



Advanced Miniaturization and Power Management for Wireless Devices

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TransSiP Agenda

- ✦ TransSiP Timeline
- ✦ Diversification "More-than-Moore"
- ✦ The Third Dimension
- ✦ Putting It All Together
- ✦ The TransSiP Vision: 3D and Beyond
 - Metamaterials
 - Power Management
 - Microshielding
- ✦ The Way Ahead



- Founded in 2014
- 3D System-in-Package (3D SiP) Pioneer
- "Transformational" System-in-Package and MtM (More than Moore) Technologies
- Growing Patent Portfolio



Novel GPS SiP module with miniaturized substrate by using RF sub-circuit embedding technology

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*Advanced Technologies and Business Development, Telit Wireless Solutions

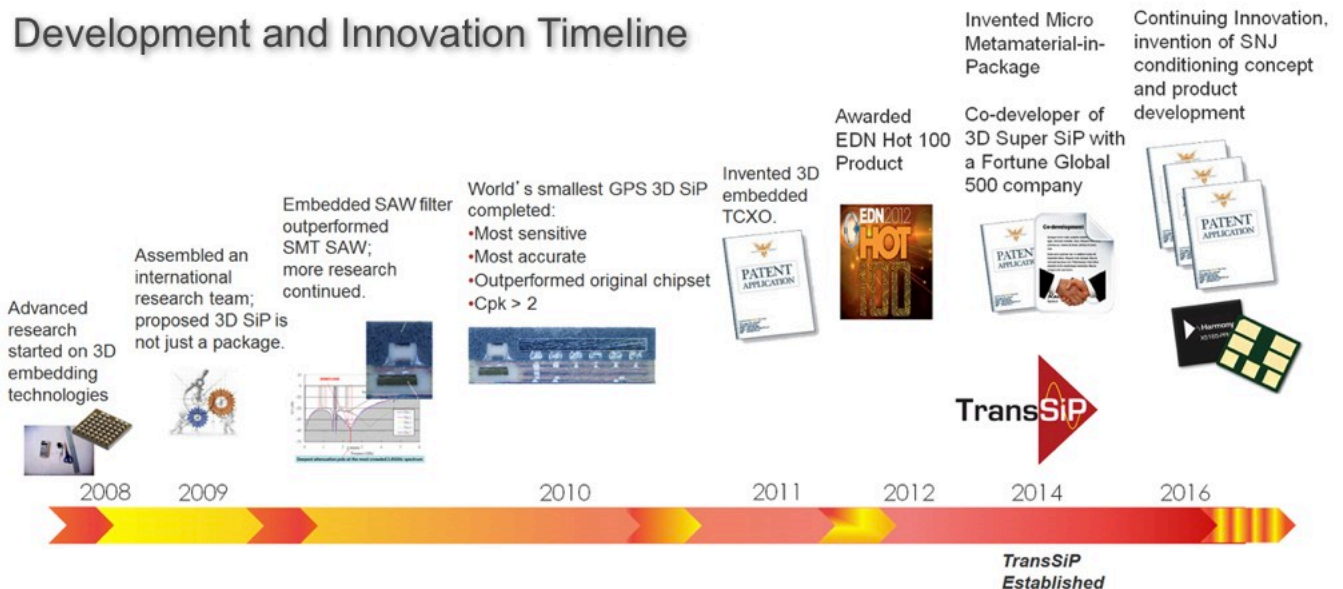
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Abstract

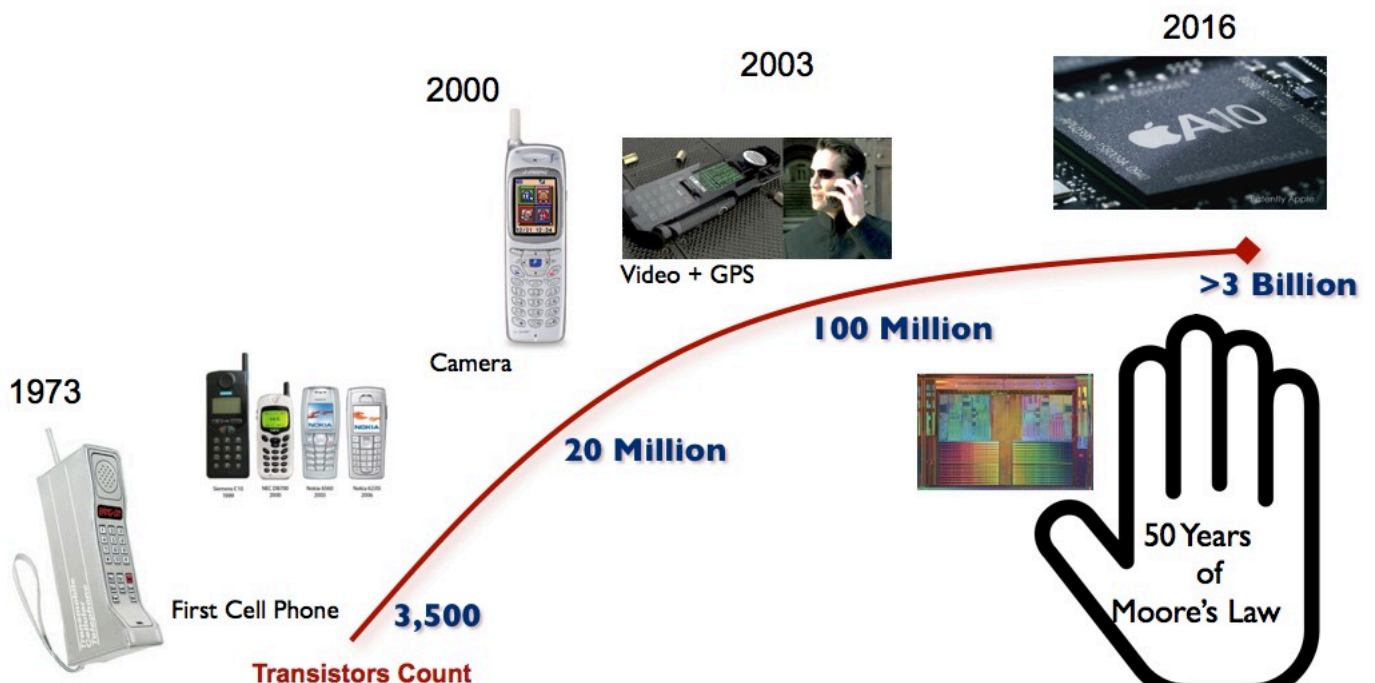
Applications of 3D System-in-Package (SiP) with device embedded substrate are penetrating to downsizing and adding multi-functional blocks for portable electronics. In particular, functional blocks, such as power supply and RF front-end are expected to be the promising future for 3D system integration for many applications. Passive components, like R, L and C, and active component, like a bare-die, are typically chosen in traditional embedded substrate applications. Besides, 3D embedded integration with power supply system and RF front-end with other peripherals, such as Real-time clock, SAW device and thermal

