Technology Brief

**Fully Buffered DIMM Technology on Intel® Architecture**

IT Data Centers

# Large-Capacity, High-Bandwidth Memory Solution

## New Memory Architecture Boosts Bandwidth, Reliability, Availability, and Serviceability (RAS)

Faster processors and I/O technologies promise to help IT data centers meet their increasingly demanding service and reliability requirements. As systems become faster, current memory technology is hampering overall system performance due to the physical limitations of memory capacity and the limited reliability of the memory subsystem. While a new memory technology is welcome, IT managers are reasonably concerned that any changes must remain compatible with their existing operating systems, applications and with the hardware that they currently have deployed.

**Fully buffered dual in-line memory module (FB-DIMM) technology is a new memory architecture that:**

- Expands the capacity and bandwidth in enterprise platforms over existing double data rate (DDR) and second generation DDR2-based systems
- Replaces earlier parallel-stub bus memory based systems
- Provides enhanced reliability, availability, and serviceability (RAS) capabilities—a key requirement for server platforms

**Key benefits of FB-DIMM technology for IT data centers include:**

- Significantly improved memory capacity to support enterprise applications. FB-DIMM provides up to four times improved capacity when compared to DDR2 technologies. As illustrated in Figure 1, FB-DIMM technology allows eight DIMM slots per channel versus two DIMM slots per channel on comparable DDR2-based platforms and is not rank limited.

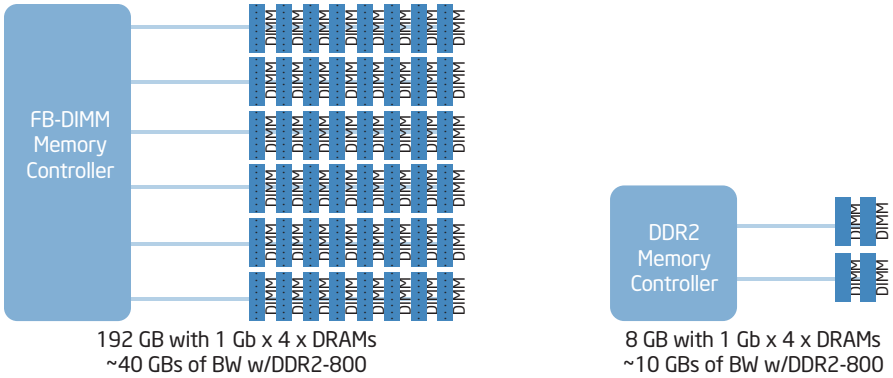
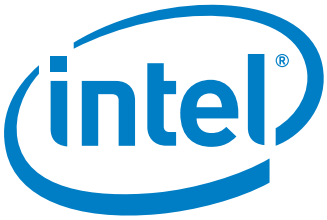



**Figure 1.** An equal pin-count configuration comparing the bandwidth and capacity of FB-DIMM- and DDR2-based systems. With the same pin count , FB-DIMM technology provides four times the bandwidth of DDR2 and 24 times the capacity of DDR2.



- **Improved bandwidth to handle more transactions simultaneously.** FB-DIMM technology bandwidth is up to two-and-a-half times more than DDR2-based DIMM based upon configuration.
- **Compatible with existing operating systems.** Systems with the FB-DIMM interface standard can boot existing operating systems without change, removing a significant barrier for adoption.
- **Lower pin count so more memory can fit in existing boards.** FB-DIMM pin count is one-third that of DDR2, having approximately 70 pins compared to 240 for DDR2. The low pin count makes it possible to implement multiple channels, which allows for easier implementations of memory RAID capabilities.
- **Headroom for future growth.** FB-DIMM technology uses 533 and 667MHz DDR2 DRAM initially but has headroom to handle up to 800 MHz DDR2 DRAM and DDR3 DRAM when these become available.
- **Reduced cost.** You can reduce costs by using less dense DIMMS because more channels are supported to reach higher capacity, rather than being forced to use high-capacity DIMMs in smaller channel systems. You can also carry memory forward to future platforms.
- **Reliable, available, and serviceable.** FB-DIMM allows for enhanced reliability, availability, and serviceability (RAS). FB-DIMM provides reliable protocol error detection, correction, and reporting capabilities. FB-DIMM increases reliability beyond standard error correcting code (ECC) data protection by providing cyclical redundancy check (CRC) protection for all command and data transfers. FB-DIMM also provides a failover mechanism, which keeps the channel available after any one wire fails with enough fault detection capability to maintain reliable operation until repair and a mechanism for hot add/remove of DIMMs to enhance serviceability. With FB-DIMM, transient data errors that used to be fatal to the server now can be dealt with in a managed fashion.
- **High data rates**. The FB-DIMM channel consists of point-to-point serial lanes. Each serial lane is self-clocking, that is, the receiver sampling clock is taken from the data stream during periodic training. Self-clocking allows interfaces to operate at very high speeds, and because there is no skew between the clock and the data, very high data rates can be achieved. FB-DIMM channels are initially expected to operate from 3.2 to 4.8 Gbps, with speeds up to 9.6 Gbps expected in the future.

## Solving Memory Capacity and Bandwidth Constraints

The FB-DIMM technology uses an advanced memory buffer (AMB) with separate interfaces for the high-speed DIMM to DIMM transfers and for the DRAM transfers. The interface between the buffer and DRAM chips is the same as today, supporting standard DDR2 DRAM in early FB-DIMM platforms and DDR3 in the future. However, the interface between the memory controller and the buffer is changed from a shared parallel interface to a point-to-point multi-lane serial interface.

## Looking Forward

Fully-buffered DIMM technology is a new memory architecture addressing the scaling needs of faster processor architectures. By enabling memory to keep pace with processor and I/O improvements in enterprise platforms, FB-DIMM removes the bottlenecks memory subsystems can impose in systems based on the latest and fastest processor technologies. Systems based on multiple processor cores, and using fast I/O interconnect technologies, such as peripheral component interconnect (PCI) Express*, benefit from the new FB-DIMM architecture. FB-DIMM allows data centers to maximize the performance of their enterprise systems and applications—and prepare for future growth and challenges.

For more information on FB-DIMM, visit: www.intel.com/technology/magazine/computing/Fully-buffered-DIMM-0305.htm