Remote Test and Diagnostics Infrastructure using IBIST

Presenter : Mohan Kumar
Authors:
Rahul Khanna, Mohan Kumar, Dominic Fulginiti, Jay Nejedlo, Venkat Chava

Intel Corporation
Outline

• Motivation
• Advantages of IBIST
• Modular Software Strategy
• Logical Architecture
• Diagnostics Hardware Abstractions (DHA)
• Standards-Based Remote Diagnostics
Motivation: Next Generation Test Challenges

PCB routing densities, reduced timing budgets

• Physical access → In-circuit test .... is dead!

Performance levels

• Higher operating frequencies
  – Oscilloscope resolution not keeping pace
  – (can’t differentiate goodness vs. badness)

• IO filtering techniques
  – Using techniques like “equalization” means we can’t externally detect an eye (pad or pins) → Means “scrap traditional validation techniques” (scopes & probes)
Motivation: Next Generation Test Challenges

Power density
• Ensure current source/sink ability of BGA power and ground Quality & Reliability

Quality & reliability
• High speed bus interconnect integrity
• Verify meeting of BER specification of interface
• Cost (design validation and factory test time)
• Platform complexity/diversity requires a re-think of traditional test techniques
Requires New Architecture

IBIST

(Interconnect Built-In Self Test)
What is IBIST?

An on-die feature enabling board/system testing which addresses static and high frequency fault spectrum associated with high performance IO
- Facilitates the validation & testing of primary buses & interfaces

IBIST Test Usage
- AC Parametric & Stress Testing, Design Verification & High Volume Manufacturing
- System Performance Bus Characterization
- Assembly & Electrical Defect Detection, Board/Platform Debug, Platform Test
- Analog/Electrical Stress/Characterization & Debug

IBIST Benefits
- Restores test access on all major buses through virtual nodal access
- Addresses expanded interconnect fault spectrum through advanced test pattern algorithms. Stresses all bus signals (data, address and control)
- Because IBIST operates independently of normal silicon operation and bus protocols enables testing to be completely deterministic.
- Auto-diagnosability, fault isolation/characterization (pin and pattern)

IBIST Example

PCI Express x2 Lane Interconnection

High level IBIST Architecture for High serial interconnect (per each link)
Papers


http://www.intertesttech.com/ate/company_news_ibist.htm
Advantages

- Enables the Diagnostics Infrastructure that can discriminate an Interconnect Error from a Component Error
  - Reduces NDF (No Defect Found)

- Enables the infrastructure to re-margin the interconnects due to environmental conditions
  - Temperature, Moisture

- Enables the infrastructure that can identify the interconnect degradation due to
  - Micro-cracks, Ageing, Dry-Solder, Temperature

- Enables the infrastructure that can evaluate the fault conditions in the customer environment.
How do we enable Eco-System
Software Strategy
Modular Software Strategy

Achieving Technology Goals
• Advancements toward faster product cycle times
• Increased quality requirements (through more advanced, more reusable tests)

Employing Advanced Software Techniques
• Standard IBIST Registers for all HW to follow
• Standard Diagnostics HW Abstractions (DHA) for sys SW
• Standard Remote Abstractions End-to-End model (CDM)

Serving Varied Usage Environments
• Design validation (post power on) internal & OEM
• High volume manufacturing (HVM)
• Aftermarket usage in the field

Modular Software strategy drives value through benefits reaching out to customers
Advantages

(1st level) Standardization of IBIST Registers
• Auto Discovery, code maturity, binding agreement b/w HW and system SW

(2nd level) Standardization of Diagnostic HW Abstractions (DHA)
• Hides implementation details, utilized by multiple agents, isolates IP
• Enables Software Reuse (e.g. EV, DV, Firmware, BIOS)

(3rd level) Standardization of Remote Abstractions
• Centralized control, distributed correlation, using variable parameters
• Remote diagnosis at the customer environment
• Validation of multiple systems (under test) w/o specialized cabling

Multi-layered approach minimizes work throughout Platform Life Cycle
Logical Architecture

1st level
IBIST Logic (Silicon)

2nd level
Diagnostic Hardware Abstractions (DHA)

3rd level
Common Diagnostic Framework (CDM)

Platform Controller

In-band SW (BIOS/OS)

JTAG

EV/SW/HVM SW Scripts

NETWORK

Novel Approach (1 to N)