Development and Innovation Timeline



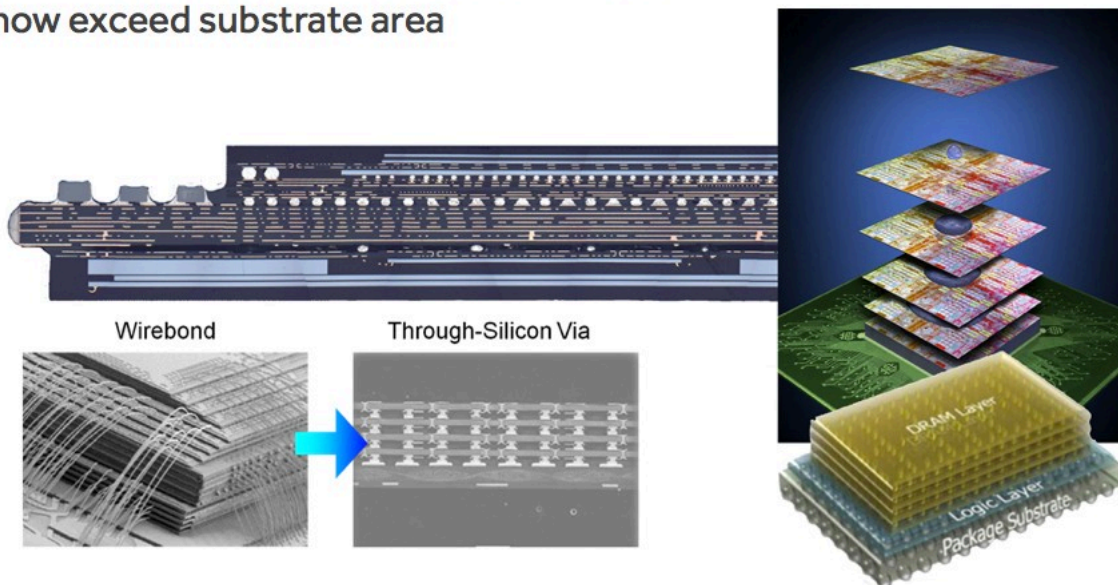
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TransSiP **How Moore's Law Shaped the Mobile Technologies**



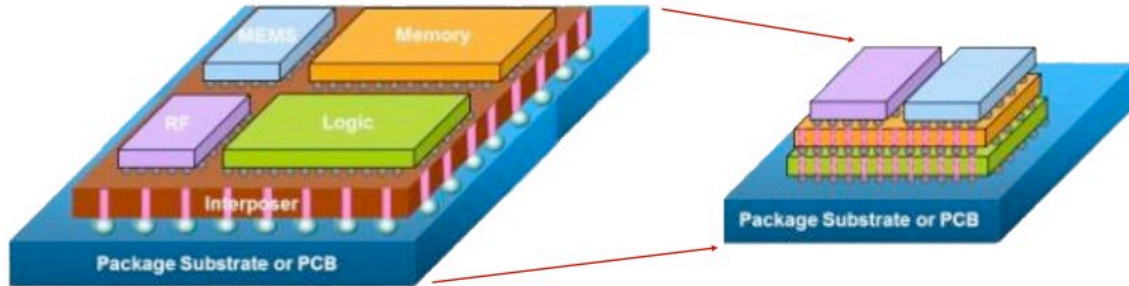


- Silicon-on-silicon means active area can now exceed substrate area



TransSiP 2.5D – Not a Bad Idea.....

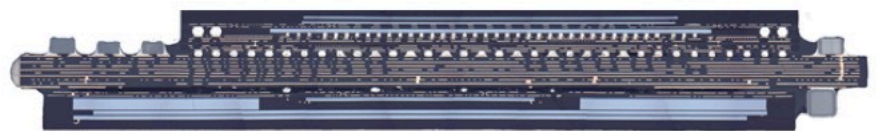
- Reduced footprint
- Shortened time-of-flight
- Reduced parasitics



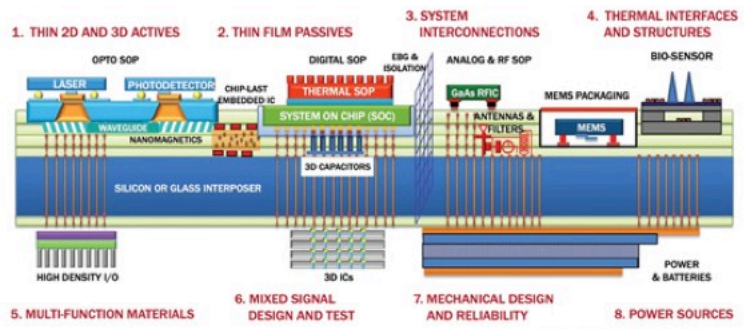
.....But it's still not the sweet spot..
(and, it can get pretty hot!)

