

Reverse Engineering for the Purpose of Intellectual Property Protection and Accelerated Product Development of SOC and SIP Structures

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Definitions of IP

- ☐ Intellectual Property (IP)

- ☐ “A creation of the mind”

- ☐ Inventions, patents

- ☐ Circuits

- ☐ Unique materials and processes

- ☐ Software

- ☐ Designs, symbols

- ☐ ...

- ☐ IP Protection

- ☐ Technical

- ☐ Legal

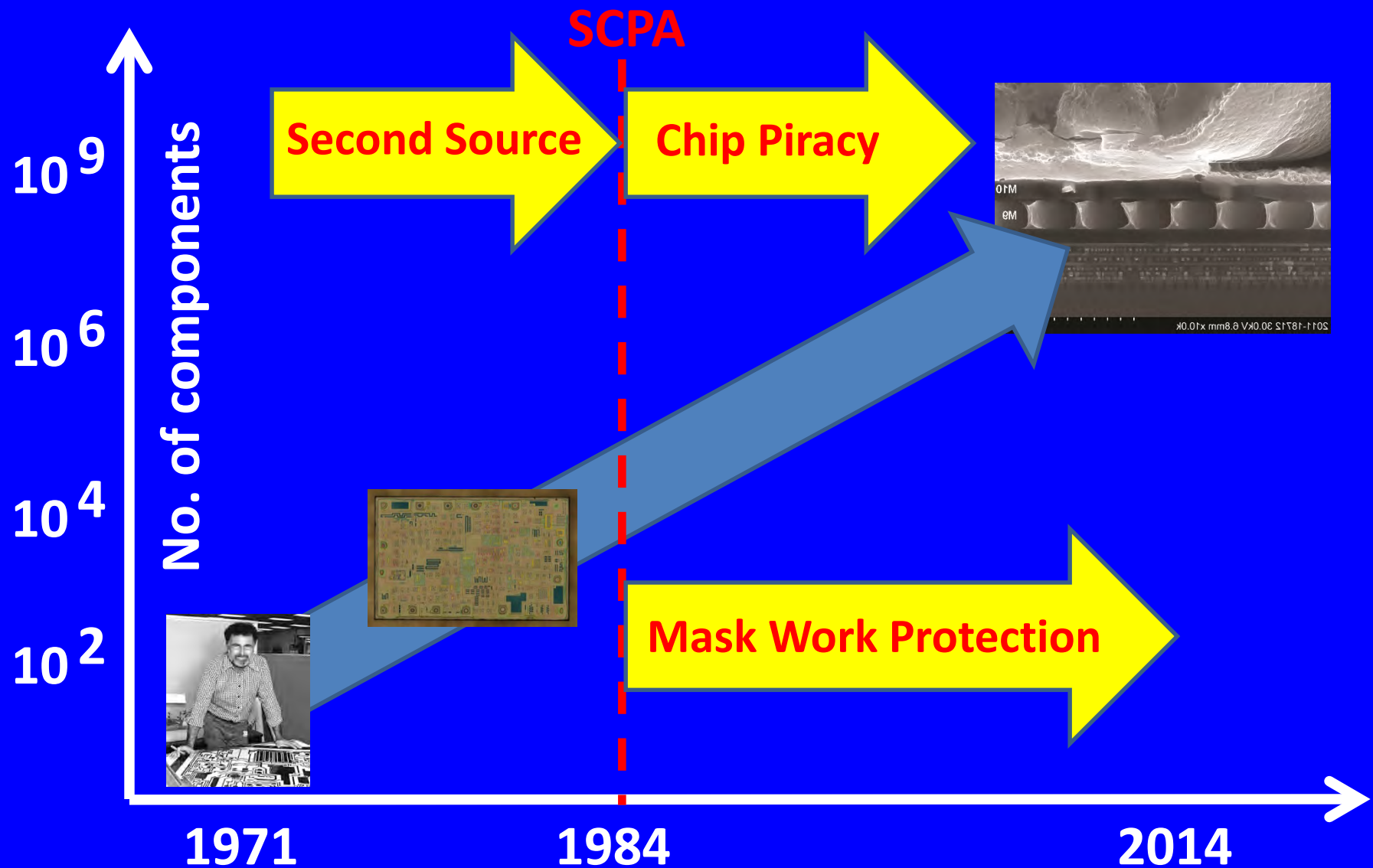
Willful Infringement ???

