Close supply chain collaboration enables easy implementation of chip embedded power SiP

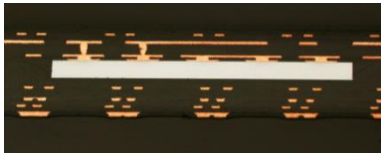
Gerald Weidinger,
R&D Project Leader, AT&S

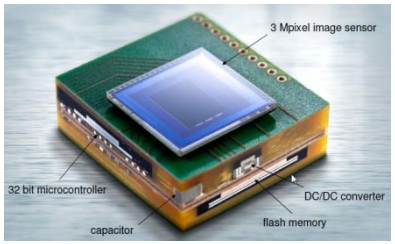
AT & S Austria Technologie & Systemtechnik Aktiengesellschaft | Fabriksgasse13 | A-8700 Leoben
Tel +43 (0) 3842 200-0 | E-Mail info@ats.net
www.ats.net

Embedding Technology Industrialization

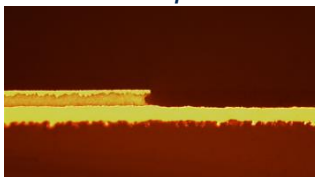
History of embedded Die Technology

Embedded silicon

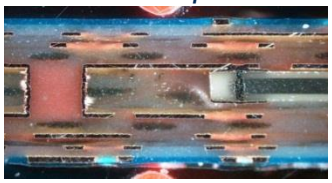


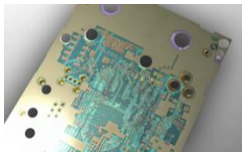


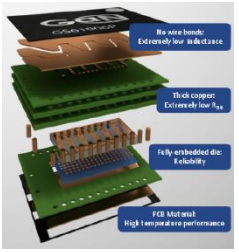
Printed capacitor



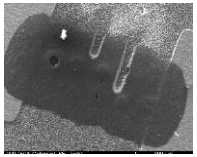
Discrete capacitor



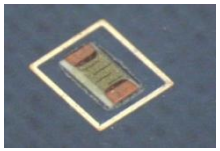


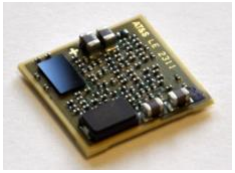


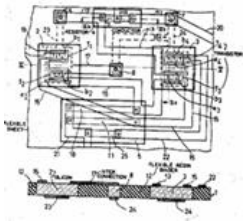
Printed resistor



Discrete resistor







Embedded Chip

1970 // 2000 2002 2004 2006 2008 2010 2012 2014 2016

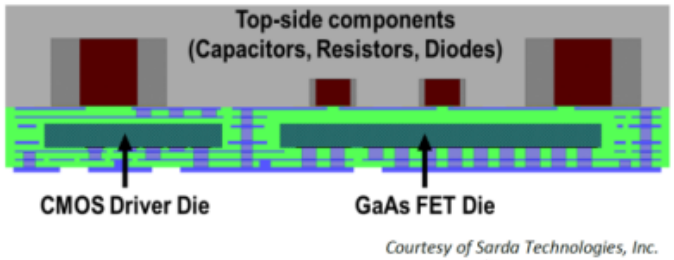
Concepts → Research → Development Projects → Industrialization → Serial Production

Embedding Technology Industrialization

AT&S

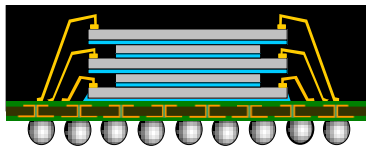
SiP Integration Density

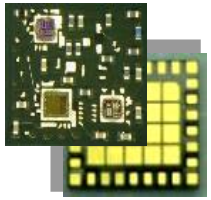
3D integration
Chip Embedding

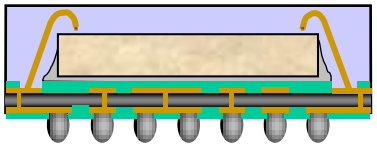


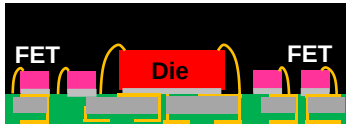
Courtesy of Sarda Technologies, Inc.