TransSiP Diversification- The New Dimension

- "Processing"
 - active devices
 - more transistors per unit area = higher cost
 - 3D packaging = higher interconnect complexity
- "Experience"
 - actives, passives, MEMS, power, RF
 - non-digital functions = mixed component types
 - mixed signals / RF = layout, floorplan, parasitics issues

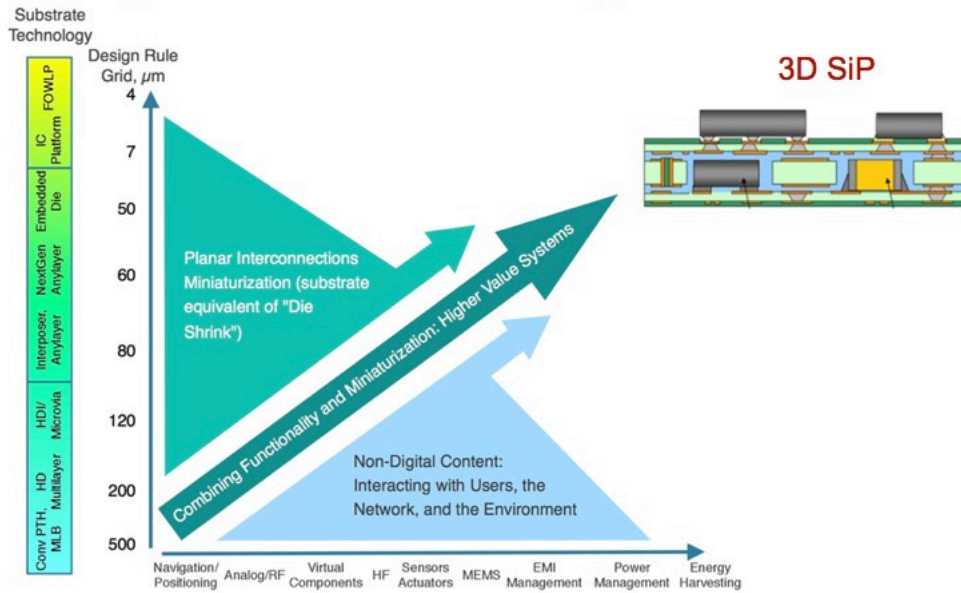


source: Chipworks



source: Georgia Tech PRC

"Processing" from the PCB & OSAT Industry



concept: ITRS

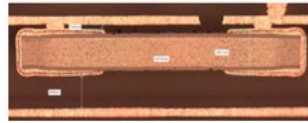
"Experience" from the IC Industry

TransSiP Agenda

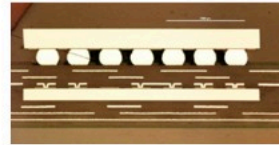
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"Laminate Embedded" Packages

- "Via" Process: Buildup Substrate Technology



Embedded Passive



Embedded Active

SMT
Embedded die

- "Pad" Process: Co-laminated Substrate Technology



Embedded Active + Passive



TransSiP "Via" Connection Generic Process Flow

Pro

+ compatible with industry standard LVH (laser via hole) buildup processes

+ On-chip design rules (40µ pads/100µ pitch)

