Test and Dependability of Microsystems

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Tutorial DTC 2010

Test and Dependability of Microsystems

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Outline

- Introduction
- Implications for Integrated Systems
- Test Challenges
- Some Test Solutions
- From Test to Dependability
- Conclusion

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Introduction

TOETS Project: Towards **O**ne **E**uropean **T**est **S**olution
application , chip and transistor levels
NXP, ST, INFINEON, PHILIPS, Q-STAR, D4T, TEMETO, ATMEL, E2V, JTAG, CEA, TIMA, UT…

- ***LIRMM (Laboratoire d'Informatique Robotique Microélectronique de Montpellier)*** : cross-faculty research entity CNRS-UM2. 350 people, including 160 researchers, 150 PhD students.
- ***Ophtimalia*** : SME, development, fabrication, and sales of *innovative electronic solutions* dedicated to *diagnostics* and *treatment* of eye pathologies, and to measuring *intra-body* physiological parameters

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Introduction

Context

- More functionalities
- Shorter time to market
- Higher quality

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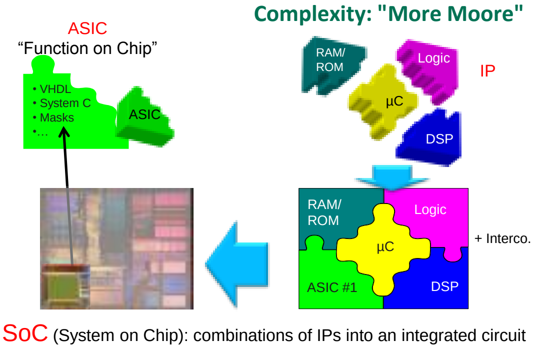
Implications for Integrated Systems

Complexity: "More Moore"



SoC (System on Chip): combinations of IPs into an integrated circuit

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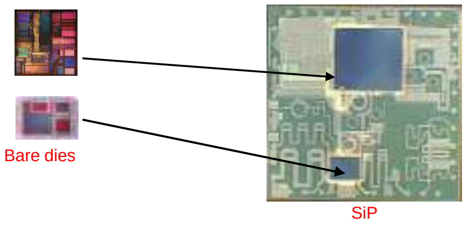
Implications for Integrated Systems

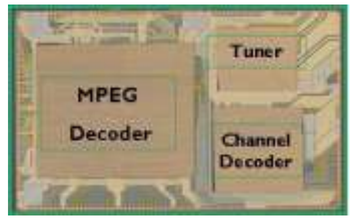
Complexity and Heterogeneous: "More than Moore"



SiP (System in Package): any combination of semiconductors, passives, and interconnects into a single package

Implications for Integrated Systems

Complex and Heterogeneous: Several MS/RF blocks



NXP

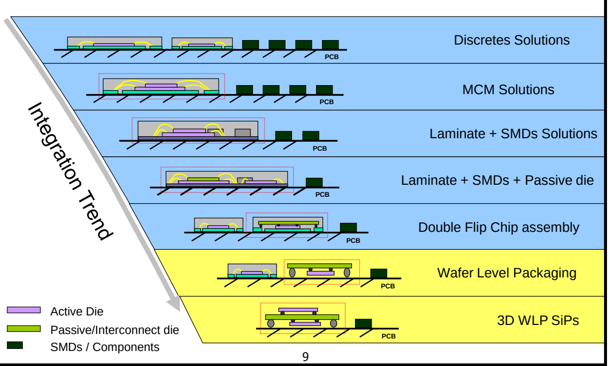
Set-top box (PNX8327)

2 ADC, 6 DAC, TX/Rx

- Video decoder: 12 ADC, 2 DAC, …
- Cell phone: GSM +TVoM+ WiFi+ Bluetooth+ GPS= 5 transceivers or Rx