Traditional Approach (1 to 1)
Diagnostic Hardware Abstractions (1)

Loopback and Compliance Abstractions
• Perform complex coordinated tests across lanes simultaneously

Pattern Generation Abstractions
• Flexible & programmable pattern generation and error checking

Pattern Checker Abstractions
• Programmable start bit & checking interval, flex checking specific bits

Error Counters Abstractions
• Records & retrieves error-log during a controlled data transmission and checking environment (Loopback)
Diagnostic Hardware Abstractions (2)

Parameter Setting Abstraction
- Compensation controls ICOMP, RCOMP
- Equalization settings for driver
- Voltage (VOC) and timing (PI) offsets

BER Eye Diagram Abstraction
- Ratio of bits incorrectly received to total bits sent across the link
- By varying TX timing (PI) and voltage (VOC)

On Die Oscilloscope Abstractions
- Waveform capture w/ programmed pattern for a repetitive waveform

2nd level abstractions provide robust functionality and ease of reuse
Standards-based Remote Diagnostics

A Suite of standards purpose-built by the industry-recognized Distributed Management Task Force (DMTF) enabling and end-to-end platform solution

**CDM**
Common Diagnostics Model

**SM CLP**
Server Management Command Line Protocol

**MCTP**
Management Controller Transport Protocol
Standards-based Remote Diagnostics – CDM (1)

Rules for representation - uses Common Information Model (CIM)
• Classes, Instances, Attributes, Methods, Associations (i.e. object oriented)
• Expressiveness in describing test attributes
  – Safety, exclusivity, relation to devices
• Associated constructs for runtime management
  – Running jobs, logged results

Standard way to describe & discover diagnostics
• Major Si vendors, OEMs, SW Vendors committed to CDM
• Many delivering compliant devices/drivers
• Can work in-band and out-of-band

CDM provides highly flexible model for representing diagnostics
Standards-based Remote Diagnostics – CDM (2)
Standards-based Remote Diagnostics - SM CLP

Industry Adoption
• Showing up in many layers of server platforms & infrastructure
  – BMCs, mgmt cards, rack aggregators, OS services
• Applicable to other platforms as well (comms, desktop, mobile, etc.)
• Not the only remote protocol allowing access to CIM-based services
  – WS-Management present in newest client mgmt standards and AMT
  – WMI/scripting for in-band

Simple Scriptable and Interactive Experience
• Allows rapid productivity and reuse with minimal client setup cost/complexity
• All you need is a remote shell, such as Secure Shell Host (SSH)

Dynamic
• Together with CIM/CDM, allows remote discovery of platform specific diagnostics
Standards-based Remote Diagnostics - MCTP

Management Component Transport Protocol
- For ‘inside the box’ communication of platform management traffic between mgmt devices
- Multiple message types for mgmt bus sharing
- Multiple media types (SMBus, PCIe and more)
- Suitable to server, desktop, mobile, comms
- Designed for low-cost microcontrollers

Platform Level Data Model
- Efficient low-level monitoring & control
  - Temp, fan, voltage, event logging, boot control, etc.
- Defines data rep & cmds to abstract the platform mgmt hardware
- Designed for effective mapping under CIM

E2E solution standards span the platform – HW, FW, OEM, OSV/ISV
The Big Picture – What it means (1)

Pre-Si  Post-Si  HVM  Aftermarket

Safety measures added / increased as you move right

Models, simulations, etc.

Test collateral carries forward as is, for maximum reuse!

OEM lab  Factory  Office / Datacenter

test cases
The Big Picture – What it means (2)

Old Way (OK)
1:1 – Local only

Old Way (Better)
1:1 – no travel 😊

Innovative Approach
1 to many, 1 to any! 😊😊

Enabling very powerful usage models/environments!
Conclusions

- Proposed diagnostic architecture allows test reuse across design, factory and field testing
- Benefits HVM by reducing test cost, greater test automation and multicast testing
- CDM provides highly flexible model for representing diagnostics
- E2E solution standards span the platform – HW, FW, OEM, OSV/ISV
- DMTF standards based approach allows abstraction of hardware implementation and IP
- Multi-layered approach minimizes work throughout Platform Life Cycle.
- Enables very powerful future usage models/environments!
  - Predictive Failure solutions
  - Dynamic re-margining to extend RAS
Questions?