- ☐ *“Don’t look at patents because you may be accused of willful infringement”*
- ☐ Willful infringement is difficult to prove: the bar is high
- ☐ Statement is widely misunderstood
- ☐ Consult with your IP department or patent attorney
- ☐ Read patents and learn from them

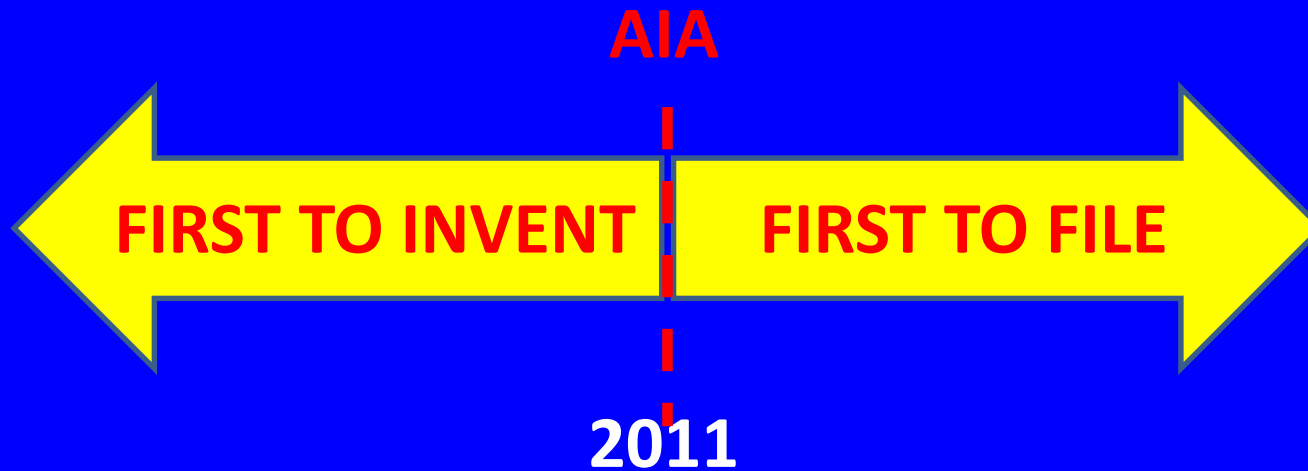
Definition of RE

- ❑ Reverse Engineering
 - ❑ “A process of extracting the knowledge or design blueprints from anything man made”
 - ❑ RE = Learning
 - ❑ Product of interest must be obtained from the open market
 - ❑ RE is legal and ethical
- ❑ **Second sourcing** is a subset of Reverse Engineering
- ❑ Today's definition of second source is a company licensed to manufacture another company's product.

RE in Microelectronics



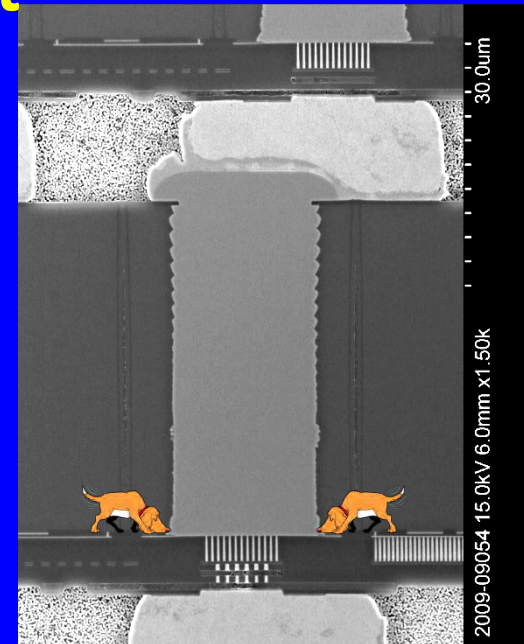
IP Protection: America Invents Act (AIA)



- ☐ Under AIA
 - ☐ File early, use provisional application
 - ☐ Be mindful of confidentiality (modified NDA)
 - ☐ Filing must be of high quality
 - ☐ Inventors need access to search tools (IP services)
 - ☐ Focus on the essential

Agenda

- ❑ Definitions:
 - ❑ Intellectual Property (IP) Protection
 - ❑ Reverse Engineering (RE)
 - ❑ Second Source and its Historical Perspective
- ❑ America Invents Act
- ❑ **RE & IP Analysis in Product Development**
- ❑ RE to Accelerate Product Development and Help Avoid Costly Mistakes
- ❑ Conclusions