3D Interconnect
2 side cooling
Shielding









Co- Design
Optimization

SiP Performance (size, electrical & thermal)

Why Chip Embedding?

Unique Selling Propositions	… in detail
Miniaturization	• Footprint reduction • Higher component integration (additional assembly layer)
Electrical performance	• Improved signal performance (higher data rates) • Reduction of parasitic effects
Mechanical performance	• Higher durability and reliability through copper-to-copper connections (copper filled microvias) • Package enables protective enclosure • High drop, shock and vibration tolerance
Thermal management	• Improved heat dissipation through direct copper connection • Improved heat dissipation FR4 versus air (compared to SMD)
Additional functions – Reduction of overall cost – EMI shielding	• EMV shielding (partial or full shielding of a package) • Package is the housing → no additional molding required
ECP is supporting the trend towards modularization	• Lower set-up costs compared to other packaging technologies (packaging versus PCB processes) • Customization of footprint and module versions can be done due to digital imaging - no separate tooling necessary (e.g. QFN)
Anti-Tamper and Security	• Hidden electronics preventing reverse engineering and counterfeiting

Embedding Technology Industrialization

Our collaboration enables customers success

- Global footprint
- Strong R&D focus
- High volume manufacturing experience , capacity and capability
- Brought product portfolio
- Strong customer base
- Long history in embedded technology

Alignment on

- Business processes
- Aligned technical capabilities
- Common focus on segments and applications

- Global footprint
- High volume manufacturing experience , capacity and capability
- Excellent testing capabilities
- Strong customer base
- Brought experience in backend processing of various applications

Supply Chain Offering

Strategic supply chain collaboration is a key success factor

Alignment on Design Rules & Roadmaps
- Substrate design
- Assembly design
- Design integration

KGD test
RDL
Thin / Dice
Inspect / TnR

Substrate manufacturing
Embedded chip
Strip Test

SMT
Top FC / under fill
Cap or Mold
Solder Ball Attach
Package saw

Package level test
Reliability test

Co-Design	Wafer to Die	Substrate embedded chip	Package assembly	Test
UTAC	*Customer Consigned Option*	AT&S	UTAC	UTAC
AT&S	UTAC			
Customer Specs				

April 2015 - Joint marketing / supply chain agreement Between AT&S and UTAC for 3D SiP with embedded chip technology. Collaboration press release April 2016. AT&S over 5 years production embedding experience.

UTAC at a glance

- Outsourced Semiconductor Assembly and Test services (OSAT) provider in support of Analog, Mixed-Signal, Logic, Power and Memory products.
- UTAC 2015 Revenue $878M; Ranked 6th in the Top Ten OSATs
- Focus – Assy, Test and Full Turnkey; Test comprises 35% of sales in 2015.
- 1997 Established in Singapore
- Mfg Footprint - Singapore, Taiwan, Malaysia, Indonesia, Thailand, China.
- >260K M^2 Manufacturing Space and ~ 12K Employees Globally.
- Sales offices located worldwide.
- Markets: Mobile Phone, Automotive, Security, Wearable's, Industrial & Medical.

