Project result

Cluster for Application and Technology Research in Europe on NanoElectronics

CT105 | 3D-TSV integration improves multimedia and mobile device applications and helps industry [3DIM^3]

Cramming more electronics onto a chip, could make consumer devices, like mobile phones and tablets, even more compact, run more functions and faster, use less power and even cost less. What makes all these benefits possible is 3D integration. The heart of the 3DIM^3 project, this emerging technology can produce highly integrated systems by stacking them vertically (height being the third dimension, hence 3D) and connecting various materials, technologies and functional components together using a high-performance technique called TSV. This project brought together successfully European partners with specialised expertise and experience in the design and production of integrated circuits based on system-on-chip and system-in-package technologies.

Deploying the technique of 'stacking', three-dimensional (3D) integration is an attractive option for many advanced consumer products. It brings together different types of chips and devices in a single package or a compact subsystem, thus gaining maximum benefit from highly specialised and heterogeneous technologies.

By replacing single-chip packages with 3D devices, higher transistor density and power savings are achieved; distances are shortened for data to travel; and manufacturing costs reduced. Key to stacking is the use of 'through silicon via' (TSV) – a chip-assembly technique which impacts the overall electrical and physical design process. However, to take full advantage of 3D integration, the decision must be made early in the architecture planning process, rather than as a packaging decision after circuit design is complete.

This requires taking 3D design space into account from the start of system design in order to distribute the different components into a new set of chips that need to be stacked. However, prior to 3DIM^3, there were several obstacles in the way of mass producing 3D integrated circuits. These hurdles ranged from the unavailability of proper CAD tools and a test methodology, to low manufacturing yields (thin-wafer handling process) and unacceptable reliability.

Essential ecosystem

That is where 3DIM^3 comes into its own. This project created the ecosystem that is enabling European industrials to exploit 3D stacking capabilities, by delivering all the main building blocks to start the design of a full 3D integrated system:

- TSV & TEV models and design rules
- 3D design kit
- Pieces of design flow
- 3D interconnect and protocols
- 3D test procedures

Importantly, the four demonstrators validated the 3D-TSV design flow, tools, methods, and interconnects developed during the project.

Partner gains from co-operation

This project underscored the benefit of co-operation and confirmed what is technically and technologically achievable through such collaboration. Crucially, it switched the mind-sets of project participants to think '3D', and to start designing and verifying, complete systems with new architecture paradigms regarding standards evolution, testability, design methodologies and heterogeneous components.

Furthermore, all 14 project partners also confirmed direct benefits to their own business, or institutional activities in the case of universities. Benefits included access to advanced technology, methodologies for 3D-IC design flow and 3D-TSV tools (designing 3D circuits, for example), and the issuance of related patents.

Key partnerships were formed to establish ways of implementing the 3D chip, and to extend a leadership position in EDA methodology and tools for 3D-TSV technology.

There was also an increased understanding of TSV technology and performance, especially in RF applications; and on the process of the integration of heterogeneous technologies and to find a mixed integration solution for silicon and dies.

ENERGY-EFFICIENT DEVICES AND ENERGY CONTROL SYSTEMS

Partners:

Cadence Design Systems
CEA-LETI
EADS DS
Fraunhofer Institute
Infineon Technologies
Lyon Institute of Nanotechnology
NXP Semiconductors
R3Logic
Recore Systems
STMicroelectronics
TIMA Laboratory
TU Delft
University of Erlangen-Nürnberg
Virage Logic

Project leader:

Dominique Marron
STMicroelectronics

Key project dates:

Start: July 2009
End: December 2012

Countries involved:

France
Germany
The Netherlands

PROJECT CONTRIBUTES TO

Communication	✔
Automotive and transport	
Health and aging society	
Safety and security	
Energy efficiency	
Digital lifestyle	
Design technology	✔
Sensors and actuators	
Process development	✔
Manufacturing science	✔
More than Moore	✔
More Moore	
Technology node	

And with unique expertise comes competitive advantage. The acquisition of significant knowledge and understanding in the interconnectivity between the specific analogue device and the high speed processing component (decoder) strengthened one electronics company's leadership position in the home gateway market.

Academic institutions participating in 3DIM³ also profited from a tight collaboration with industrial partners, and from technological advances and know-how in new packaging technologies. They were also able to set up a framework to promote future 3D research initiatives, and consolidate their leading academic position in Europe on computer architecture and embedded systems.

Maintains competitive edge

For consumers and end-users, as mentioned earlier, 3DIM³ means even smaller, faster, cheaper mobile phones and tablets that contain more functions and consume less power.

But what is the impact of 3DIM³ on the industry as a whole?

Innovative 3D design solutions will enable European multimedia, mobile device manufacturers to increase the ability of their designers to build larger and better quality systems in less time and at lower costs. This means that these device manufacturers will be able to maintain leadership in this strategic market.

The know-how improvement in 3D integration will also impact semiconductor fabs (fabrication plants) by improving the production process in the near future. Critically, this project's contribution to the European knowledge will secure Europe's future forefront position in semiconductors worldwide.

The increased production of 3D devices and increasing complexity of managing the 3D products will drive widespread adoption of 3D design for mobile and multimedia devices.

Of course, it will take some time before 3D products can be massed produced, but the work and results from 3DIM³ can already be used to define the architecture of highly complex products, thanks to the technological achievement this project produced in modelling, architecture, algorithms and CAD.

Most encouragingly, the design experience of 3DIM³ continues to be felt through seminars and workshops, targeting European designers, with the objective of improving on the design experience 3DIM³ started.

And the fact that universities are now adding 3D system design to their curriculum further confirms that 3D stacking is here to stay.

CATRENE (Σ! 4140), the EUREKA **C**luster for **A**pplication and **T**echnology **R**esearch in **E**urope on **N**ano**E**lectronics, will bring about technological leadership for a competitive European information and communications technology industry.

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