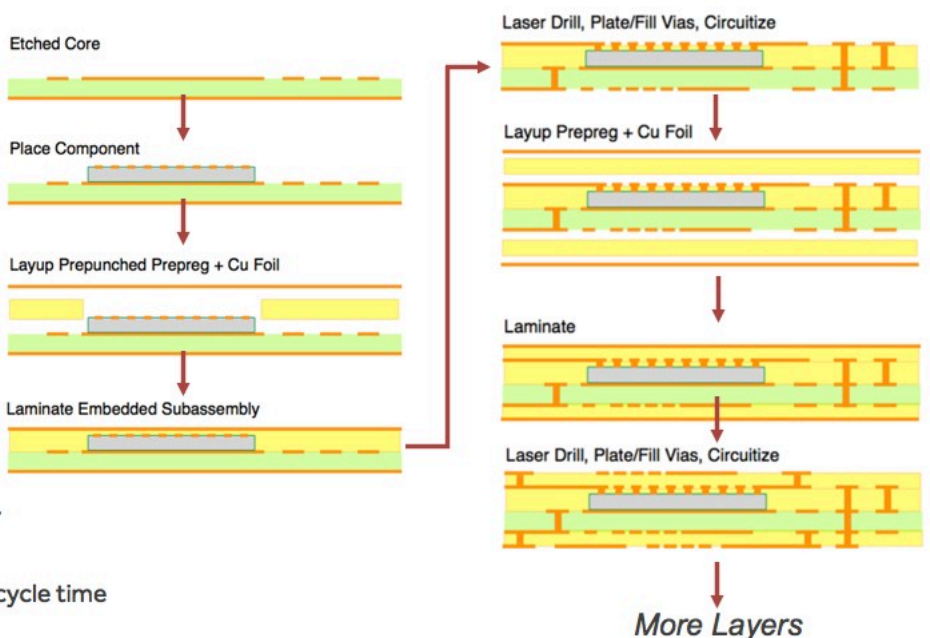
Con

- copper plating required on devices- additional cost

- registration is an issue

- no wiring on encapsulating layer

- serial/sequential process- long cycle time



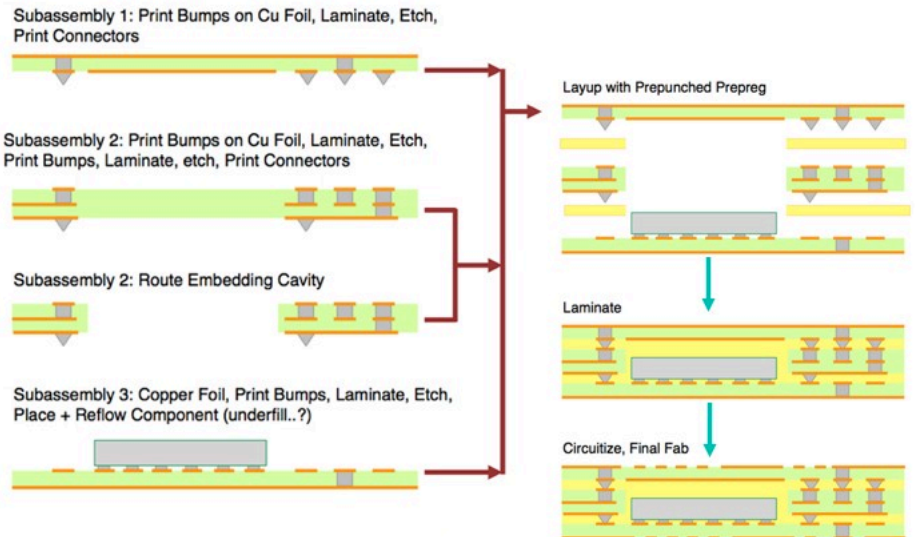
TransSiP "Pads" or "Any-layer Post" Connection Process Flow

Pro

- + standard components and assembly processes used (solder / conductive adhesive)- no added cost
- + pad-to-device registration issues confined to well-known assembly issues and tolerances
- + hybrid processes (conductive post / LVH) can be used for maximum flexibility
- + wiring channels available in encapsulating layer(s)

Con

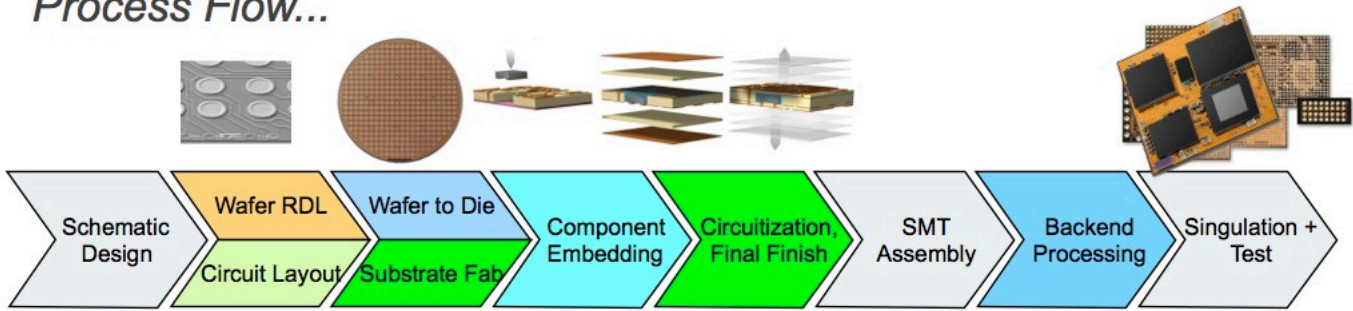
- most solutions are proprietary or derivatives of proprietary technologies (ALIVH, B2iT)
- Density for conductive post solution limited to 0.2mm pitch



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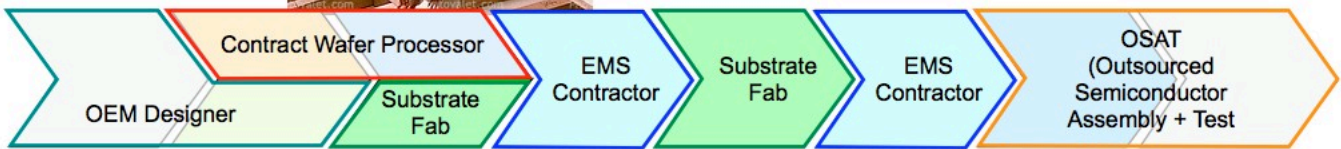
Process Flow...



Logistics....

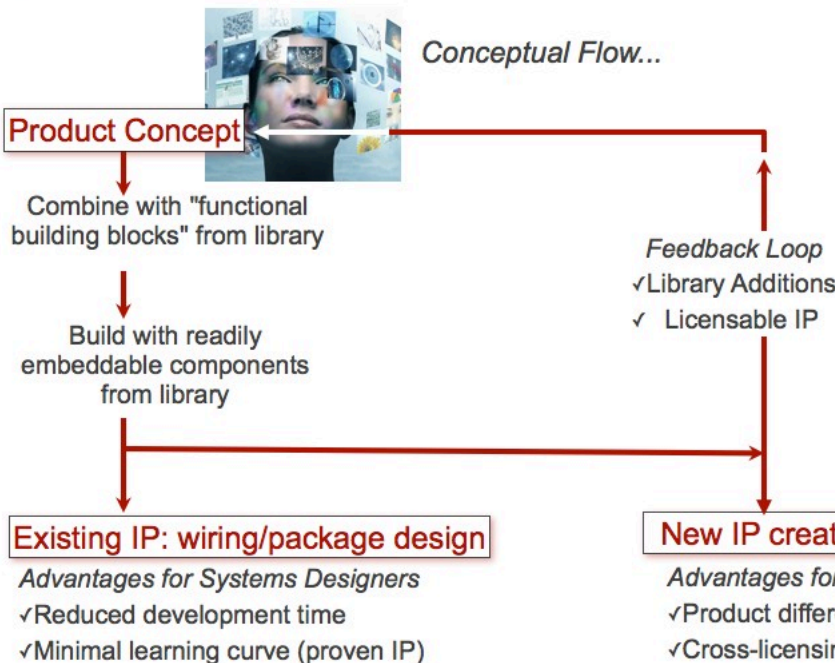


...Flow?



TransSiP A New Paradigm: "The Organic Fab"

Conceptual Flow...



