In the last few years, as the central and graphics processing unit (CPU and GPU) technology has advanced, the need for high DRAM memory bandwidth has led to an increased focus on high bandwidth on-package links. And so, localized high-density interconnects devices between two or more dies has been investigated to provide high bandwidth signaling in order to open up new opportunities for heterogeneous on-package integration. The typical proposed devices are interposers in glass, organic or silicon substrates. Intel has developed its own approach called an Embedded Multi-die Interconnect Bridge (EMIB), which offers simpler integration.

We have analyzed the Intel Core i7-8809G, which is the eight generation of Intel core i7 processor. The processor features a CPU, a discrete GPU and second generation high bandwidth memory (HBM2) on the same package. The GPU has a 4GB high bandwidth cache assembled from one 4-Hi HBM2 stack of four DRAM dies, giving almost 200GB/s of bandwidth.

Whereas NVIDIA and AMD both use interposers with via-middle TSVs, the Intel product uses EMIB technology. This consists of a silicon bridge buried in the printed circuit board (PCB) substrate, making the interconnection between the HBM2 stack and the GPU. The approach has some inherent advantages, such as the ability to implement high-density in interconnect without requiring TSVs and to support the integration of many large dies in a large area.

Focusing on the GPU and HBM integration, the report shows that in a small 29mm x 19mm area 12-layer flip-chip ball grid array (fcBGA) package, both components use under 700mm² of silicon, an impressive silicon-to-package ratio.

This report includes a complete physical analysis of the packaging process, with details of all technical choices regarding processes, equipment and materials. Also, the complete manufacturing supply chain is described, and manufacturing costs are calculated.

The report compares the Intel solution with AMD’s Radeon Vega Frontier and NVIDIA’s Tesla P100, highlighting the integration choices made by all companies.

**COMPLETE TEARDOWN WITH**

- Detailed photos and cross-sections
- Precise measurements
- Material analysis
- Manufacturing process flow
- Supply chain evaluation
- Manufacturing cost analysis
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