



An FPGA-Based Emulation Platform For **Optical-Enabled** System

# CPU + IO FPGA 仿真平台

Wenbo Shen, Xinxin Zhang, Qigang Wang  
Shunyu Zhu, Xiangbin Wu, Prabhat Gupta\*

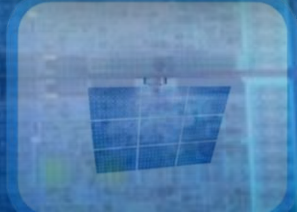
**Dong Liu / 刘东**

Intel Labs China

\*Intel Architecture Group

July 2010

# New Focus for Intel Labs China: *Advanced Research in Embedded Systems*



# Embedded Systems Research

Embedded  
Applications

Connected  
Embedded  
Systems

Embedded  
Software

Embedded  
Architecture

Embedded IO

Electronic  
HW/SW Design

Intel® Technologies

Cores, SoC Building Blocks, Video Analytics co-processors,  
MeeGo\*, SW Tools, ...

# Agenda

- Design challenges
- Evaluation methods
- Our approach
- Implementation
- Q&A

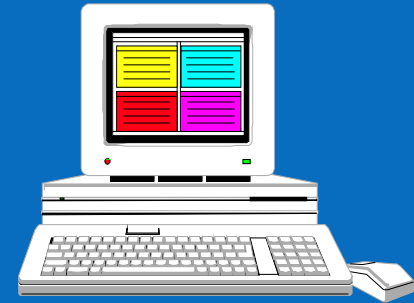
# Design challenges

- Besides the well-known issues:
  - Memory wall
  - Power wall
  - Frequency wall
  - SW productivity
- We must make the system
  - Balanced
    - I/O, CPU and interconnection
  - Efficient
    - Cost, performance



# Evaluation methods

- Simulation
  - Pros: flexible, cost effective, fast turnaround
  - Cons: slow, insufficient model accuracy
- Emulation:
  - Pros: flexible, speed, model accuracy, convincing result
  - Cons: HW resource limited, difficult to scale
- Hybrid-simulation



# Our view and approach

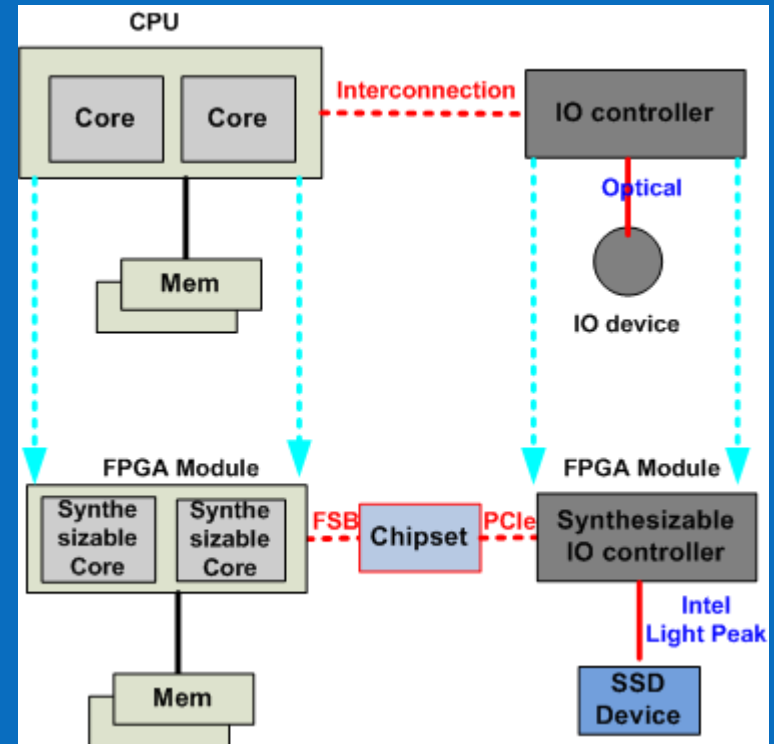
- More and more BW required
  - HD video, data sharing, video conference....
- Electrical cable approaching physical limitation
  - Eye closes at  $\sim 10$ Gbps data rate on FR4 board \*
- I/O will be the next focus for optical technology penetration
  - Discrete chips can be used
  - Optical on-die integration not mature yet
  - Intel announced LightPeak to simplify I/O design