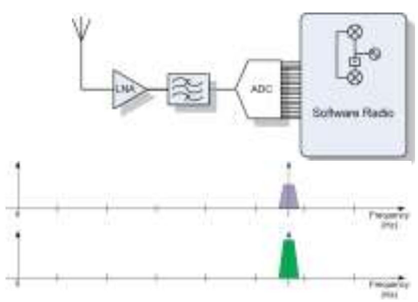
Implications for Integrated Systems

Complex and Heterogeneous: Packaging and 3D



Implications for Integrated Systems

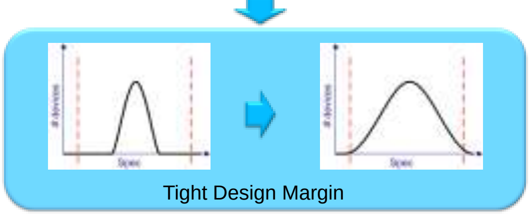
High Performances: Software Radio Example



Implications for Integrated Systems

Low Yield

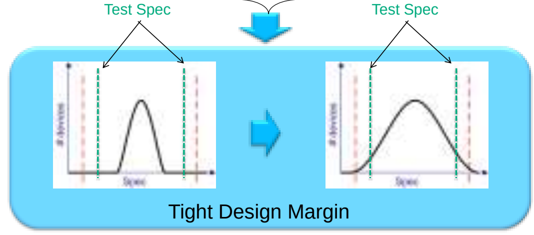
High Performances + Short Time to Market



Implications for Integrated Systems

Low Yield

High Performances + Short Time to Market
+ **high Quality**



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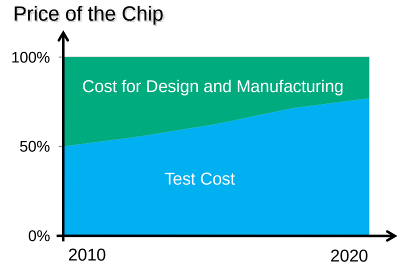
Test Challenges

Test vs. Manufacturing Costs



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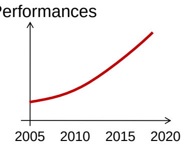
Test Challenges

Complexity,
Heterogeneousness,
Performances



- Expensive Test equipment
  - ATE : 1M$
  - MS/RF option: 300k$
- Long testing time

Test Challenges

- Test equipment
- Test time

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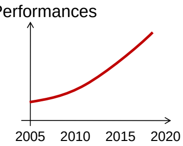
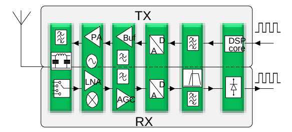
Test Challenges

Complexity,
Heterogeneousness,
Performances





- Access
  - Few primary I/O
  - Complex system
  - Signal Integrity

Test Challenges

- Test equipment
- Test time
- Test access

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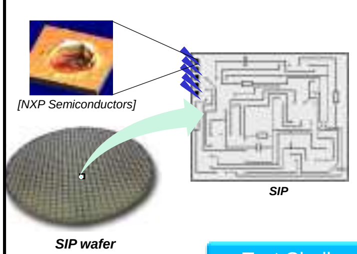
Test Challenges



- Acceptable Yield
  - Known Good Die
- Recursive test
  - Missing dies
  - Scrubbing effect

Test Challenges

- Test equipment
- Test time
- Test access
- KGD
- Recursive test

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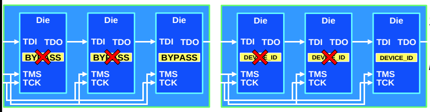
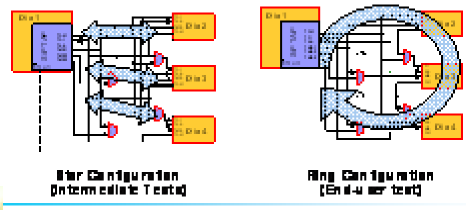
Test solutions

