 330 million, in 2013 is expected to be 300 million. Saturation of high-end smart phone, the Samsung 2014 will focus on the low-end smart phone and tablet markets.

2013 With the evolution of mobile technology processor core, quad-core smart phone into a high with the times, the user experience, quad-core phone's performance to meet consumer demand for video, games and other entertainment applications. With the domestic smart phone brand factory Huawei, Lenovo, ZTE, Coolpad, Millet have joined the Board of nuclear war, the quad-core smart phones began to enter the mid-market, and gradually spread to the low-end market. 2013 quad-core high-profile rise of smart phones, and more than Samsung, Apple phone more price advantage, so that more consumers, especially in emerging markets like China and India, began to consider the purchase cost-effective smart phone.

Low-end smart phones' mainstream stored as 8GB, 16GB, despite losing to the high-end market, NAND Flash consumption, but with the quad-core smart phones is growing, expected storage capacity will be 16GB, 32GB transfer, will be an army of ants the potential to become consumed NAND Flash newborn powers.

In addition, in December 2013 China's Ministry of Industry officially released to the three operators of TD-LTE 4G licenses in 2014 the mobile phone brand factory will increase the proportion of the 4G mobile phone shipments to more than 30 percent, will drive the smart phone market size expanding.

**Exhibit 16：2013 global top five mobile phone brand factory shipments of smart phones quarter**

| | 2012 Q1 | 2012 Q2 | 2012 Q3 | 2012 Q4 | 2013 Q1 | 2013 Q2 | 2013 Q3 |
|---|---|---|---|---|---|---|---|
| **Samsung** | 4220 | 5050 | 5630 | 6370 | 7070 | 7240 | 8600 |
| **Apple** | 3510 | 2600 | 2690 | 4780 | 3740 | 3120 | 3200 |
| **Huawei** | 510 | 660 | 760 | 1080 | 990 | 1110 | 1270 |
| **LG** | 490 | 580 | 700 | - | 1030 | 1210 | 1200 |
| **Lenovo** | - | 490 | 660 | - | - | 1130 | 1100 |
| **ZTE** | 610 | 640 | 750 | 950 | 910 | 1150 | - |

Source:Strategy Analysis,IDC,Unit:10 thousands

## ■ Mainstream embedded storage products in the tablet market

2013 tablet market is still Apple's iPad sales dominance, Samsung, Google, Amazon, Lenovo, Asus and other brand factory tablet shipments showed a steady growth trend, no brand tablet meteoric rise in the low-cost advantage, sales astonishing. According to IDC estimates, in 2013 the global tablet shipments will reach 221.3 million, an increase of 53.5% in 2014 to grow to 270.5 million.

### 3.1,2013 global no brand tablet chip shipments will reach 130 million, to seize the tablet market share

2013, the domestic tablet chip vendors as: Allwinner, Rockchip, Amlogic and other leading on no brand tablet' sales astonishing. MediaTek due to integrate the advantages of 3G communications tablet, began full force in the tablet market, and almost monopolized the 3G call tablet the major markets. MediaTek variety of tablet chips are highly integrated, high performance, low power consumption and other characteristics, subject to a number of domestic flat-panel favored brand factory, expected 2013 flat chip shipments are expected to more than 20 million, 2014 will 6-8 chip launch tablet shipments are expected to be over 50 million. Expects 2013 global chip no brand tablet shipments will reach 130 million, in 2014 shipments are expected to rise to 160-180 million, while the surge in shipments of market competition will become more significant.

### 3.1.1,Low-end tablet using TSOP NAND+DDR3 embedded storage solutions

Amazing no brand tablet sales in the low-cost advantages, has far exceeded the brand tablet, white card tablets will be able to do very low prices, have a great relationship with the embedded storage solutions. According to the market understood that 2013 domestic tablet vendor as Allwinner, Rockchip, Amlogic, Actions and other platforms are mostly using 2Gbx8bit DDR3 embedded with TSOP NAND storage solutions, rather than low-power LPDDR2 with eMMC.

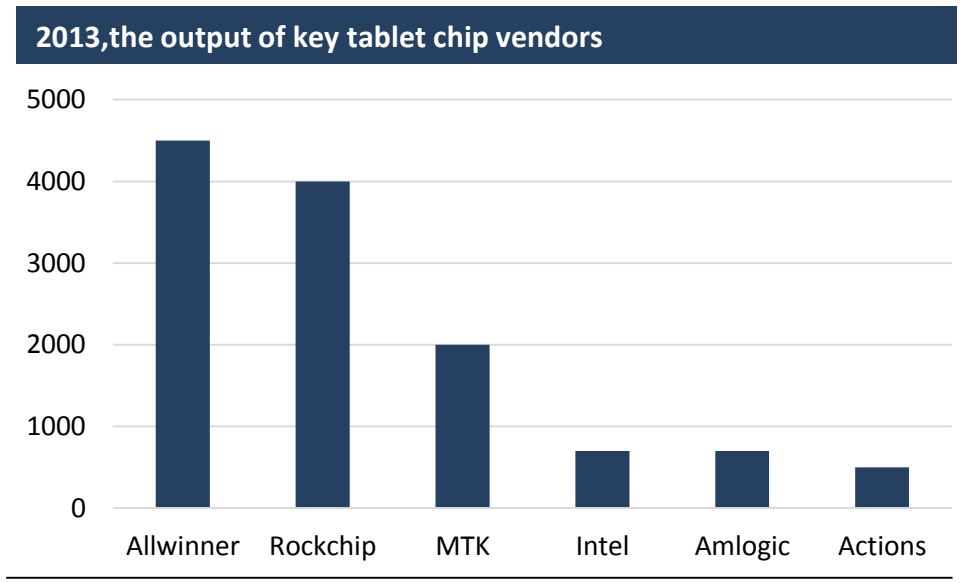
Due to the price-sensitive of the low end on no brand tablet vendors, some manufacturers were forced to adopt a relatively low-quality or counterfeit DDR3 and TSOP NAND. 2013, lots quality accident had happened and this