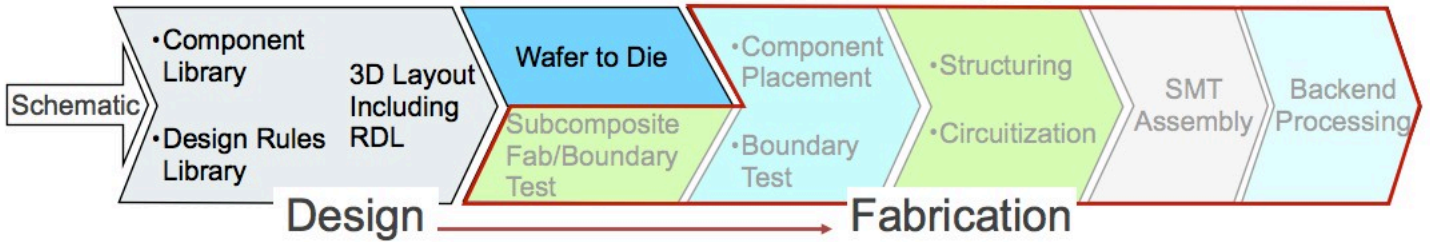
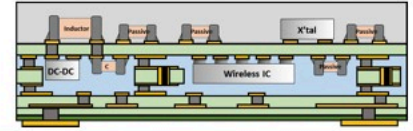
Advantages for Chip/Component Vendors

- ✓Broaden market
- ✓Shorten silicon time-to-market

Advantages for Developers/Marketers

- ✓Accelerates adoption rate
- ✓Shorten time-to-market
- ✓Readily available components from library
- ✓Proven IP
- ✓Promote IP reuse (cross-licensing)

"Organic Fab"
Logistics Flow



Standard Tools + Libraries

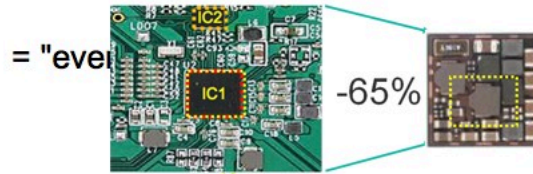
The "Organic Fab": Via or Pads Processing

concept: TransSiP

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TransSiP "3D Heterogeneous SiP" is More-than-Wire (MtW)

- "Embedding" is viewed as a "wiring solution" (small, integrated printed circuit board)



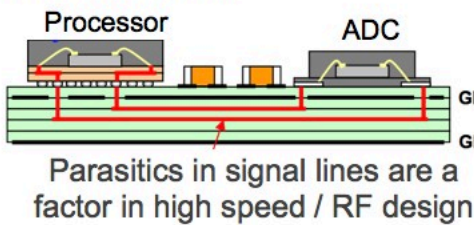
- "3D Heterogeneous" solutions-
 - are "More-than-Wiring" (MtW)
 - incorporate distributed circuit elements as designed-in passive R, L, C
 - provide "better than book" performance through proactive use of circuit parasitics

= "everything but the kitchen sink"



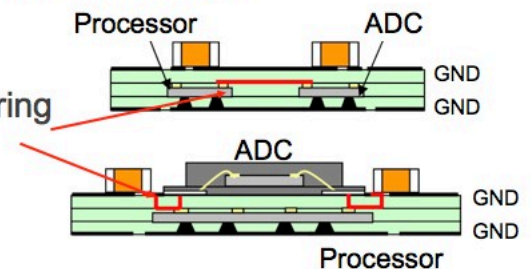
TransSiP MtW (More than Wiring)- Turning Liabilities into Assets

The Problem:



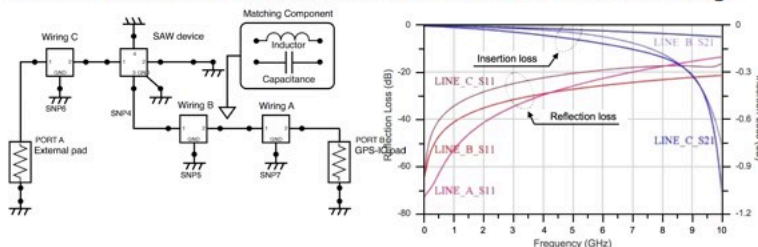
The Solution: MtW Enables-

1. Reduced wiring length

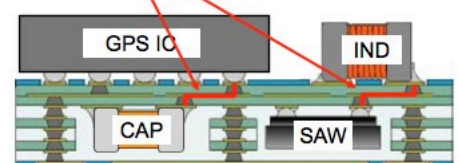


2. Controlled Equivalent L, R, C

Transmission Line Characteristics of GPS SiP Internal Wiring



Short, controlled Zo tracks



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TransSiP **The Fourth Dimension**

- ⚡ Meta-materials are formed by altering the electromagnetic characteristics of natural materials
- ⚡ High impedance surfaces and surfaces with defined electromagnetic band-gap offer the potential for dramatic improvement in
 - small antenna gain and efficiencies
 - EMI suppression/shielding
 - transmission line characteristics for multi-Gbps frequencies
 - PDN (power delivery network) self-impedance

