SYSTEM IN PACKAGE
.... 2006 - 2016

NEW TECHNOLOGY IS HERE
A system in package (SiP) or system-in-a-package is a number of integrated circuits enclosed in a single module (package). The SiP performs all or most of the functions of an electronic system, and is typically used inside a mobile phone, digital music player, etc. Dies containing integrated circuits may be stacked vertically on a substrate. They are internally connected by fine wires that are bonded to the package. Alternatively, with a flip chip technology, solder bumps are used to join stacked chips together.


Promise of system in package
- More Function in Less Space
- Optimized Cost and Reduced Design Cycles
“The complexity for minimum component costs has increased at a rate of roughly a factor of two per year”

April 19, 1965
Gordon Moore - INTEL co-founder
“integrated circuits would double in performance every 18 months”
"the cost for producers to fulfill Moore's law follows an opposite trend: R&D, manufacturing, and test costs have increased steadily with each new generation of chips."

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WHY SYSTEM IN PACKAGE

Cost/Function vs. Time to Market

System on Chip

System in Package

System Complexity
Why System in Package

SEMATECH 2009 - Darvin Edwards, Masood Murtuza, Texas Instruments, Dallas, TX USA
Multichip Modules (MCM) & Hybrid Integrated Circuits (HIC)

- **60’s & 70’s - Original Developments**
  - IBM System/360 - IBM Bubble memory - IBM 3081 thermal modules

- **80’s & 90’s - Deployment to HiRel industry**
  - Aerospace
  - Military aircraft electronic
  - Radars
  - Super-computers
**Multichip Modules (MCM) and Hybrid Integrated Circuits (HIC)**

Examples of Products developed by Chris Barratt’s Team during 90’s

**Variable attenuator**
- Balanced structure
- Center frequency 12 GHz
- Octave Bandwidth
- Attenuation 0 to 40 dB
- Application: Radars

**Dielectric Resonator Oscillator**
- Output power 5 dBm
- Frequency ca 30 GHz
- Varicap tuned to allow phase lock
- Frequency stability +/- 200ppm
- over temp -20 to 80°C
- Application: Military Helicopters

**YiG filter with integrated balanced mixer**
- Frequency range 2 to 26 GHz
- 3 ball YiG preselection filter (< 2dB loss over band)
- Doubly Balanced wideband diode mixer
- Application: Military Aeronautics
End 90’s - System in Package came to Consumer Mass Market
- Pentium Pro Intel (November 1995) : processor and “cache” on 2 separate dies
- Memory Sticks by Sony (1998) : 2x128 MB memories squeezed into 1 component
Early 00’s SIP growth is driven by Cell Phone industry for Handsets & Infrastructure

2003 World Wide Package Volume (Source: INEMI 2004 annual report)

- Total 120 Billion Units electronic packages
- Including 3 Billion Units SIP
- 1.75 Billions RF Cellular SiP
- 0.25 Billions WLAN & Bluetooth SiP
• Early Stage SIP Design from Insight SiP Original Team

- National Semiconductor GSM Base Station VCO/PLL for Ericsson

- National Semiconductor Bluetooth Modules LMX98xx family
  http://www.ti.com/product/LMX98xx
INEMI Recommendations (Source: INEMI 2004 annual report)

A number of recommendations have been made for SiP technology in the roadmap including:

- Improved design tools for emerging technologies like embedded passives and optoelectronic
- Tools and methodologies to address chip and package co-design
  - Mixed signal co-design and simulation (SI, Power, EMI)
  - For transient and localized hot spots - simulation of thermal mechanical stress and thermal performances
- ........
Unique Flexible Design Methodologies

- From system definition down to fully tested layout
- Standardization of the SiP design
- Automated design
- Portability
- Greater Integration
- Ability to embed functions within the package irrespective of the manufacturing technology
- Aggressive design schedules
INSIGHT SiP METHODOLOGIES

Circuit Design
- L, C, Balun...

Buried Function Design

Layout/EM
- ADS, Cadence, Designer,...

S Parameters
- Active Circuits

Parametrical/Mechanical Objects
- For Each Object

Circuit Simulation, ADS, Designer, ...

EM/Circuit Simulation, ADS, Designer, HFSS...

Layout Design

Substrate Manufacturing
- Multi-layers / Thin Film

Test of Buried Functions

SiP Final Test

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**Schematic Only Simulation Results**

- Schematic only Simulation Results
  - **Test Results**
  - **EM PCB layout + schematic + models Results**
  - **Adjust model complexity for fit**
**INSIGHT SiP DESIGNS EXAMPLES**

- LTCC WiFi Integrated Filter/Baluns: 7 x 7 x 1.5 mm
- GPS Module, Baseband, Radio, SMD: 6 x 4 x 1 mm
- 2 die SiP, Secure NFC Contact-less: 5 x 5 x 0.8 mm
- 4 die SiP, BT ASIC Memories: 12 x 12 x 1 mm
• June 29, 2007 - Launch of Iphone Gen 1
  - iPhone development began in 2004 with a team of 1000 employees inside Apple Labs “Purple Project”
  - Successful market starts with iPhone 3G launched on July 11, 2008

• First Insight SiP design embedded in Apple Products
  - Iphone 3GS launched on June 19, 2009
  - Smart antenna tuning module.
  - Design done with Peregrine Semiconductor (now Murata Subsidiary)

• Today Insight SiP Designs are embedded in leading smart phones.
M2M device Miniaturization

• First step during Years 00’s:
  - Modules on small PCB - no embedded antenna

• Second step:
  - Antenna integration within the module

• Third step:
  - Antenna in package within OBD Connector
    3G/4G + GPS + Glonass
• 2010 - Bluetooth Smart is Launched
  - January 2010 : Bluetooth V4.0 standard approval by Bluetooth SIG

• Insight SiP BLE Modules
  - 2010 : First generation - ISP091201
  - 2013 : Second generation - ISP130301
  - 2016 : Third Generation - ISP1302 and ISP1507

• 2013 - iBeacon
  - June 2013 : Apple introduces iBeacon protocol
  - 2014 : Insight SiP Beacon First Generation
April 24th, 2015 - Apple Watch is available in Stores
Manufacturing with multiple established partners
- Amkor
- ASE
- AT&S
- Barry Ind
- Kyocera
- Tong Hsing

Break by Application Volumes

Quality standards in production
- ISO9000 standards and several other equivalent certifications
- OHSAS18001 – Health and Safety management
- ISO13485 – Medical requirements
- AS9100 – Aerospace requirements
- QS9000 – Automotive requirements
• Highly integrated microcomputers
  - Linux Microcomputer in SiP

• Indoor positioning
  - Pulse UWB - ISP1510

• Super High Speed Data transfer
  - Transfer Jet
  - 60GHz
THANK YOU!