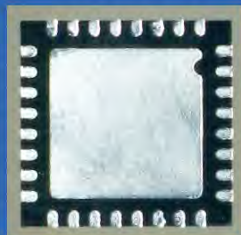
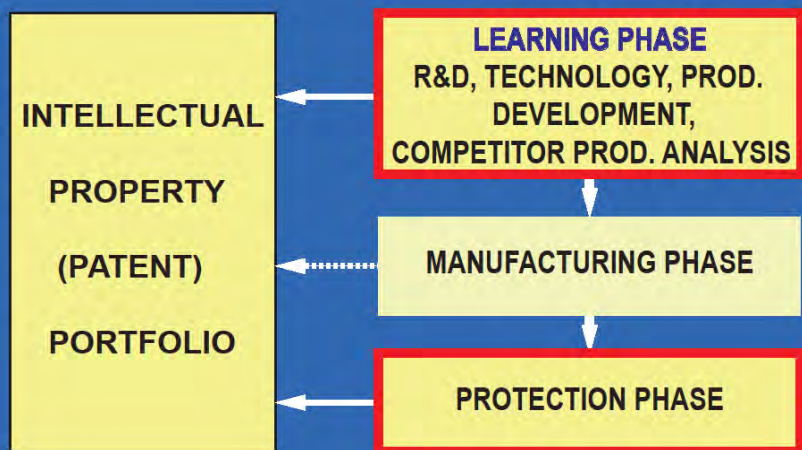