UTAC at a glance

UTAC Dongguan, China (UDG)

[Since 1988, >500k sq ft, China Logistics, WW distribution]

BGA, LGA, QFN, Memory Cards, USB, SiP

3D SiP w/ Embedded chip

UTAC Thailand (UTL)

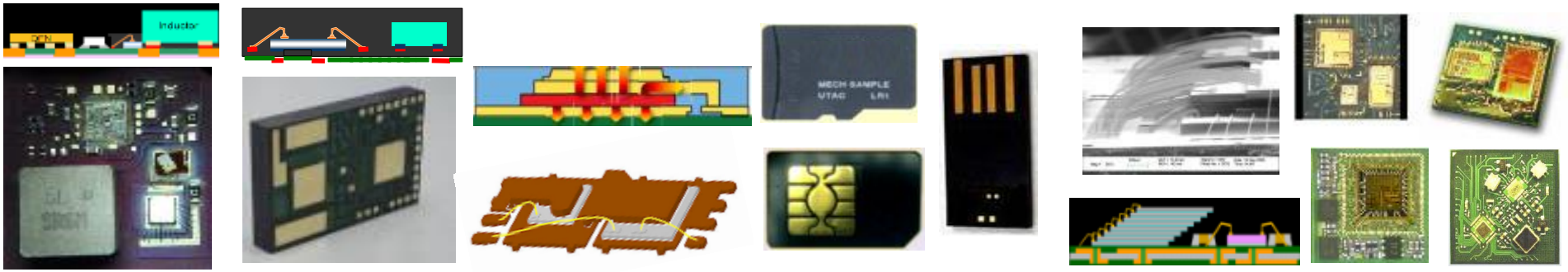
[Since 1973, 640k sq ft, Auto & Security certifications.]

QFN, GQFN, LGA, MIS, MEMS, Power QFN with Cu Clip

UTAC Shanghai, China (USC)

[90k sq ft, WGQ Free trade zone, Focus - Asia customers]

QFN, FBGA, LGA, MIS



AT&S – a world leading high-tech PCB company

High-End Interconnection Solutions
for
Mobile Devices, Automotive, Industrial, Medical Applications

Continuously
Outperforming market growth

3
in High-End Technology worldwide

€ 762.9m
Revenue in FY 2015/16, 5.2% organic growth

9,165
employees

One of the
most profitable Players in the Industry:
EBITDA margin of 22%
in FY 2015/16

1
manufacturer in Europe

Cost-competitive production footprint with
6
plants in Europe and Asia

AT&S at a glance & global footprint

BU AIM Headquarters
Plant Leoben, Austria
Headquarters
Staff: ~ 950
Customer Orientation:
9% Automotive
91% Industrial

AT&S AG
Headquarters
Leoben, Austria

BU AIM
Plant Fehring, Austria
Staff: ~350
Customer Orientation:
44% Automotive
56% Industrial

BU AIM
Plant Nanjangud, India
Staff: ~1.100
Customer Orientation:
60% Automotive
40% Industrial

BU MS
Plant Chongqing, China
Staff: ~1800

BU MS
Headquarters
Hong Kong, China

BU AIM
Plant Ansan, Korea
Staff: ~280
Customer Orientation:
13% Automotive
47% Industrial
40% Mobile Devices