\*Source : Intel

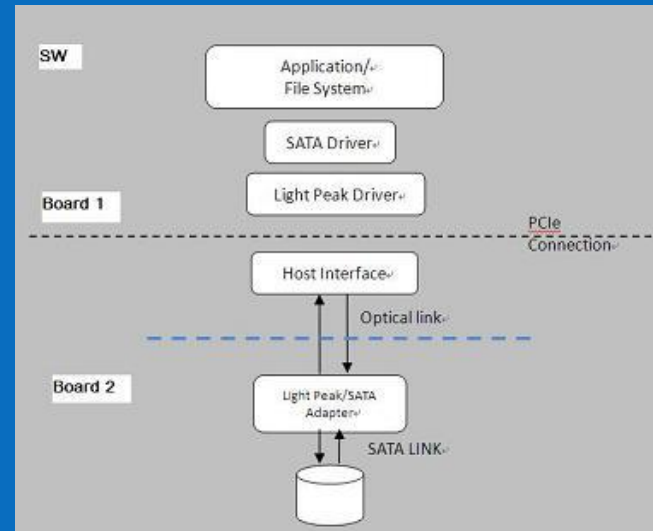
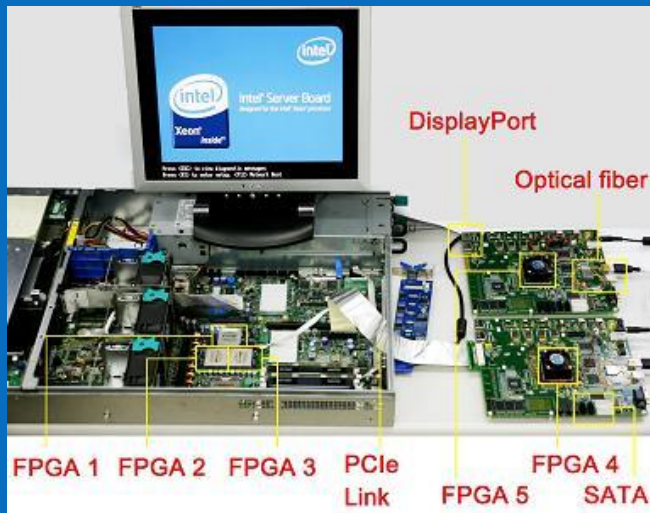
# Our view and approach (Cont.)

- I/O throughput increased to 10+Gbps enabled by optical
  - IO controller? Special offloading engine?
  - Interconnection?
  - uArch of the cores?
  - HW/SW partitioning?
- Research platform needed to explore the huge design space!
- We adopt FPGA emulation approach and implement **core** and **IO controller** in FPGA
  - Flexibility to changes both IO and core





# The Implementation



- SATA SSD as the IO device
- The data and control path: SATA SSD and LPK controller ↔ optical fiber ↔ LPK to PCIe transformer ↔ PCIe cable ↔ motherboard and core