Access + Recursive Test ➔ Sip-TAP



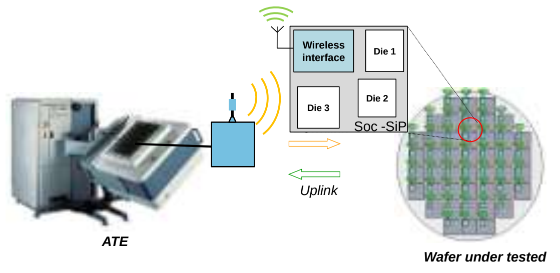
Solution for end-user:
SiP-TAP

F.de Jong, A. Biewenga ITC 2006



Test solutions

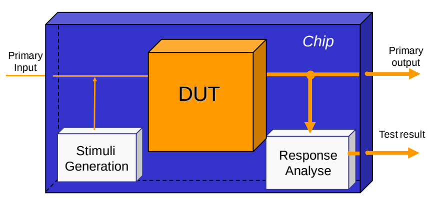
Recursive Test ➔ Wireless Test



- A tester with a radio interface
- Integrating a “wireless module” in each DUT

Test solutions

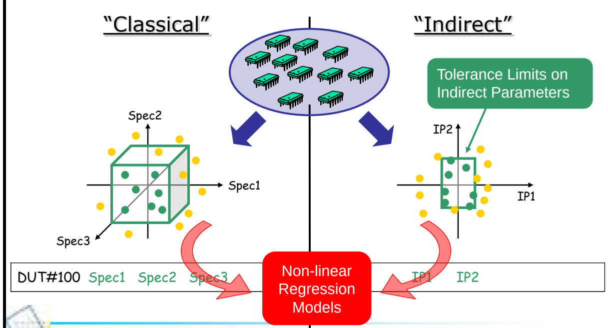
Equipment + Time + Access ➔ Built-in-Self Test



- Low-cost (no?)Test Equipment
- At Speed Test
- Up-to-date Technology

Test solutions

Equipment + Time + Access ➔ Indirect Test



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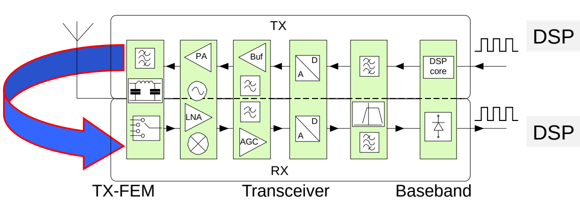
Test solutions

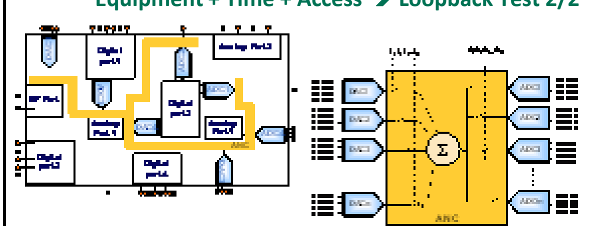
Equipment + Time + Access ➔ Loopback Test 1/2



- Low-cost Test Equipment
- Test simulation
- Easier BIST implementation
- Close to the application conditions

Test solutions

Equipment + Time + Access ➔ Loopback Test 2/2



Using DSP-based methods / algorithms, the contribution of the non-linearity of each converter is discriminated.

The converters may be re-used as embedded instruments in the loop!

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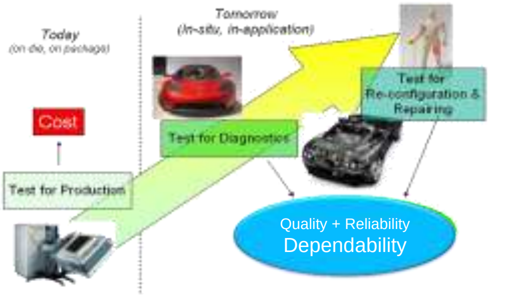
From Test to Dependability

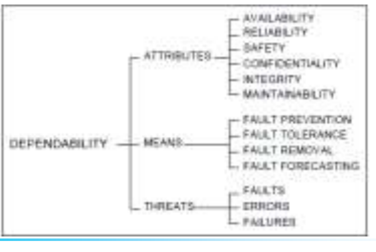
From production test to in situ repair



From Test to Dependability

General concepts 1/2

- Dependability: "a measure of the degree to which an item is operable and capable of performing its required function throughout the lifespan of the contract"



From Test to Dependability

General concepts 2/2

- Correct service: when the service implements the system function
- Failure: an event that occurs when the delivered service deviates from correct service
- Error: part of the system state that may cause a subsequent failure
- Fault: adjudged or hypothesized cause of an error

From Test to Dependability

How to attain dependability?