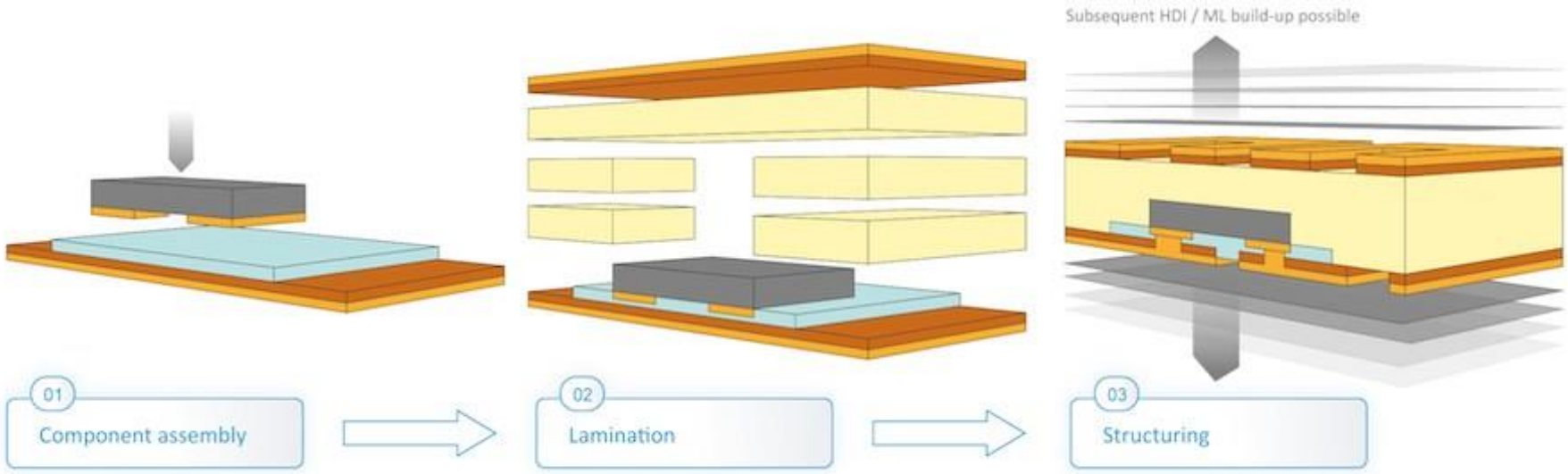
BU MS
Plant Shanghai, China
Staff: ~4600
Customer Orientation:
84% Mobile Devices
14% Automotive
2% Industrial

- AT&S AG Headquarters
- Sales Offices /Representations
- Business Unit Mobile Devices & Substrates (BU MS)
- Business Unit Industrial & Automotive (BU IA)

ECP® Basics – What's ECP®

AT&S ECP® - Embedded Component Packaging

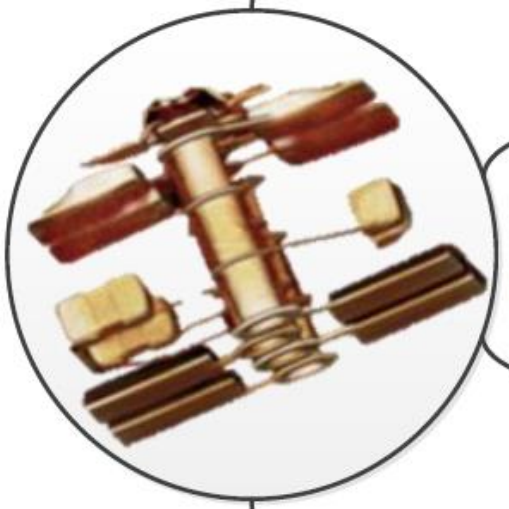
ECP® (**E**mbedded **C**omponent **P**ackaging) uses the space in an organic, laminate substrate (Printed Circuit Board) for active and passive components integration



Components embedding into the PCB core with copper plated microvia connections

ECP® Basics – Keyfacts

AT&S ECP® - Embedded Component Packaging



Components

- Active and/or passive components
- Copper surface on IO‘s
- Thickness 100µm - 350µm
  - In development: 80 – 500µm