**Exhibit 17：2013 global top five tablet brand factory shipments of tablets quarter**

| | 2012 Q4 | 2013 Q1 | 2013 Q2 | 2013 Q3 |
|---|---|---|---|---|
| **Apple** | 2290 | 1950 | 1460 | 1410 |
| **Samsung** | 790 | 880 | 810 | 970 |
| **Asus** | 310 | 270 | 200 | 350 |
| **Amazon** | 600 | 180 | - | - |
| **Microsoft** | - | 90 | - | - |
| **Lenovo** | - | - | 150 | 230 |
| **Acer** | - | - | 140 | 120 |

Source:IDC,Unit:10 thousands

**Exhibit 18：2013,tablet chip shipment forecast of the major vendors**




Source:www.chinaflashmarket.com Unit:10 thousands

has seriously affected the overall quality image of tablet industry, many lamented that the, While some vendors to no bottom line, when the whole industry is a fatal blow.

On the other hand, due to the continuous improvement of each original NAND Flash process technology, the 2014 TLC NAND Flash MLC NAND Flash price relative advantages will become more apparent, more trouble is with the change of NAND Flash manufacturing process, in particular the tablet's main chip is upgraded to quad-core and Octa-core, will further increase the flat chip factory technical support for TSOP NAND difficulty and complexity, each NAND Flash Factory are actively promoting the use of flat-panel plant more eMMC, to improve product quality flatbed and lower failure rates.

### 3.1.2,Low-end tablet multicore development, driven by the surge in demand eMMC

Most tablet chip plant in 2013 have launched a Quad-core chip, but also released new dual-core chips. With the domestic flat-panel fab Quad-core chip from 15 dollars to 10 dollars less than the dual-core chip prices dropping to $ 5 or even less, the effect will enable more customers to low-cost dual-core and quad-core transfer, storage capacity will be the mainstream from 4GB/8GB to 8GB/16GB, eMMC demand will increase in leaps and bounds, there will be a substantial increase in the consumption of NAND Flash capacity.

### 3.2, Intel BayTrail affect low-power mobile processor SoC platform for the tablet market

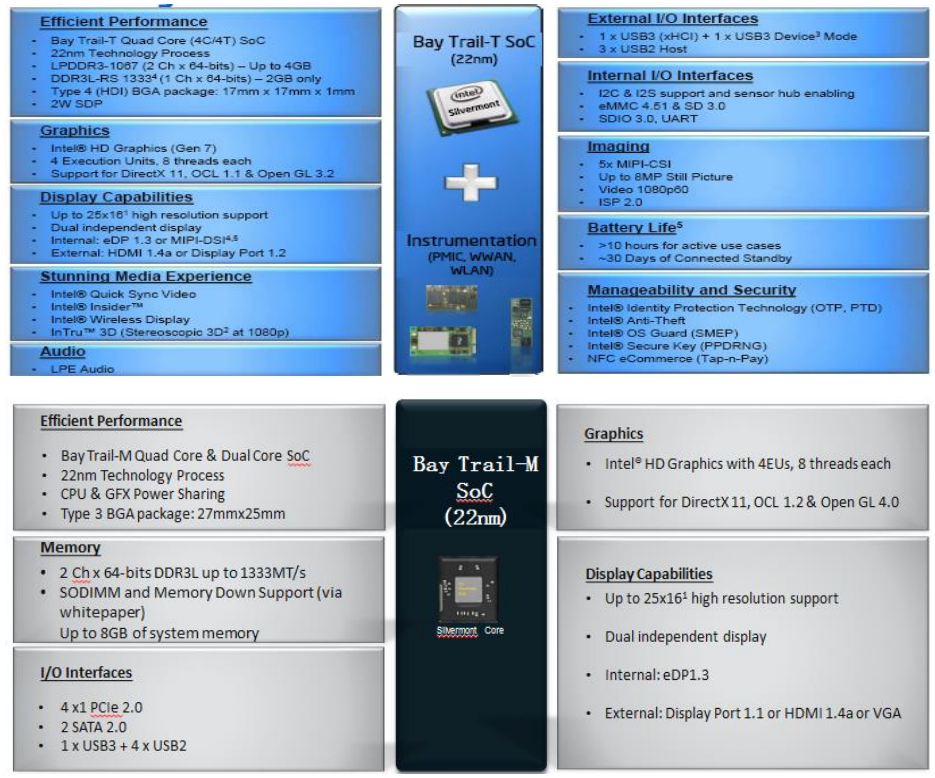
While the war in full swing on the occasion of the tablet market, Intel released the first tablet specifically for the Atom chip Z3000 series (codenamed "Bay Trail-T"), support for Windows 8.1 and Android operating system into the tablet market. Intel not only has a strong R & D strength and inherent supply chain advantages, but also jointly conducts a comprehensive deployment of Shenzhen manufacturers and invests one billion dollars to promote their plan, set in 2014 flat chip shipments of 40 million target amount.