Product Development Flow

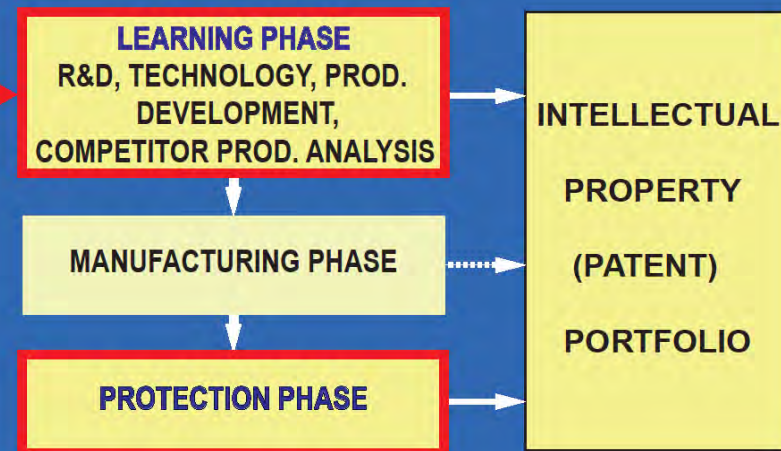
Competitor

Your company

RELEASED PRODUCT



PLANNED PRODUCT



RE

RE from an IP Analyst's Perspective

DEVELOPMENT DEPARTMENT

WANTS TO KNOW
COMPETITORS' PRODUCTS
AND TECHNOLOGIES



IP DEPARTMENT

WANTS TO KNOW
COMPETITORS' IP AND
TECHNOLOGIES

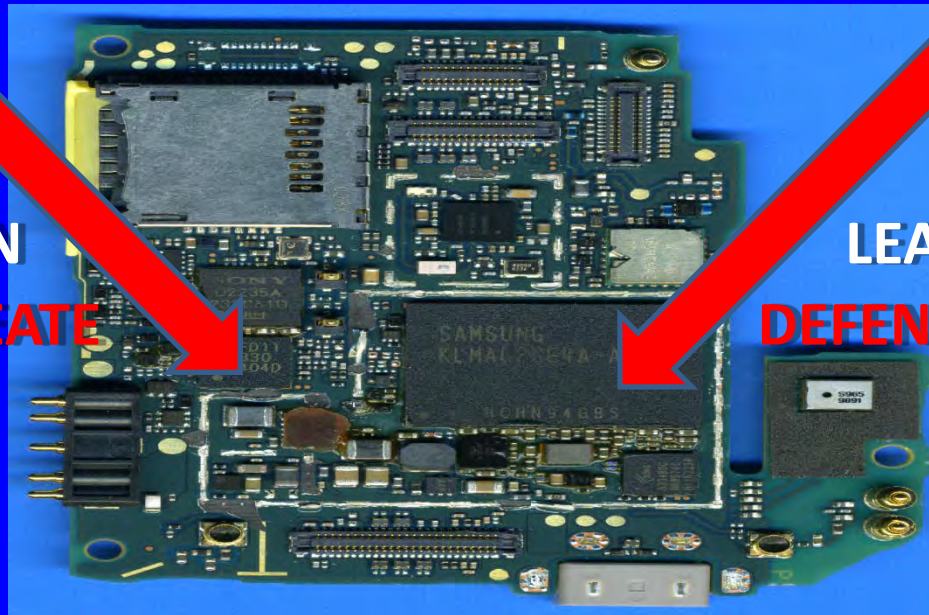


ANALYZE

UNDERSTAND

LEARN

CREATE



ANALYZE

UNDERSTAND

LEARN

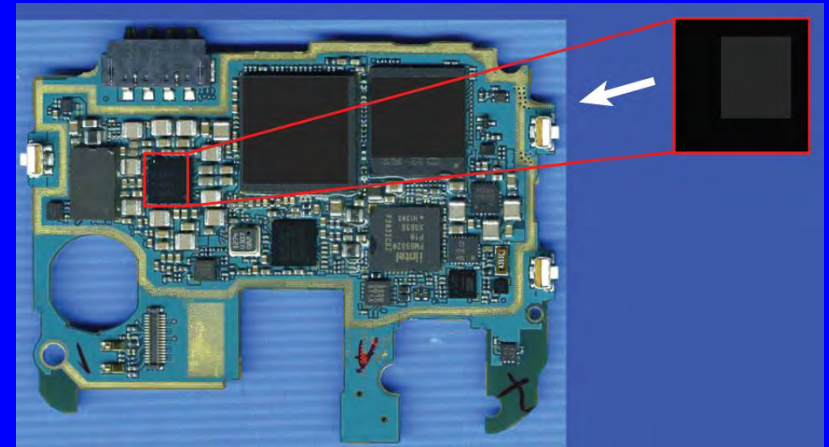
DEFEND

The Toolbox of An IP Analyst

CONTENTS OF THE ANALYST'S TOOL BOX	IP ANALYSIS, IP PROTECTION	COMPETITIVE INTELLIGENCE
Prior art and literature search	Patent applications, IP protection	Competitive landscape analysis, identification of key features of competing products
Patent mapping	IP protection (discovery)	Guidance for engineers in new IP development
Claims analysis and claim charts	IP protection, preparation for litigation	Guidance for engineers in new IP development
Reverse engineering (RE), in-depth analysis, teardown analysis	IP protection (discovery)	Information for product definition and development
Trend analysis	Portfolio Research	Technology trends analysis for guiding R&D
Patent portfolio analysis	Portfolio management, monetization	Portfolio's strength/weakness analysis for strategic technology management

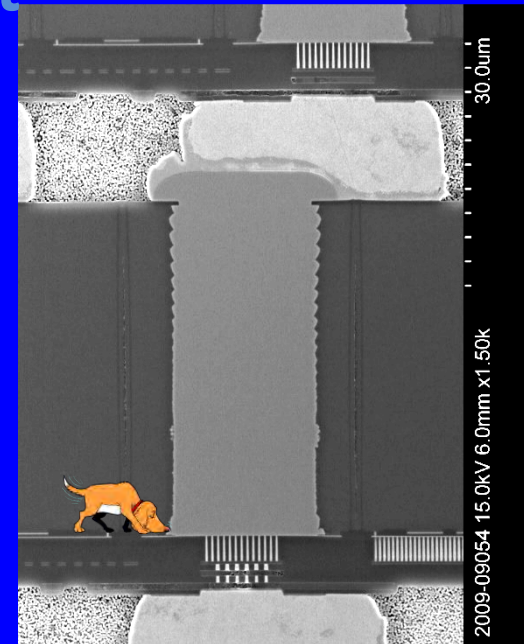
RE in Product Development

- ❑ RE in product development phase provides
 - ❑ Competitive intelligence
 - ❑ Understanding of competing technologies
 - ❑ Direction for R&D
 - ❑ In-depth understanding of the market
 - ❑ Support in product development and design validation:
 - ❑ Design/development
 - ❑ **PDN analysis**
- ❑ RE helps
 - ❑ **Accelerate product development**
 - ❑ **Avoid costly mistakes**