Interconnection

- Laser drilled microvias
- Galvanic copper plating
- HDI PCB processes

Build-up

- PCB material and processes
- Various combination of stack-ups possible

Advantages

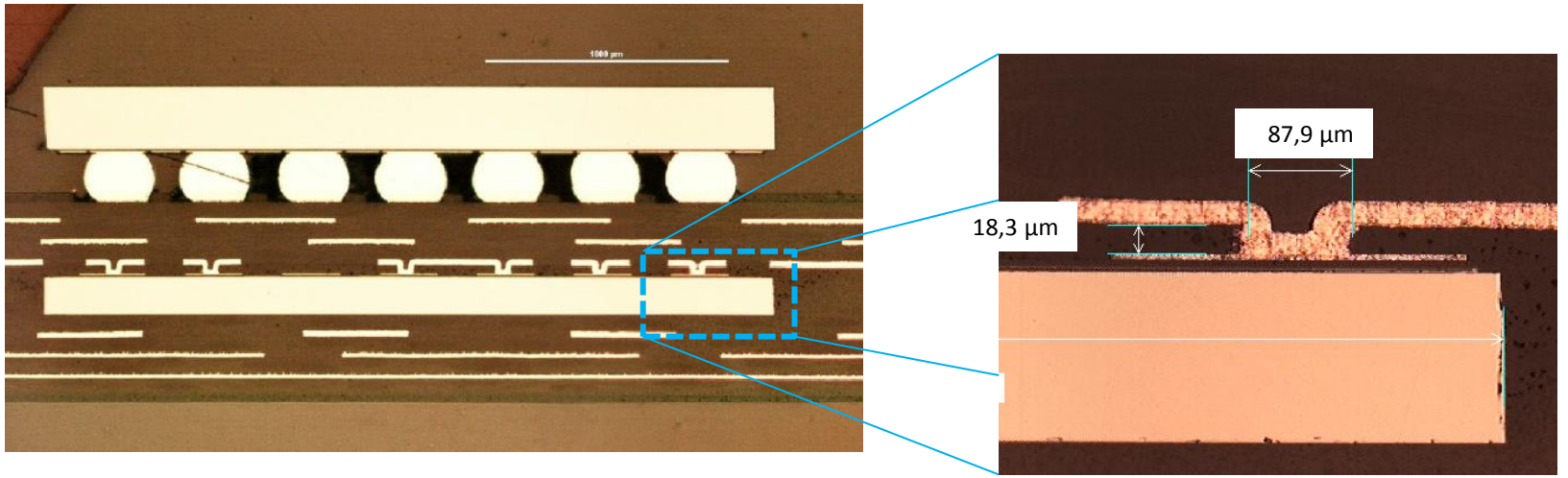
- Miniaturization
- Reliable interconnection
- Performance
- Protection of components

Product Illustrations

X-section of embedded devices

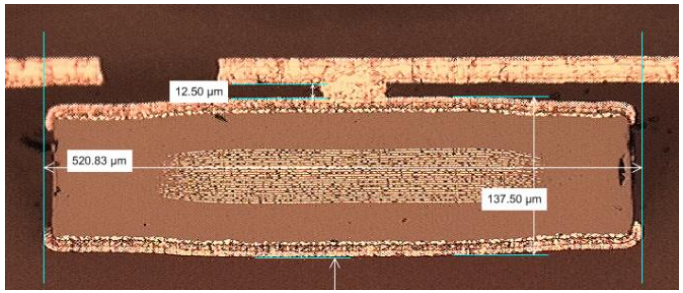
SMT CSP

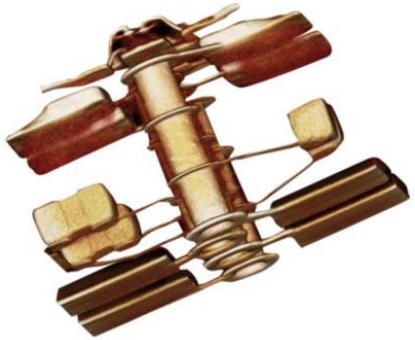
PCB with embedded IC



For interconnection, same technology and processes as for HDI/microvia PCBs!

Embedded passives





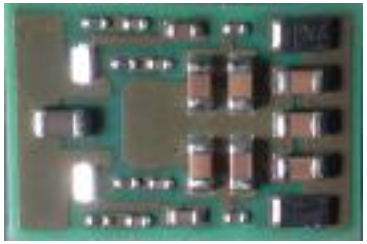
CT image of embedded caps in a 4 layer PTH board)