**Exhibit 19：The mainstream tablet embedded storage solutions**

| Core sturcture | Storage Profiles | Tablet chip platform | Tablet's representive product |
|---|---|---|---|
| **Single core** | 4GB NAND TSOP+512MB DDR3 | A10/A13，Rockchips 2926/2928 | V5，Teclast A70，Cube U25GT etc |
| **Dual-core** | 4/8GB NAND TSOP/eMMC +1GB DDR3 | Allwinner A20/A23, Rockchips 3168/3066,Amlogic MX,MTK 8377/8312 | Sony erriosn S10，Teclast P98，Lenovo A2207etc |
| **Quad-core** | 8/16GBeMMC+1GB LPDDR2 | Allwinner A31/A31S, Rockchips 3188/3168,Amlogic M8,MTK 8389/8382,Actions 7029/7039 | Teclast P98HD，Vido N90，Newman M11 etc |
| **Octa-Core** | 16/32GB eMMC+2GB LPDDR2 | - | - |

Source:www.chinaflashmarket.com

**Exhibit 20：Intel Bay tTrail low-power mobile processor SoC platform**




If it is for Windows tablet, then stored in V4.5 specification eMMC 32GB and 64GB based, Android tablet if it is, then stored as V4.5 specification eMMC 8GB from.

## ■ Mainstream embedded memory applications in emerging markets

With Smartphone products as cell phones, tablet products raise, personal video, music, communication, sharing, and entertainment began to penetrate into family life applications, such as smart TVs, wearable, intelligent set-top boxes, smart routers. Such products are equipped with an open operating system, with a high frequency CPU processor, built-in NAND storage, etc., represent the next generation of intelligent products.

**Exhibit 21：Emerging Intelligent Embedded Storage Solutions**

| New applications | Mainstream storage solutions | Major vendors | Representative products |
|---|---|---|---|
| **Smart TV** | 4GB/8GB eMMC+1GB /2GB DDR3 | Xiaomi、Le TV、TCLetc | Le Super TV，Xiaomi TV etc |
| **Smart watches /Smart wrist** | 4GB/8GB eMMC+1GB /2GB DDR3 | Sony,Samsung, Tuman, Google etc | SW2，Galaxy Gear，T-Fire，Google Gem etc |
| **Smart Box** | 4GB eMMC+1GB DDR3 | XiaoMi，Ali，Baidu，360 etc | MI Box，Tmall box etc |
| **Smart Router** | 4GB eMMC+1GB DDR3 | XiaoMI，Baidu，360，ShenDa etc | XiaoMi router etc |

Source: www.chinaflashmarket.com ,for reference only.

# NAND Flash related application market- - SSD storage product

## ■ NAND Flash technical development decreases the SSD cost

### 1.1, The NAND Flash produce SSD from 2xnm trun into 2ynm, lower the cost

2013 upstream chip factory Samsung, Toshiba, Micron, SK-Hynix's NAND Flash SSD will produce nanometer process technology by the 2xnm turned 2ynm, further reducing production costs. Toshiba technology, for example, using 24nm technology can be put before the 12-inch 64Gb/Die the MLC Wafer cutting out more than 500 pieces, 19nm technology can cut out more than 800 films, according to 1500 U.S. dollars per Wafer cost, single 64Gb Die Price reduced from 3.5 to 2.5 U.S. dollars, then the 128GB (64GbX16) prices fell by 66 dollars to 50 dollars, 26% reduction in production costs.

### 1.2, SSD main suppliers will mass produce 2ynm NAND SSD

2013 SSD major manufacturers Samsung, Toshiba, Intel, Micron etc. has promoted to the consumer and the server market new SSD products. The process technology of SSD NAND Flash will transfer to 2ynm era. The cost of 2ynm SSD production reduced by 20 % or more than the privious 2xnm SSD. In 2014 will enter 1xnm era, by when the SSD production costs will be decreased.

### 1.3, 3D NAND Flash technology will increase the SSD sales volumn and decrease the price

Upstream chip factory like Samsung, Toshiba, Micron have already started planning 3D NAND Flash technology, Samsung's first 3D NAND Flash chips used in the SSD, storage capacity up to 480GB, 960GB, focusing on the enterprise market. 3D NAND Flash SSD is not only provide TB storage capacity also can reach the next level of further enhance performance, reduce power consumption. Although Samsung has not yet announced the price of its 3D SSD, but from 3D NAND architecture considerations, 3D technology is mature and will at least cost down the SSD. Now cloud computing, enterprise private cloud, the rise of cloud storage, data center storage continues to expand in the Internet era, meanwhile it needs high-speed transmission of large capacity storage devices.