Agenda

- ❑ Definitions:
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 - ❑ Reverse Engineering (RE)
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- ❑ RE & IP Analysis in Product Development
- ❑ **RE to Accelerate Product Development and Help Avoid Costly Mistakes**
- ❑ Conclusions



Power Delivery Network (PDN) Analysis

- ❑ PDN is the path from the voltage source/regulator to the circuit block (Vdd)
- ❑ PDN is a major concern in 3D integrated structures as it impacts performance:

- ❑ **Power integrity**

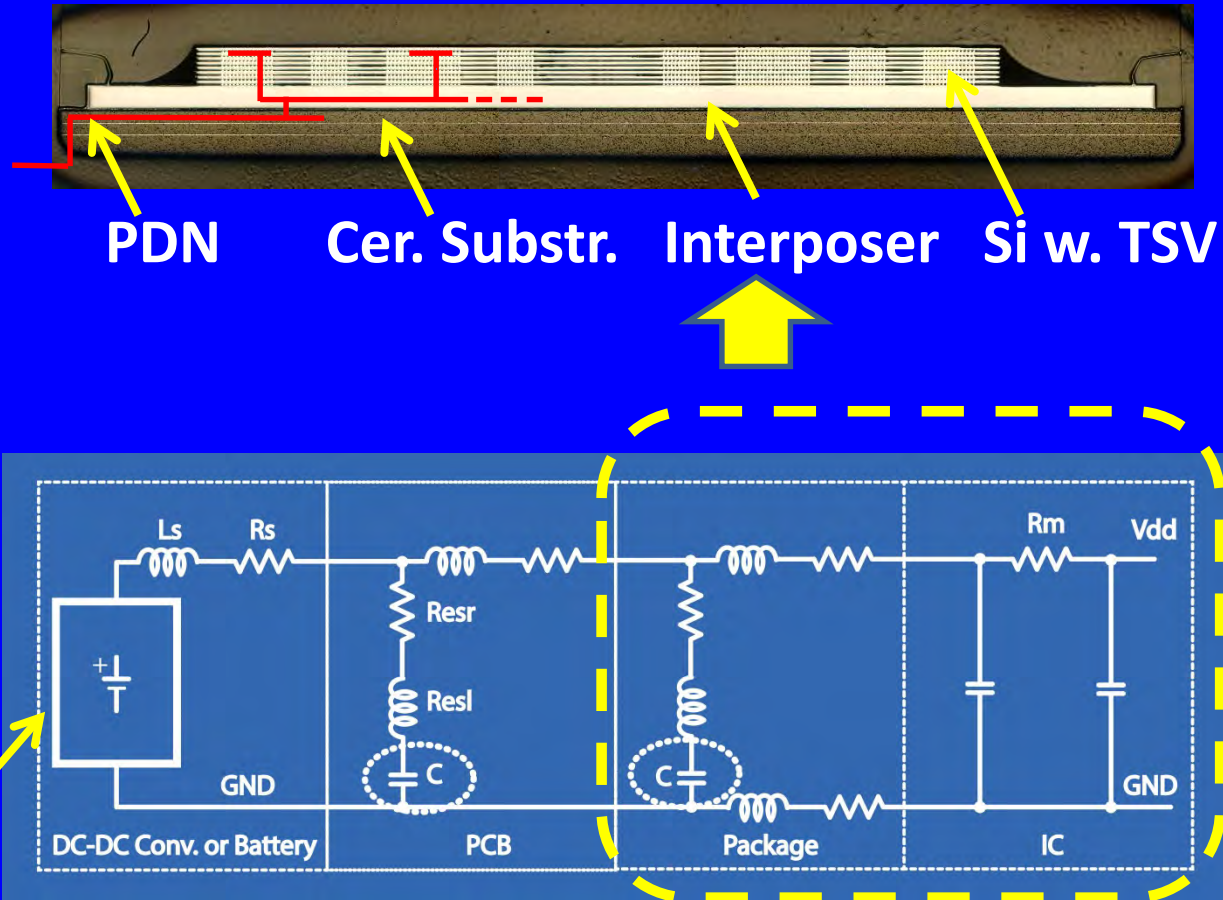
- ❑ Ripple
- ❑ Load Reg.
