Mobile Technologies Index
Memory: The ever-predictable DRAM path

In a world constantly unsettled by disruptive innovation, it is comforting to know there are a few things you can count on. The phenomenal price-performance curve for Dynamic Random Access Memory (DRAM) has been a predictable constant for more than 30 years. It is easy to take this for granted.

We believe the long-term trend will continue. We forecast a compound annual growth rate (CAGR) of 48 percent for DRAM as measured in Gigabits per dollar (Gb/$) through 2015 (see Figure 1), compared to a 49 percent CAGR in 2007-2011. This means the growth rate of improvement in memory will be second only to the expected gains in processor speed (53 percent CAGR in GigaHertz per dollar) among the seven components of the Mobile Technologies Index, which are our key indicators of mobile innovation trends.

“The continued dramatic increases in the amount of affordable memory will lead directly to growth in the capabilities and innovations of operating systems, applications and use cases that mobile devices will be able to handle during the five years of the PwC Mobile Innovations Forecast,” predicts Daniel Eckert, PwC Director for Mobile Computing.

While the CAGR as illustrated in Figure 1 continues a decades long trend, what is changing is that we have now reached a critical level of performance at which mobile devices can meet and exceed (in combination with other capabilities) the wide range of uses previously seen only on laptops and desktop computers.

Our analysis of 30-plus years of data shows a 55 percent CAGR in Gb/$ since 1980, meaning our forecast is consistent with history. This does not mean that DRAM is immune to the semiconductor industry’s boom and bust cycles, as the past decade illustrates.

First, consider that from 2004 through 2008, chip manufacturers achieved CAGR improvements of 70 percent per year. This was due to three factors:

- an increase in capital spending by chip makers after the dot-com implosion and before the 2008 recession, especially 2003 to 2006;
- although the transition began earlier, 12-inch wafer capacity surpassed 8-inch capacity during 2004-2008, dramatically increasing the available volumes;
- consistent growth in demand, due to the surge in purchases of laptops, netbooks and other mobile devices.
Next, note that during the global recession (2008-2010), the growth of DRAM in Gb/$ slowed to 20 percent per year. Overcapacity also resulted in price declines, leading some manufacturers to close some fabs. This has been factored into our forecast.

Looking ahead, we anticipate 48 percent CAGR in DRAM based on several factors: renewed capital expenditure that began in 2011; improving worldwide gross domestic product (GDP) relative to the recession and the rapid growth in markets for smartphones and tablets. Continued sales of PCs of all types will also contribute to the continued price-performance improvements in DRAM.

By 2015 average smartphones will have 40 percent of the 4GB of DRAM that PCs on average have today. Likewise, by 2015 the top 10 percent of smartphones will have 65 percent of the DRAM that PCs have today, and will perform correspondingly. The trend for tablets is even more dramatic (see Figure 2). Figure 3 shows the actual amounts of DRAM in gigabytes, on average, over our forecast period.

Already on the market, the iPhone 5 and the Samsung Galaxy S III both have 1GB of DRAM. The iPad 3 also has 1GB of DRAM, while the Samsung Galaxy Note II, a hybrid smartphone-tablet, has 2 GB.

DRAM represents 5 percent to 15 percent of a smartphone’s bill of materials. That portion is likely to remain steady over the five-year forecast because OEMs will load more DRAM on their devices as the price–performance curve improves, and will offer more applications that need it.

Computing power, memory capacity and storage (the topic of our next article) all work together to create the user experience. As the amounts of each increase in tablets and smartphones relative to traditional PCs, mobile devices will become capable of performing functions and running applications previously associated only with PCs.
DRAM is a key enabler of mobile innovation. DRAM and the central processing unit are the heart and soul of any computing device. And today’s mobile devices are powerful computing machines because of the amount of DRAM and powerful processors. But simply scaling up DRAM on the motherboard doesn’t address the speed at which processors can consume data. Higher functionality often means placing more memory on the processor itself.

“Performance related to DRAM includes more than just increased density and total Gb/$. Chip and system designers continue to look for ways to get past the ‘memory wall’ caused by the latency and limited bandwidth of traditional off-processor memory,” says Robert A. Chinn, a Principal in PwC’s Semiconductor Advisory Practice. “Companies are exploring new technologies and both existing and new architectures to more tightly couple memory with CPUs/GPUs/APUs to improve overall performance.”

In later reports of the Mobile Innovations Forecast, we will examine future use cases in more detail, however, for purposes of positioning DRAM in the Mobile Technologies Index, consider how DRAM has enabled today’s mobile capabilities.

Smartphones and tablets would not exist as we know them if DRAM price–performance improvement had not increased at such a dramatic rate. DRAM is the secret sauce behind many mobile capabilities that we take for granted today:

- Camera functionality from digital stills to HD video capture and processing;
- Enhanced displays from increasing screen size, to HD level resolution to emerging 3D capabilities and multi-touch support;
- Running multiple applications and being able to seamlessly switch between them.

Smartphone functions that are now standard, such as Bluetooth, Wi-Fi, GPS and motion sensing, would not have been possible without the availability of lower cost, denser DRAM. These functions are enabled largely by advances in smartphone operating systems. And operating systems, such as iOS, Android, Blackberry OS, Windows Phone and others, need ever increasing amounts of DRAM to function. Today’s operating systems were not feasible in a hand-held device even five years ago because the cost of providing the necessary DRAM would have pushed device price points beyond acceptable levels to consumers.
During the five-year forecast period, continued improvement in its CAGR will allow greater amounts of DRAM on mobile devices to support new use cases that involve more data, more computing power and more and different multi-processing.

The drivers of new use cases will tend to be processor speed, network speed, image processing and software, not DRAM. But by becoming more affordable, more DRAM on the device will not constrain these innovations, and will in fact support them when they become feasible. More affordable DRAM will support use cases like these:

- The bit rates from a new HD standard, called ultra-high definition television (UHDTV). There are two proposed digital formats: 4K UHDTV with 8.3 megapixel (MP) resolution and 8K UHDTV with 33.2 MP resolution (16 times the number of pixels in the current HDTV standard);
- Multiple HD video streams on a tablet for a telepresence group experience;
- Highly immersive 3D gaming experiences including precise gesture control of game mechanics and
- Simultaneous application processing with high DRAM requirements.

The latter use case anticipates an evolution from today’s multi-processing scenarios, which position one application as dominant and background applications waiting to be switched into the foreground for user interaction. New use cases will emerge in which background applications are actively processing environmental inputs without direct user interaction, even as a foreground application maintains user attention.

Consider the following future scenario: You are at a business conference running an app that captures the voice of the speaker, converts the speech to text and automatically summarises the content. Now you need to respond to a complicated incoming email from your office. The device continues to run the content capture and summarisation app even as you are answering your email. While all this was going on, your device also scans the room for colleagues entering the auditorium, and lets them know you are here, too, via a text message.

This kind of scenario, with multiple applications simultaneously processing large amounts of information, will drive the specification for more DRAM in future mobile devices.

In summary, more affordable DRAM will continue to be a major supporter of mobile innovation.

Let’s talk

If you have any questions about the Mobile Innovations Forecast or would like to discuss any of these topics further, please reach out to us.

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