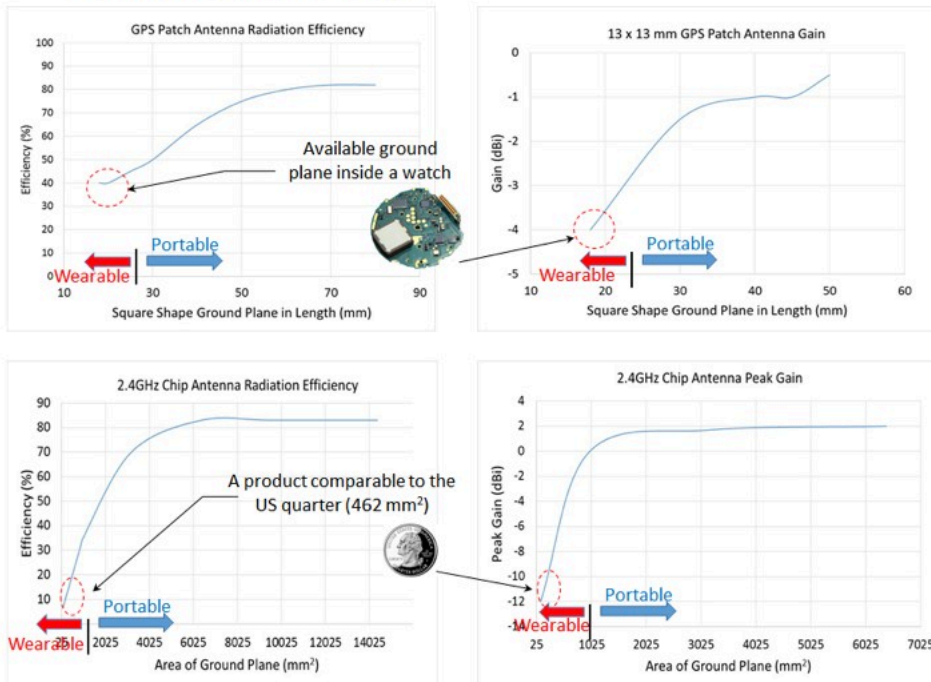


13 x 13mm Patch Antenna Results	From This	To This!
Radiation Efficiency	40%	82%
Gain	-4 dBi	1.3 dBi

MtW + Meta-Materials = "Much Better than Book"

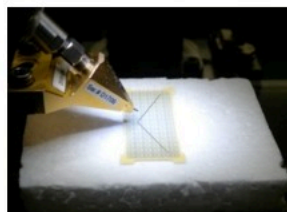
TransSiP New Antenna Concept for Small Wireless Devices

The Problem- Antenna efficiencies drop dramatically with decrease in reference plane area

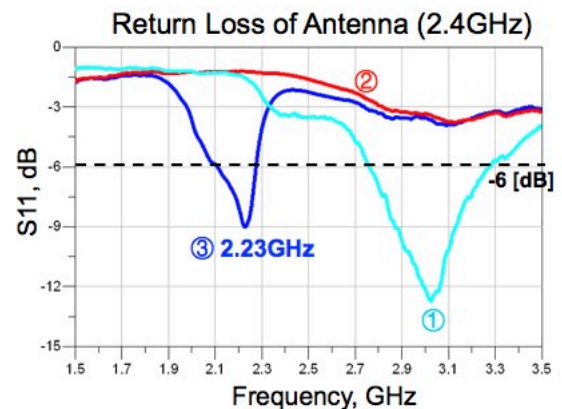


TransSiP New Antenna Concept for Small Wireless Devices

The Solution- creation of virtual reference plane using "left handed" EBG structure



- Tunable characteristics
- Efficiency gain

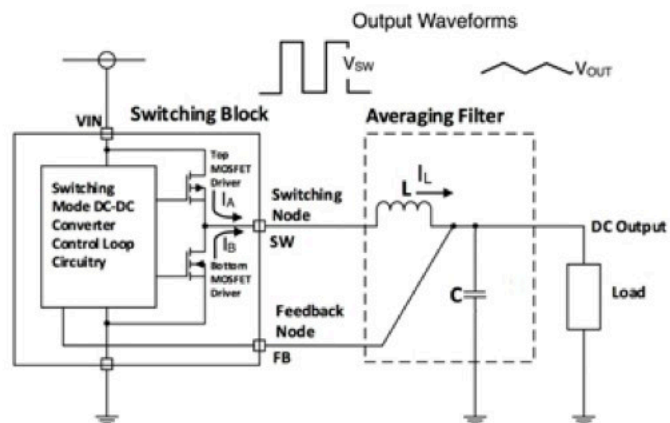


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TransSiP Supply Bias Noise Components

Four Classic Noise Components:

- Ripple
- Harmonics of switching frequency/frequencies
- Ringing
- Spurious/transient events

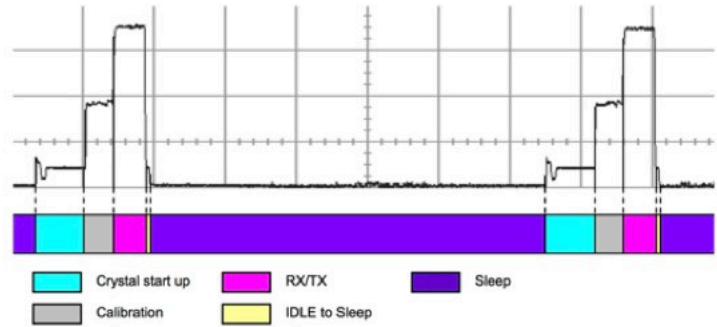


These can be attenuated using an averaging filter, but...

Downstream circuit behavior suggested there was another component outside the frequency domain

TransSiP The Power Management Problem

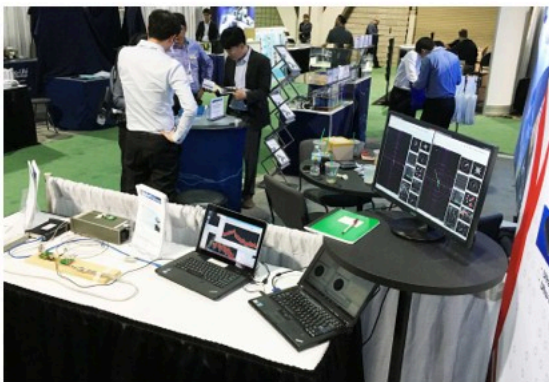
- RF circuitry is sensitive to supply bias noise
- Highly efficient switched mode Pulse-Frequency Modulated (PFM) type converters are noisy
- Linear ("low dropout" or "LDO") regulators are used, but efficiencies are between 5 - 60%
- LDO supply bias exhibits spurious/transient noise



Voltage conversion efficiency is 5% or less for most of a RX/TX system's life!