**Exhibit 22：Latest products of main SSD supplier**

| Manufacturer | Representative Products | NAND Flash | Technology | Controller Chip | Density | Interface |
|---|---|---|---|---|---|---|
| **Samsung** | 840 Evo | MLC | 19nm | Samsung MEX | 120GB-1TB | SATA III |
| | 840 Pro | MLC | 21nm | Samsung MDX | 64 GB -512GB | SATA III |
| | XS1715 | MLC | 21nm | Samsung MDX | 400GB-1.6TB | PCIe |
| | SM843T | MLC | 21nm | Samsung MDX | 120GB-960GB | SATA III |
| **Toshiba** | THNSNF | MLC | 19nm | Toshiba | 64GB-512GB | SATA III |
| | PX02SM | eMLC | 24 nm | Toshiba | 200GB-1.6TB | SAS |
| **Intel** | 530 | MLC | 20nm | SandForce | 80GB-180GB | SATA III |
| | 335 | MLC | 20nm | SandForce | 240GB | SATA III |
| | DC S3700 | MLC | 25 nm | Intel | 100GB-800GB | SATA III |
| | DC S3500 | MLC | 20nm | Intel | 80GB-800GB | SATA III |
| **SanDisk** | X110 | MLC | 19nm | Marvell | 64GB- 256GB | SATA III |
| | X210 | MLC | 19nm | Marvell | 128/256/512GB | SATA III |
| | Extreme II | MLC | 19nm | Marvell | 120GB-480GB | SATA III |
| **Micron** | M500 | MLC | 20nm | Marvell | 120GB-960GB | SATA III |
| | P420m | MLC | 25nm | Marvell | 1.4TB, 350GB, 700GB | PCIe |

Source:www.chinaflashmarket.com ,for reference only.

## ■ Interface of SSD will change from SATA III to PCIe

In both the general consumer market and OEM / ODM market, currently mainstream is SATA III interfaces. SATA III interface transfer rate is 6Gbit / s, the theoretical bandwidth is 600MB / s, and the next step of development, it will transform to the PCIe interface, take PCIe Gen2 x2 for example, the theoretical bandwidth of up to 1GB/s.

## ■ Controller Flash Chip cost down the SSD cost and the interface is transferring from SATA III to PCIe

### 3.1,Taiwan controller flash chip manufactory promote low cost SATA III chip in order to cost down the SSD cost

There are three representative SSD controller chips in the market: LSI's SF-2281, Marvell's 88SS9187/88SS9174 and Samsung SATA III controller chip (compatible with the full range of Samsung products), which implements the transition from SATA II to SATA III interface.

Using LSI or Marvell controller chip to produce SSD has limitation and difficulties:

1.Expensive, the price of controller chip was over $20 at the beginning and now still above $10.

2.LSI focus more on supporting Intel, Toshiba and other flash vendor, however, they do not show enough support to the small manufactories, and they don't provides development Kit. So the Small and Medium-Sized manufactories cannot response to the OEM/ODM factories quickly,so it will effect the producing and shipment.

3.Marvell provides development kits, but still needs expensive licence fee and R&D investment.

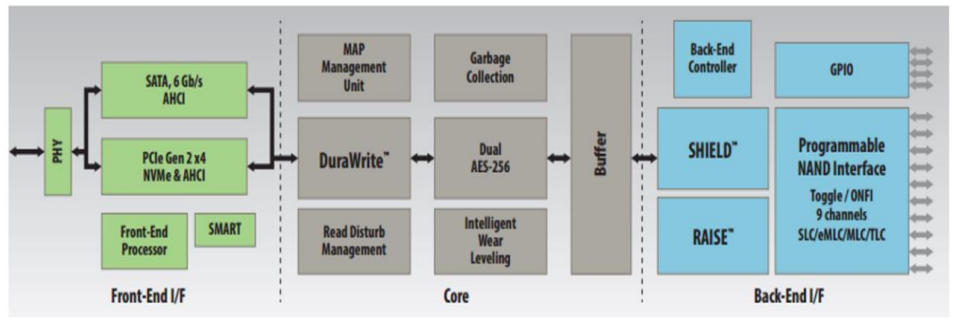
2013 Taiwan manufacturers have introduced low-cost SATA III controller chip, representative models controller chip are JMF667H, SMI SM2246EN and Phison PS3108/PS3109. JMicron and SMI are only support control chip and SATA III SSD solutions to the guests, but Phison also produce SSD independently and sales promotion.

**Exhibit 23: Theoretical maximum bandwidth of interface**

| Interface | Theoretical maximum bandwidth |
|---|---|
| **SATA III** | 600MB/s |
| **PCIe Gen2 x1** | 500MB/s |
| **PCIe Gen2 x4** | 2GB/s |
| **PCIe Gen3 x1** | 1GB/s |
| **PCIe Gen3 x4** | 4GB/s |

Source:www.chinaflashmarket.com ,for reference only.

**Exhibit 24: SF-3700 structure**




Source:www.lsi.com

**Exhibit 25: Controller information of main controller manufactories**

| Controller manufactory | model | interface | Flash | Maximum capacity | ECC technology |
|---|---|---|---|---|---|
| **LSI-SandForce** | SF-3700 | SATA III/PCIe | SLC/MLC or TLC | 2TB | LDPC |
| **Marvell** | 88SS9187 | SATA I/II/III | SLC/MLC | 960 GB | BCH |
| **Silicon Motion** | SM2246EN | SATA I/II/III | SLC/MLC | 256GB | BCH |
| **Phison** | PS3109 | SATA I/II/III | SLC/MLC | 256GB | BCH |
| **JMicron** | JMF667H | SATA I/II/III | SLC/MLC | 256GB | BCH |

Source:www.chinaflashmarket.com ,for reference only.