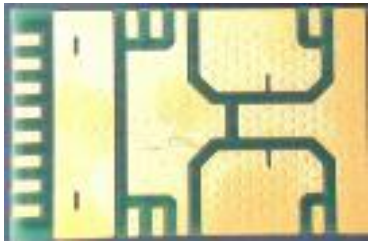
Application Examples

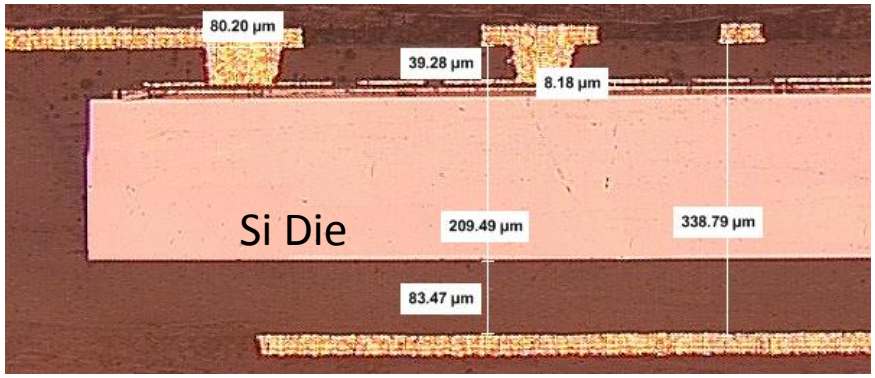
Package Type: 4.5 x 7.2mm LGA-SIP
Highlights: 2 embedded die + 24 passive components on substrate top side

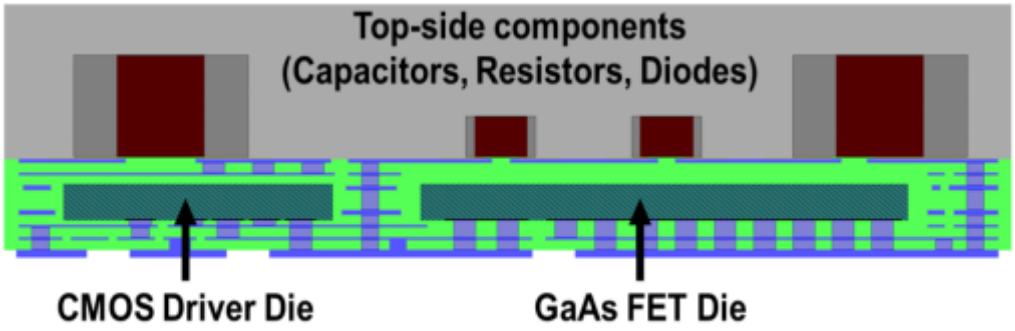
Package size / Type	4.5 x 7.2 mm LGA-SIP
Substrate Thickness	560 um ± 10% 320um core
Die thickness	200 um Max.
Surface finish (Die DAP)	Electrolytic NI/AU
Surface finish (Land Pad)	Electrolytic NI/AU
# of Passive Component (Top of substrate surface)	24ea Passive
Component Sizes	Passive 10ea 01005, 10ea 0402, 4ea 0201.
# of embedded chip	2
Strip Size	188x64mm
Substrate Metal layer	4 Layer