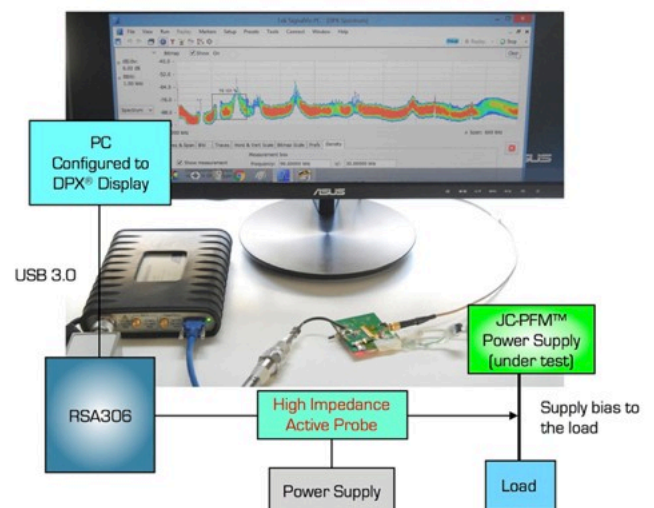
TransSiP A Novel Analytical Approach

- Rate of occurrence of signals shown by color coding
- Spectral histogram captures very hard to analyze transient events over time



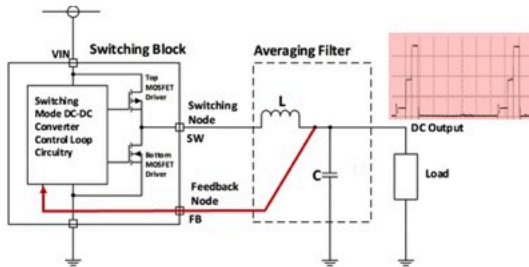
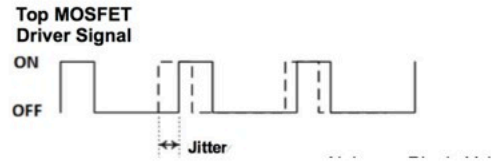
APEC 2016, Long Beach, CA

TransSiP Demonstrated SNJ Measurement enabled by DPX[®] Real-time Spectral Histogram



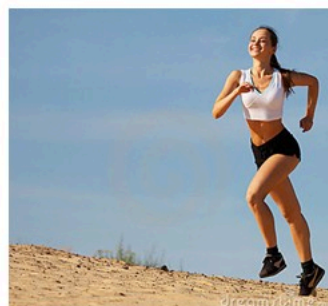
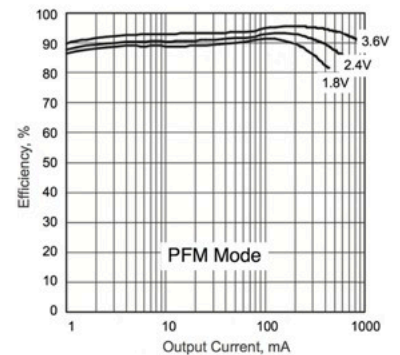
- ✓ Ripple
- ✓ Harmonics of switching frequency/frequencies
- ✓ Ringing
- ✓ Spurious/transient events
- ✓ **Switching noise jitter (SNJ)**

Switched-Mode Converter Output Characteristics



SNJ = Timing dislocation of switching decision in the Control Loop

- Enabling technology for use of highly efficient (80-95% across load range) PFM DC-DC Conversion
- Improved sensitivity and performance for spread-spectrum wireless and navigation/positioning circuitry in power-constrained devices
- Potentially significant increases in autonomy/battery life depending on power management strategy
- Enhanced user experience through improved performance and increased autonomy

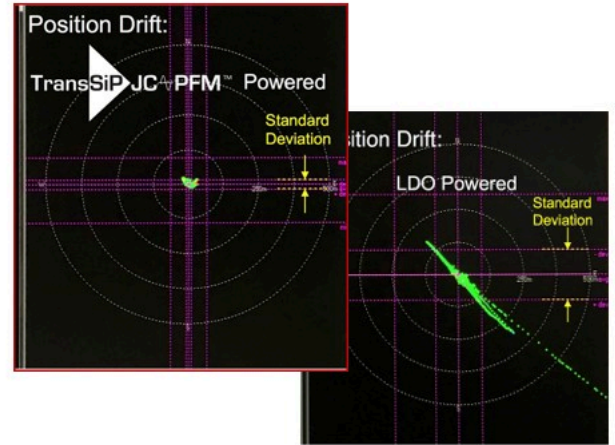
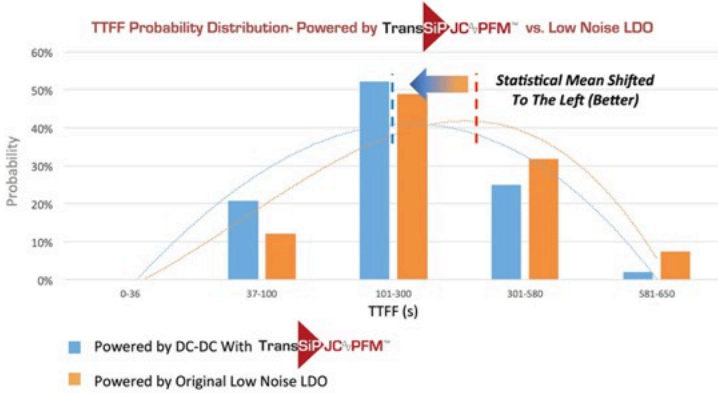
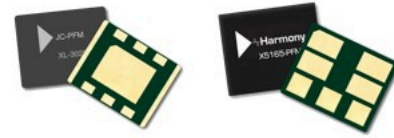


TransSiP What SNJ Conditioning Does

Identical GPS/GNSS Receivers in parallel powered by LDO and SNJ-conditioned PFM

- Significant reduction in Position Drift error
- Significant reduction in Time-To-First-Fix

TransSiP **JC-PFM™**
DC-DC Conversion Solution
Micro DC-DC Converter + Harmony™ SNJ Conditioner



Patents Pending



Advanced Miniaturization / Power Management for Wireless Devices

TransSiP More Details on Public Domains

Tags:

- JC-PFM DC-DC
- SNJ Conditioning



Powering wearable electronics: a new dimension

Desmond Wong, Founder, President and CEO and William Burr, Vice President of Business Development, TransSiP - September 02, 2016



Although "wearable" electronics includes a number of different form factors and applications with greatly varying development and market trajectories, in most cases power management is a key issue. Whether virtual/augmented reality (VR/AR), smart clothing/e-textiles, medical/healthcare devices, smartwatch/fitness trackers, or personal connectivity devices, not only battery life but also the DC-DC conversion strategy directly impacts the autonomy of the device as well as the user experience.