**3.2,Controller begin to support PCIe interface and TLC NAND**

SSD will transform from SATA III interface to PCIe, and storage media transforms from the current MLC to TLC and 3D NAND, the process of upgrade and transition of this technology, it's a natural need to push the control technology, the PCIe controller market, Marvell, Samsung and LSI is still the industry leader.

## ■ SSD FORM FACTOR transform to NGFF and SATA EXPRESS

The FORM FACTOR of SATA SSD is including 2.5-inch, half-slim, mSATA, M.2 (NGFF), BGA, etc. Currently in OEM/ODM market, the mainstream is still SATA III mSATA and also transferring to M.2 (NGFF), In 2014, the transition begin from SSD Interface to PCIe, OEM/ODM market will use NGFF PCIe, maximum supports PCIe x4, if it is PCIe Gen3 x4, theoretical bandwidth will be 4GB/s.

The interface of 2.5 inch is in the middle of transition to the PCIe, FORM FACTOR will also transit to the SATA EXPRESS, same as M.2 NGFF, SATA EXPRESS defined different signal on the same physical interface, including SATA, SAS and PCIe.

## ■ The main application of SSD market development

In 2013, the demand of SSD in the PC, NB and other consumer electronic products market is steady growing, as mobile Internet to improve the data storage requirements, SSD in the server market demand surge, while lower prices prompted an increase in the SSD industry applications. Three major areas of SSD market : consumer market, the server market and industry-oriented applications to expand SSD market, according to IHS iSuppli expects 2013 Q3 SSD quarter sales more than 18 million units in shipments is expected to exceed 60 million units, in 2014 the shipments will continue to increase.

**Exhibit 26:**

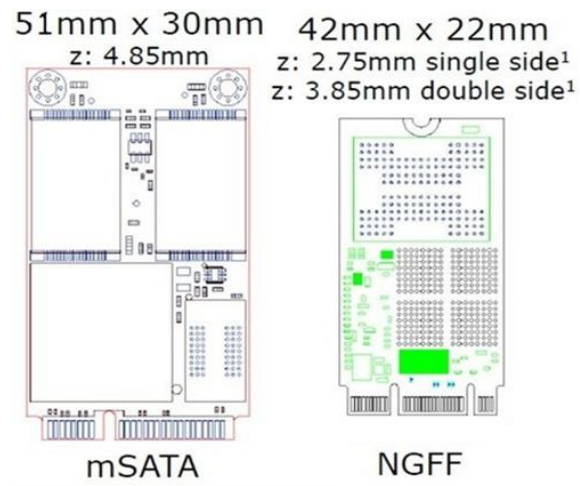



**Exhibit 27: Interface and FORM FACTOR trends**

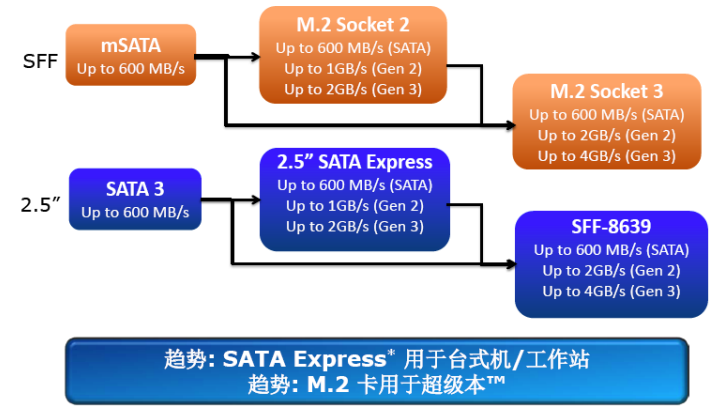
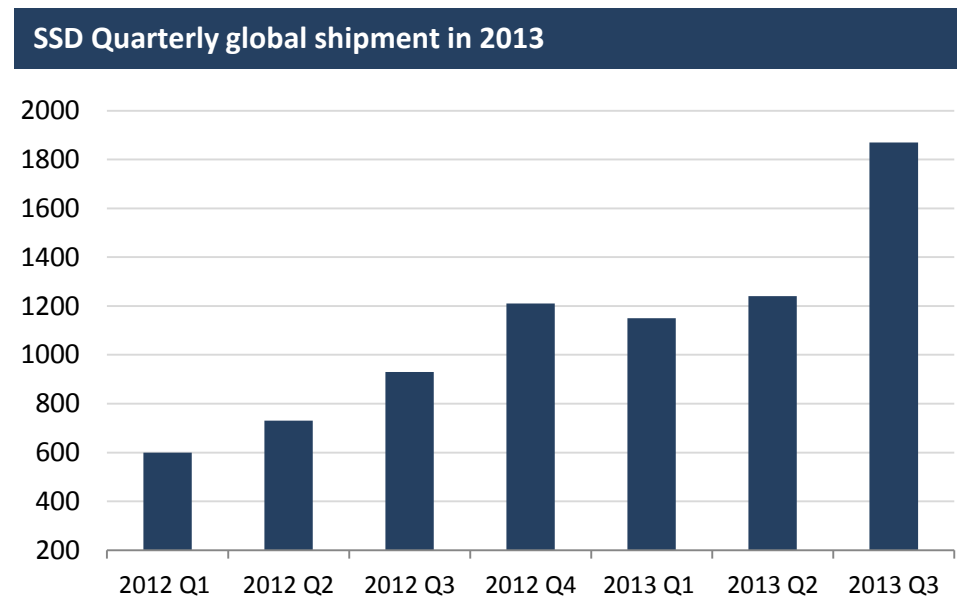



**Exhibit 28：SSD quarterly global shipments forecast in 2013**




Source:IHS iSuppli Unit:10 thousands

**5.1,Consumer Market - [PC sustain future shipments around 300 million, SSD demand will be increased steadily]**

**[Reduce costs, accelerate SSD penetration in the consumer market]**

2013 the price of SSD with SATA III interface fell by 10% to 20% and in 2014 will continue to fell, while SSD controller chip plant in 2014 increasing support for TLC NAND Flash and PCIe interface, the second half is expected to be low TLC SSD enter the consumer market applications and at the end of this year SSD PCIe interface will become the mainstream in the high-end notebook.