- ❑ Efficiency

- ❑ **Signal Integrity**

- ❑ Noise immunity
- ❑ Error rates
- ❑ jitter

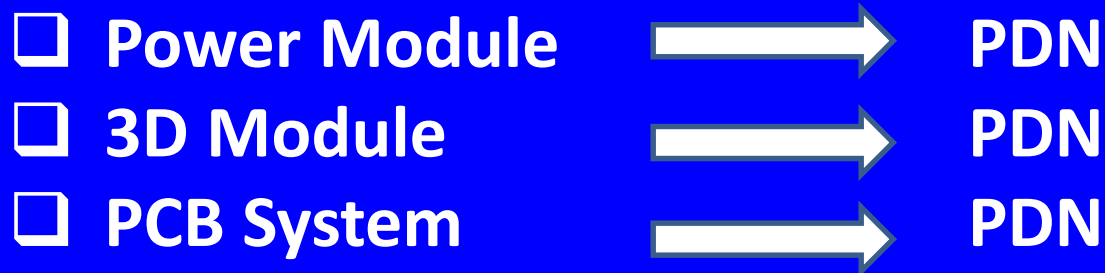
- ❑ **EMI**

DC-DC Conv. Module

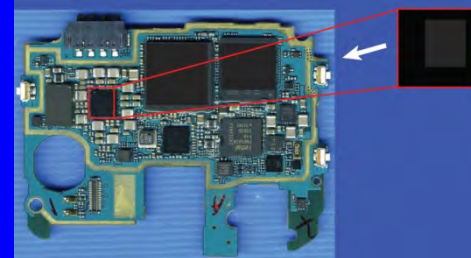


Timely PDN Analysis: Why is it Problematic?

- ❑ Ideally, IC design validation should be done in the final PDN environment, but it doesn't exist yet: The IC design is completed before the

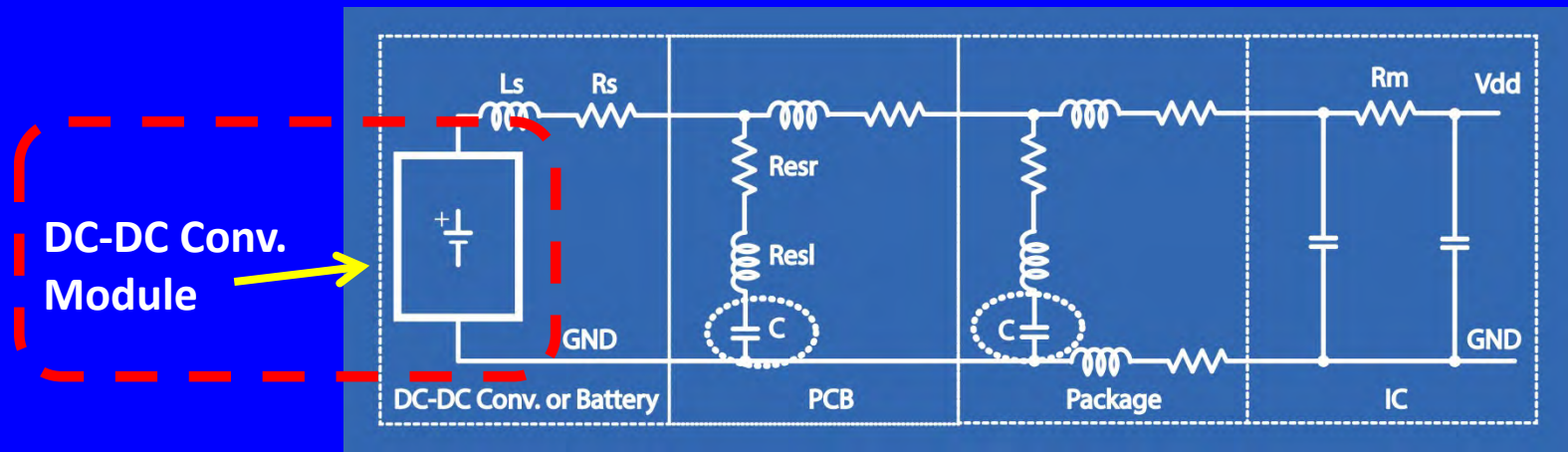


- ❑ Validation in three phases:
 - ❑ Approximate lumped element PDN model
 - ❑ **“Representative” PDN environment >>> RE**
 - ❑ Actual PDN environment