Assy Layout







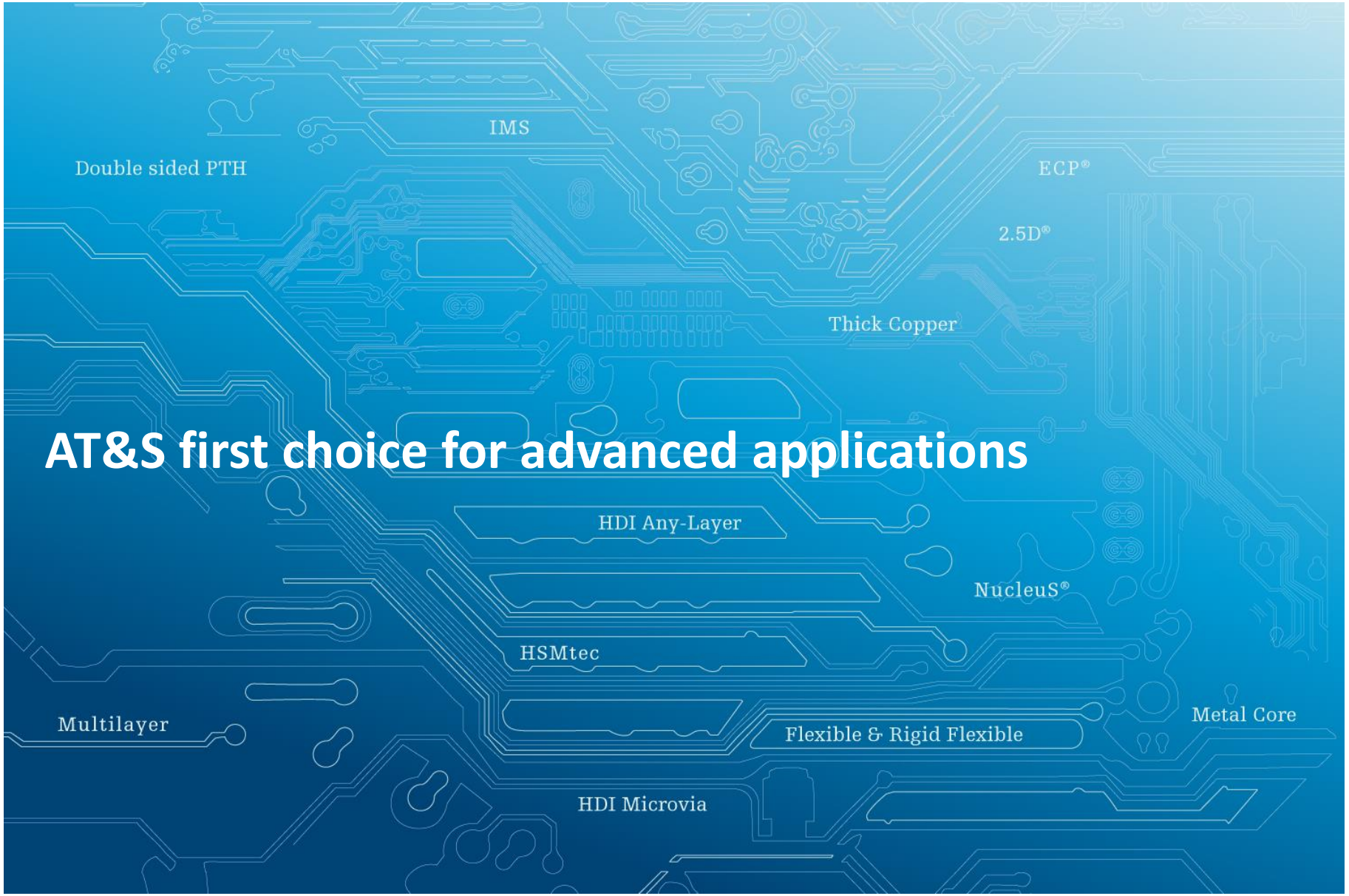


Courtesy of Sarda Technologies, Inc.

UTAC & AT&S Collaboration

Summary

- System in a package (SiP) is a strategic focus area for UTAC and AT&S
- 3D SiP with Embedded Chip provides integration, size and performance benefits over 2D planar SiP solutions
- 3D Embedded Chip technology adoption is accelerating in Power and High Density Interconnect Applications
- Supply chain collaboration for emerging 3D SiP solutions with embedded chip technology will advanced the technology and provide full turnkey (FTK) supply solutions for customers.
- Flexible business models available to fit to customer requirements



AT & S Austria Technologie & Systemtechnik Aktiengesellschaft | Fabriksgasse13 | A-8700 Leoben
Tel +43 (0) 3842 200-0 | E-mail info@ats.net
www.ats.net