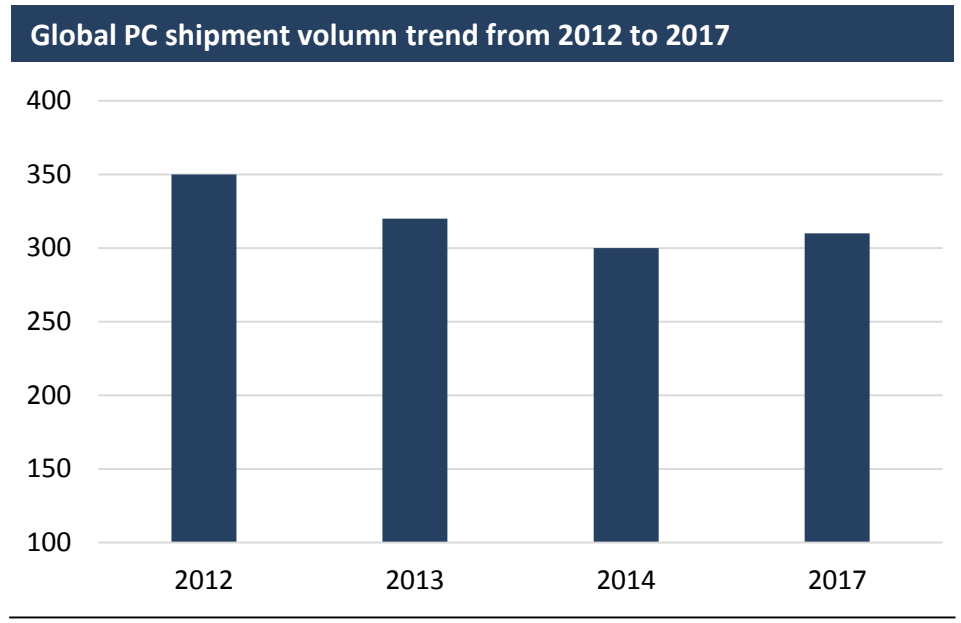
**5.2,Server Market—[Under stimulate mobile Internet era, the server market SSD demand increased]**

With the server continually increasing on the transmission speed, the server market in 2014 will be equipped with SSD SATA III interface to transition to high-bandwidth PCIe, in order to upgrade the speed.

**5.3,SSD unique advantage in application is growing**

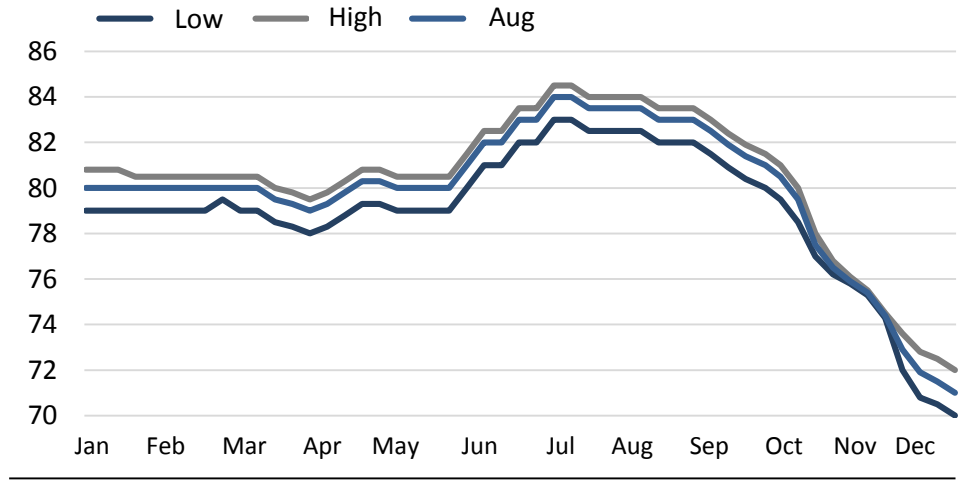
Apart from the consumer market and the server market, SSD used in the areas of military, aerospace, medical, surveillance, automotive, education is growing very fast. Large storage applications in the industry needs customization products, focuses on the value of the stored data reliability, stability, and high-speed transmission products seismic resistance, high / low temperature, low noise, etc.,SSD is expensive before so storage function is HDD and CF / SD memory card based, SSD prices continue to decrease in recent years, so the SSD becomes a new way in the storage industry.