Attempts to prolong battery life are driving innovative solutions for duty cycle management, but the power conversion baseline remains tied to linear voltage regulation despite the existence of more efficient switching mode DC-DC conversion options. The primary reason for this is because the spread-spectrum communications and navigation/positioning functions of most remote, portable, wearable, and IoT devices are sensitive to supply bias noise. The bias voltage supplied by linear regulators is relatively quiet, but conversion efficiencies drop to 5% or less at the standby power loads used in all power-constrained devices.



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Steve Taranovich

An Enabling Technology for Power-Constrained Devices

Steve Taranovich, Editor-in-Chief, Planet Analog, 9/6/2016

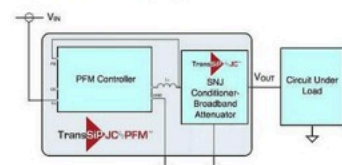
Bo Email This Print Comment

Low power is an important feature in portable, battery-operated devices in today's technologies and as we progress towards such systems in which wearables, 5G smart phones, and energy harvesting become ubiquitous, low power will be an absolute necessity.

TransSiP a company with an extensive patent portfolio, has grown an extensive innovation in More-than-Moore (MM) technology. MM is the aspect of microelectronic products which complements the digital part of integrated systems. This approach enables the functionalities of a product that are not digital-related – and although it will not enable scaling according to "Moore's Law", the unique capabilities of this effort will enable migration from system board-level into the System-in-Package (SiP) or onto the chip (SoC).

TransSiP has developed advanced 3D heterogeneous, meaning active and passive, embedded System-in-Package innovations. The use of micro-metamaterials in their semiconductor packaging technology along with unique DC/DC conversion system architectures for use in noise-sensitive systems achieve the goal of extending the battery life in wearables and IoT microsystems.

Their recent introduction of their JC-PFM DC-DC converter chipset designed with a new concept in switched-mode DC-DC power conversion. This architecture consists of an integrated micro DC-DC converter and Harmony SNJ conditioner. This family of devices integrates all the components needed to provide output voltages ranging from 1.0V to about 4.0V (±2.0%, 0.1V step increments) at 50/200mA with up to 93% conversion efficiency at full load and over 80% in power saving mode in two microLGA packages.



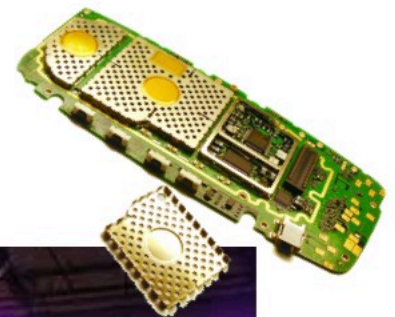
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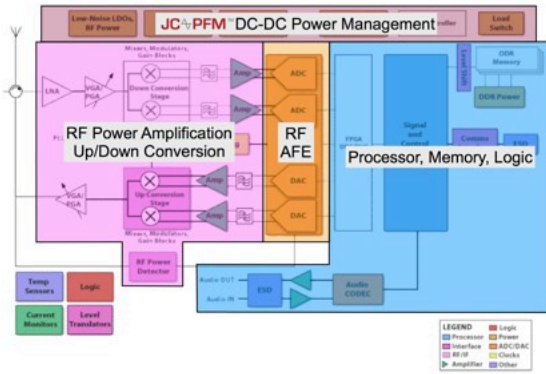
TransSiP **TransSHIELD™** - micro-shielding solution

*The Problem-EMI shielding cans are bulky,
interfere with assembly processes.. and
they just don't fit anymore!*

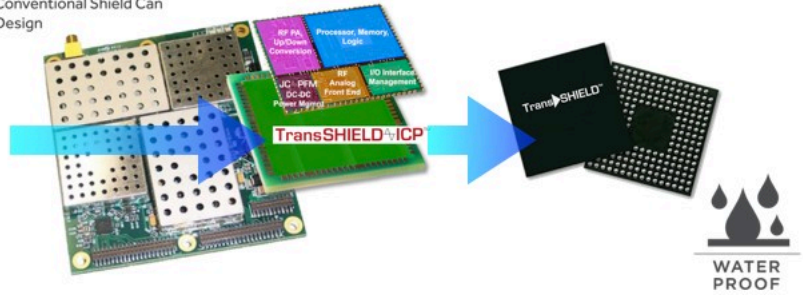
*The Solution-Form Faraday cages around
sensitive components, and
make them very small*



TransSiP TransSHIELD™ Applications Example: Software Defined Radio



Conventional Shield Can Design



- ⚡ design with off-the-shelf components
- ⚡ partition into RF/EMI blocks
- ⚡ carrier + interposer fab
- ⚡ ICP (interposer-carrier package) assembly

Available NOW from a top-ranked supplier with following certifications:

- Accredited Nadcap
- MIL-PRF-55110
- MIL-P-50884E
- MIL-P-31032
- ITAR
- ISO 9001
- ISO 13485
- RoHS



Patents Pending

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▲ MtM Technology Enablers

- performance / range / user experience
- autonomy / power management
- miniaturization

▲ Customized IP solutions for 3D SiP

▲ Proven IP time-to-market accelerators

▲ Innovative business solutions

Enabling the Emerging Future