By…

- Fault prevention: design and manufacturing
- Fault tolerance: ***error detection*** and recovery
- Fault removal: design (verification) and operational life time (***maintenance***)
- Fault forecasting: qualitative and quantitative evaluation

From Test to Dependability

How to attain dependability for miniaturized systems?

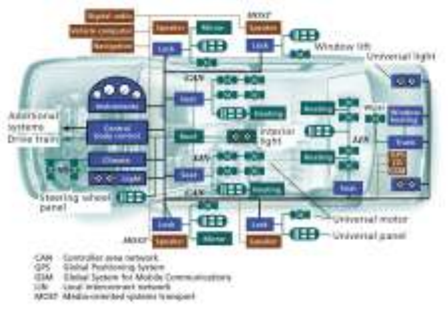
By implementing / improving…

- ***Error detection*** :
  - BIST (built-in-self-test)
  - BISD (built-in-self-diagnosis)
- ***Maintenance*** :
  - BISR (built-in-self-repair)
  - BISC (built-in-self-calibration)

Easy to tell, but not easy in practice, especially for heterogeneous micro-systems!!!

From Test to Dependability

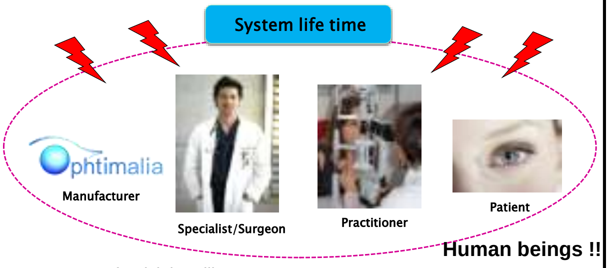
Example1: automotive



Source : Bosch

From Test to Dependability

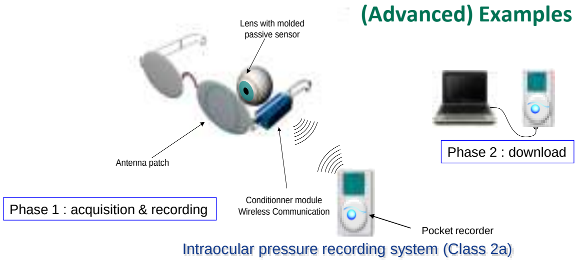
Example 2: Medical



- Strategy for risk handling
- System level management to avoid any real failure

From Test to Dependability

(Advanced) Examples



Intraocular pressure recording system (Class 2a)

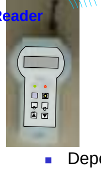
- Dependability issues:
  - Too high RF power transmitted to the eye ➔ control circuitry
  - Poor contact between sensor and cornea ➔ reference

From Test to Dependability

(Advanced) Examples

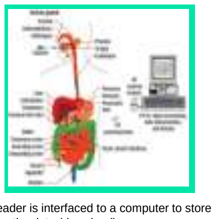
The temperature information is transmitted continuously to the reader (acquisition and recording)

Capsule (Class 2a)



Reader

• Autonomy of 10-15 days continuous after activation
• Size : 17.2x8.2mm



The reader is interfaced to a computer to store and analyze the data (download)

- Dependability issues:
  - Power drop down during transit ➔ management circuitry
  - Temperature measurement error ➔ calibration + in-situ checks

From Test to Dependability

Two major items

In Class 2 electronic medical devices, dependability mainly focuses on:

1. The safety and the security of the patient:
   - ➢ Hardware + software monitors / controllers are embedded, re-using functional and DfT resources
2. The accuracy of the practitioner diagnosis:
   - ➢ Built-in functions are provided for in-situ test, diagnosis and repair

Conclusion

- Test Challenges (for production test)
  - Test equipment
  - Testing time
  - Test access
  - KGD
  - Recursive Testing
- Test solutions (at research level)
  - BIST
  - SiP-TAP
  - ANC
  - Wireless Test
  - Loopback
  - …
- New Challenge = Dependability
  - BIST, BISD, BISR
  - At System level