**Exhibit 29：PC shipment volumn will be stable in coming years**




Remark: PC sales volumn including laptop, PC. Unit:million

**Exhibit 30：2013 SSD 128GB Price Quotes Chart**




Source:www.chinaflashmarket.com, data expiration time:Dec. 25th, for reference only,Unit:yuan

## NAND Flash related products- - traditional storage product

■ **Flash Memory Card sales volumn is increasing, especially in high performance and large capacity application market**

**1.1,New SD Specification increases the writing speed up to 30MB/s**

SD 1.0 specification from a minimum 2MB / s write speed to the SD 3.0 specification, UHS Speed Class 1 (U1) guaranteed minimum 10MB / s write speed, SD Associationand published in early November 2013 the latest the UHS Speed Class 3 (U3) specification, the minimum write speeds up to 30MB / s. SD specification development will provide more storage space and higher write performance, it can support consumer electronics devices, mobile devices and industrial equipment storage.

In 2013, UHS Speed Class1 (U1) standard Flash Memory Card became the mainstream in the market. Samsung, Toshiba, Sandisk, Trancent, Netcom and Kingmax promote this new products actively and the main capacity is from 8GB to 64GB, some of the factory promote the maximum 256GB Flash Memory Cards. Manufacturers are expected to begin in early 2014 to push UHS Speed Class 3 (U3) standard flash memory card products, the second half of 2014 it will become the mainstream products in the market.

**1.2,Main stream Flash memory card market trend**

The first half of 2013 the mainstream flash memory cards Micro SD price fluctuations, from January to March influnced by TLC NAND Flash supply shortages, flash memory cards, USB flash drives, NAND Flash price performance rose particles, which Micro SDHC 4GB (CL4 ) Shenzhen market price rose 90% in Q1, 4GB (CL4) rose about 30% in Q1. April and May prices went down, but at the end of May, the message of NAND Flash shortage spread and again the overall prices go up.

The second half of 2013, smart phone, tablet PCs demand is cooling in July and August, Q3 demand performance is not as expected, Micro SD demand less than before and the price decline is more pronounced. But after the impact of SK-Hynix Wuxi China factory explosion news in September and the demand increasing in Q3, Micro SD overall price increase of around 5%, beginning in late October sluggish performance overall market demand, prices continued lower, second half of the Micro SD entire product price declines of about 20%.

**Exhibit 31：Micro SDHC 4GB/8GB(CL4)Price trend of 2013**

| Marks | Operable Under | Applications | SD Memory Card | |
|---|---|---|---|---|
| Speed Class | C10 | High Speed Bus I/F | Full HD video recording | SD, miniSD, microSD |
| | | | HD still consecutive recording | SDHC, miniSDHC, microSDHC |
| | C6 C4 | Normal Bus I/F | HD ~ Full HD video recording | SDXC, microSDXC |
| | C2 | | SD video recording | |
| UHS Speed Class | U1 | UHS-I Bus I/F | Full higher potential of recording real-time broadcasts and capturing large-size HD videos | SDHC UHS-I and UHS-II, SDXC UHS-I and UHS-II |
| | | UHS-II Bus I/F | (UHS Speed Class1 denotes a 10 MB/s minimum write speed) | |
| | U3 | | Capable of recording 4K2K video | |
| | | | (UHS Speed Class 3 denotes 30 MB/s minimum write speed) | |

Source: internet

**Exhibit 32：2013 Micro SDHC 4GB, 8GB Price Quotes Chart**


Source:www.chinaflashmarket.com, data expiration time:Dec.20th, for reference only,Unit:yuan

**1.3,Flash memory cards widely applied and the demand increased**

Flash memory cards are now using in smart phones, tablet PCs as secondary storage , according to IDC 2013 smart phone shipments will more than 1 billion, Tablet PC sales will exceed 200 million, driven by a certain amount of demand of memory cards, and now smart phone configurations are generally higher, increasing to stimulate consumers to games, entertainment, photographs and other interests, some consumers use flash memory cards to increase storage capacity; while demand in terms of safety records are also increasing, from the bus system car video surveillance, to the private car driving recorder, image resolution due to continuously improve and expand the use of market demand for flash memory cards is also rising; other digital cameras, navigation systems, e-books, MP3 / MP4 and other electronic products also need to use flash storage cards. Flash cards with low price, small size, portable/easy to use, large storage capacity and other characteristics are widely used in consumer electronics products.

With the high quality of life also the rise of entertainment, 4k/2k HD video / movie has become the high quality standard of TV and cameras.While screen camera is also required higher standard. The new UHS Speed Class 3 (U3) specification minimum write speeds up to 30MB / s, SDXC or SDHC devices will be able to record 4K/2K ultra-high resolution video, future UHS Speed Class 3 (U3) specification products will become mature and it will show its advantages, more important is the cost of flash memory card will be cheaper than which can support 4K/2K video capture. In this way it will attract the target consumers from flash storage to card products.

## ■ USB Flash Drive Market needs Radical innovation to stimulate the demand

**2.1,USB 3.1 standard transmission rate increases to 10Gbps**

August 2013 USB-IF organization released the USB 3.1 standard specification, USB 3.1 specification uses a more efficient data encoding technology, and provides more than double the effective data throughput. The theoretical transfer speed of USB 3.0 from 5Gbps increased to 10Gbps and is backward compatible to meet consumer demands for high-speed transmission.

In 2013, many memory module factories launched new USB 3.0 flash drive, the mainstream storage capacity is from 32GB to 128GB and the factories gradually stop the promotion of USB 2.0 flash disk. In 2014, USB 3.0 flash drive will become the mainstream in the flash market. After the new USB 3.0 specification was released, the majority of the layout module plant will also be introduced in USB 3.1 flash drive products, there will be new products of USB 3.1 flash drive appear in the market in 2014.