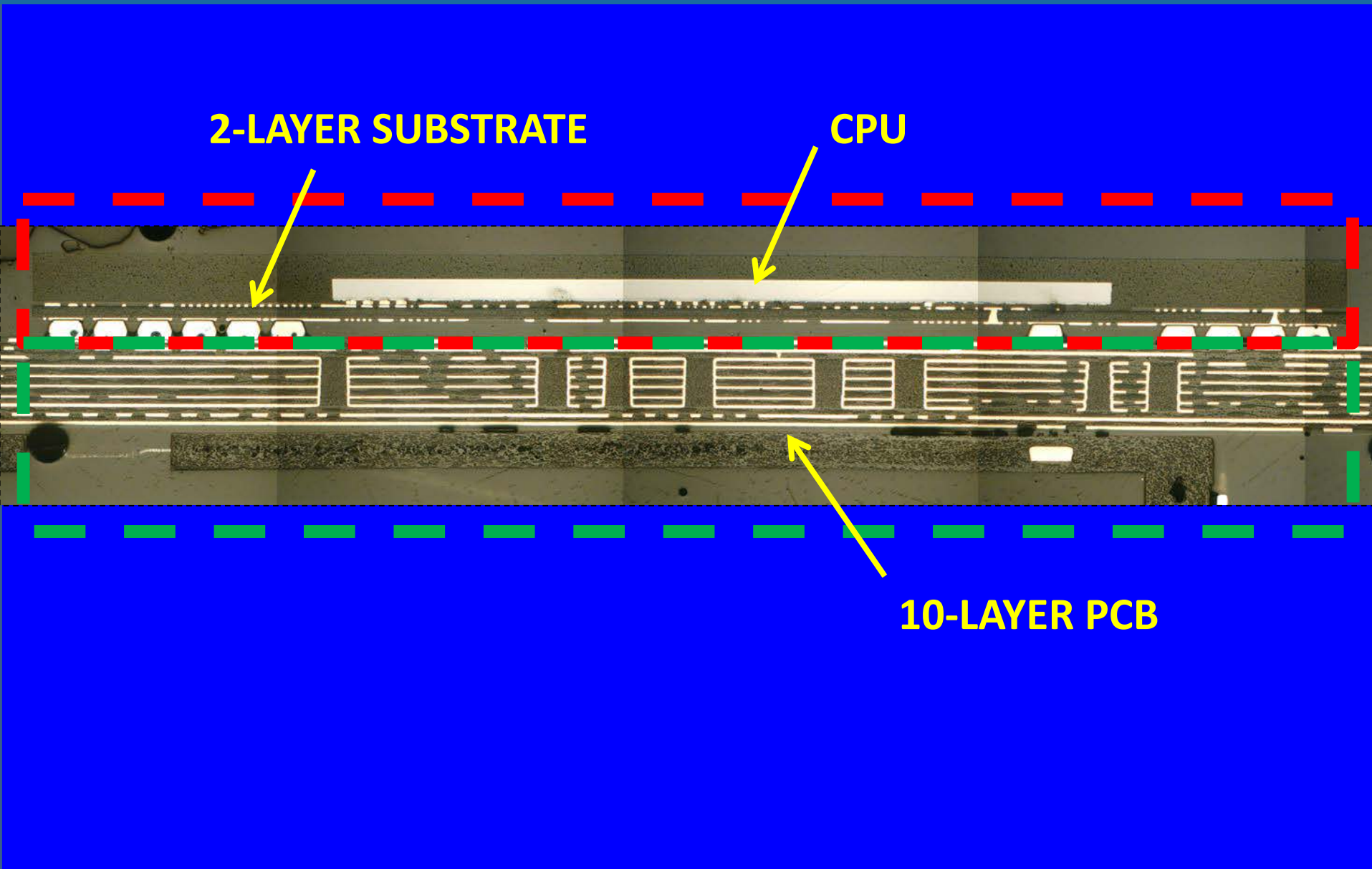
PDN Inside a DC-DC Converter Module

Buck Converter Example:

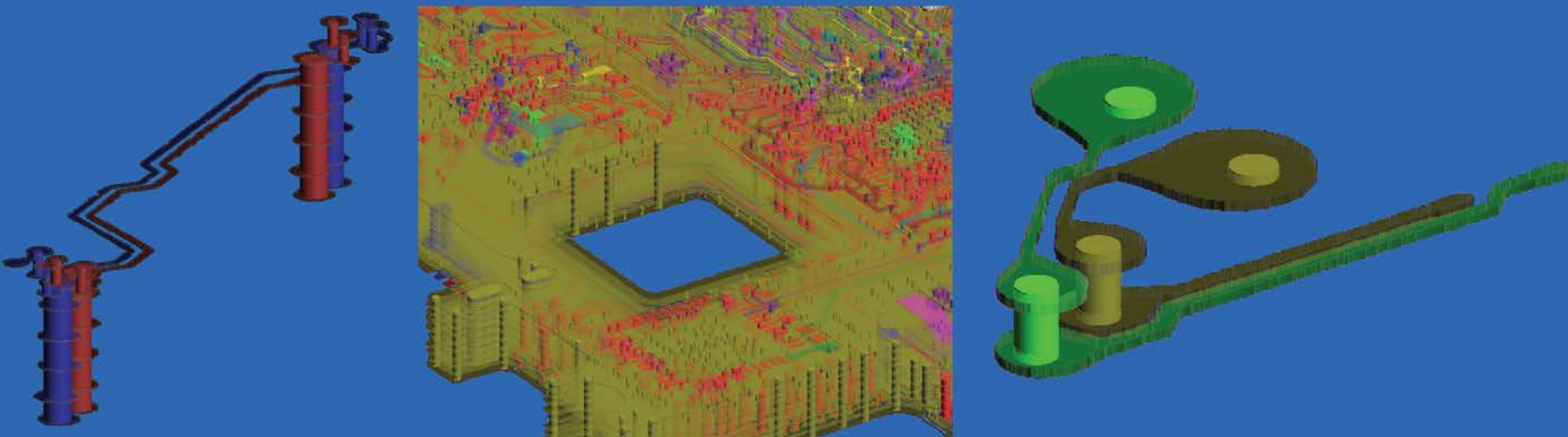


❑ What can go wrong?

3D Package: PDN Reconstruction Process in 3D



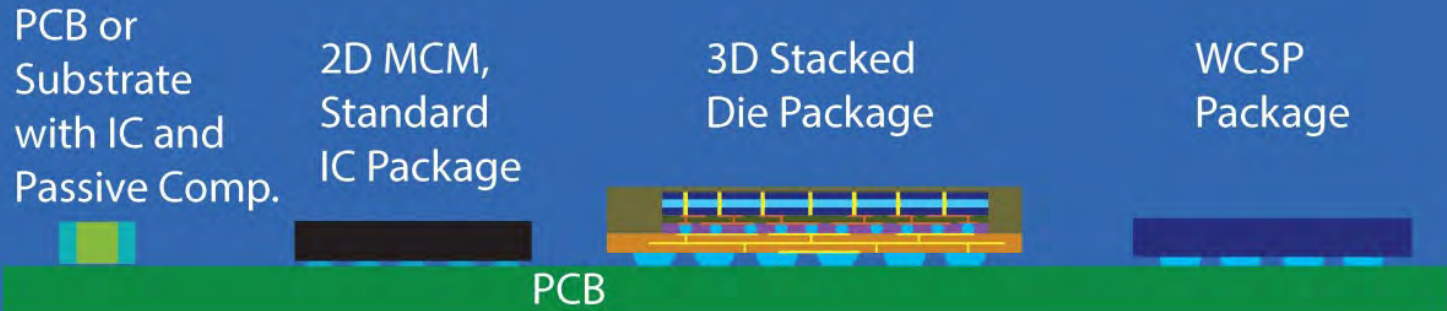
3D Reconstructed PDN



Courtesy of Bayside Design, Inc.

**Reconstructed 3D structure in mcm file format.
Ready for 3D EM field solver analysis or L, R, C extraction**

Input Files to 3D Field Solvers



**CAPTURE OPTICAL 2D LAYER IMAGES, THEN
RE-CONSTRUCT IN 3D**

Tool: Software: Format:	APD .brd	APD .mcm	SIP .sip	APD or SIP .mcm or .sip
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**3D FIELD SOLVER EDA TOOLS: SIGRITY (CADENCE)
ANSYS ECAD: Siwave-DC, Q3D, Silicon Frontline R3D, ...**

Conclusions

- ❑ RE is a legal and ethical process.
- ❑ Inventors need to be aware of the America Invents Act.
- ❑ RE contributes in product development and protection phases.
- ❑ Proactive PDN analysis is essential in 3D packaging.
- ❑ RE can help set the direction of R&D, reduce time to market, and avoid costly mistakes.