# Legal Disclaimer

- INFORMATION IN THIS DOCUMENT IS PROVIDED IN CONNECTION WITH INTEL® PRODUCTS. NO LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT. EXCEPT AS PROVIDED IN INTEL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, INTEL ASSUMES NO LIABILITY WHATSOEVER, AND INTEL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY, RELATING TO SALE AND/OR USE OF INTEL® PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT. INTEL PRODUCTS ARE NOT INTENDED FOR USE IN MEDICAL, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS.
- Intel may make changes to specifications and product descriptions at any time, without notice.
- All products, dates, and figures specified are preliminary based on current expectations, and are subject to change without notice.
- Intel, processors, chipsets, and desktop boards may contain design defects or errors known as errata, which may cause the product to deviate from published specifications. Current characterized errata are available on request.
- Nehalem, Lynnfield, Clarkdale, Clarksfield, Arrandale, Westmere, Ibox Peak and other code names featured are used internally within Intel to identify products that are in development and not yet publicly announced for release. Customers, licensees and other third parties are not authorized by Intel to use code names in advertising, promotion or marketing of any product or services and any such use of Intel's internal code names is at the sole risk of the user
- Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance.
- Intel, Core and the Intel logo are trademarks of Intel Corporation in the United States and other countries.
- \*Other names and brands may be claimed as the property of others.
- Copyright © 2010 Intel Corporation.
- Intel® Active Management Technology requires the computer system to have an Intel® AMT-enabled chipset, network hardware and software, as well as connection with a power source and a corporate network connection. Setup requires configuration by the purchaser and may require scripting with the management console or further integration into existing security frameworks to enable certain functionality. It may also require modifications of implementation of new business processes. With regard to notebooks, Intel AMT may not be available or certain capabilities may be limited over a host OS-based VPN or when connecting wirelessly, on battery power, sleeping, hibernating or powered off. For more information, see [www.intel.com/technology/platform-technology/intel-amt/](http://www.intel.com/technology/platform-technology/intel-amt/)

# Risk Factors

The above statements and any others in this document that refer to plans and expectations for the first quarter, the year and the future are forward-looking statements that involve a number of risks and uncertainties. Many factors could affect Intel's actual results, and variances from Intel's current expectations regarding such factors could cause actual results to differ materially from those expressed in these forward-looking statements. Intel presently considers the following to be the important factors that could cause actual results to differ materially from the corporation's expectations. Current uncertainty in global economic conditions pose a risk to the overall economy as consumers and businesses may defer purchases in response to tighter credit and negative financial news, which could negatively affect product demand and other related matters. Consequently, demand could be different from Intel's expectations due to factors including changes in business and economic conditions, including conditions in the credit market that could affect consumer confidence; customer acceptance of Intel's and competitors' products; changes in customer order patterns including order cancellations; and changes in the level of inventory at customers. Intel operates in intensely competitive industries that are characterized by a high percentage of costs that are fixed or difficult to reduce in the short term and product demand that is highly variable and difficult to forecast. Revenue and the gross margin percentage are affected by the timing of new Intel product introductions and the demand for and market acceptance of Intel's products; actions taken by Intel's competitors, including product offerings and introductions, marketing programs and pricing pressures and Intel's response to such actions; Intel's ability to respond quickly to technological developments and to incorporate new features into its products; and the availability of sufficient supply of components from suppliers to meet demand. The gross margin percentage could vary significantly from expectations based on changes in revenue levels; capacity utilization; excess or obsolete inventory; product mix and pricing; variations in inventory valuation, including variations related to the timing of qualifying products for sale; manufacturing yields; changes in unit costs; impairments of long-lived assets, including manufacturing, assembly/test and intangible assets; and the timing and execution of the manufacturing ramp and associated costs, including start-up costs. Expenses, particularly certain marketing and compensation expenses, as well as restructuring and asset impairment charges, vary depending on the level of demand for Intel's products and the level of revenue and profits. The recent financial crisis affecting the banking system and financial markets and the going concern threats to investment banks and other financial institutions have resulted in a tightening in the credit markets, a reduced level of liquidity in many financial markets, and extreme volatility in fixed income, credit and equity markets. There could be a number of follow-on effects from the credit crisis on Intel's business, including insolvency of key suppliers resulting in product delays; inability of customers to obtain credit to finance purchases of our products and/or customer insolvencies; counterparty failures negatively impacting our treasury operations; increased expense or inability to obtain short-term financing of Intel's operations from the issuance of commercial paper; and increased impairments from the inability of investee companies to obtain financing. Intel's results could be impacted by adverse economic, social, political and physical/infrastructure conditions in the countries in which Intel, its customers or its suppliers operate, including military conflict and other security risks, natural disasters, infrastructure disruptions, health concerns and fluctuations in currency exchange rates. Intel's results could be affected by adverse effects associated with product defects and errata (deviations from published specifications), and by litigation or regulatory matters involving intellectual property, stockholder, consumer, antitrust and other issues, such as the litigation and regulatory matters described in Intel's SEC reports.