**2.2,Mobile USB: The latest protential market**

USB Flash products are mainly used in PC storage but the sales volumn of PC keeps falling these couple of years.

Meanwhile, the arise of cloud storage, cloud service and company data centre is weakened demand of USB Flash products.

Although the cloud storage is very convenience, but there are certain Internet-based storage security risks, and also need the support of large flow networks. USB Flash Dirve performance homogeneity and application is also very simple but USB Flash Dirve has irreplaceable advantages such as: privacy, large storage capacity, small size, portable and easy to use and so on.

Due to the rapid development of smart phones and smart terminals,the standard interface has changed from Micro USB 2.0 to Micro USB 3.0. Also the contents of the PC can be readable on almost all the dual-core smartphone. In the growing demand trend of mobile working, entertainment, data sharing and storage, etc., many manufacturers began to use a USB flash drive into the phone, to create a mobile phone USB with Micro USB interface, not only to achieve mobile phones and computers inter-fast data transfer, and can share the data, also backup data, encrypted information, and support cross-platform operation, the most important is to expand the mobile phone capacity. With the expansion of smart phones and tablets, mobile USB drive applications become available on the market. The cost is about the same as the common USB drive, market demand will greatly popularize dual interface Flash Drive. In 2014, the quantity of mobile USB drive is expected to reach 100 million.

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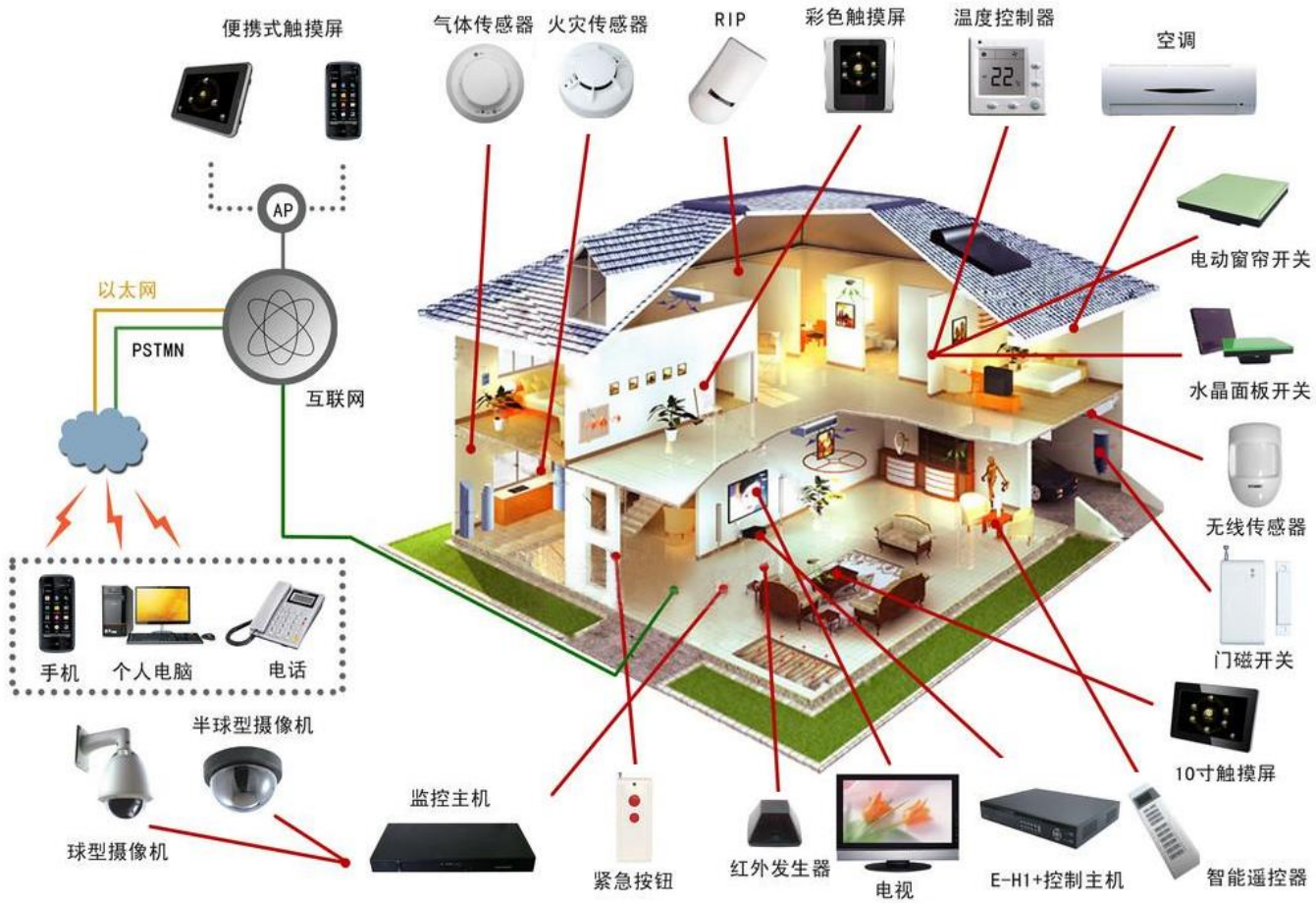
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