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Automotive and AI: System Integration & Innovation in IC Packaging

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ASE Europe, ASE Group
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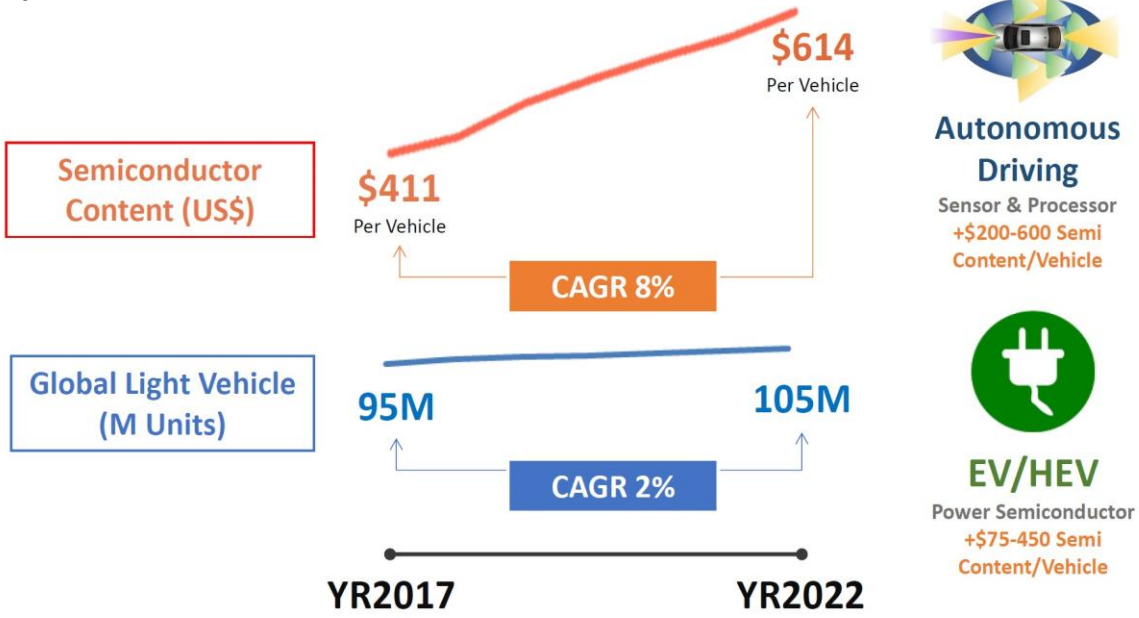
Opportunity and Challenge for automotive IC

- Global auto electronics revenue reached $134B in 2018 and is expected to grow at 6% CAGR in the next few years. Powertrain and ADAS are the 2 fastest growing applications, driven by electrification, EV, and autonomous driving mega trend.

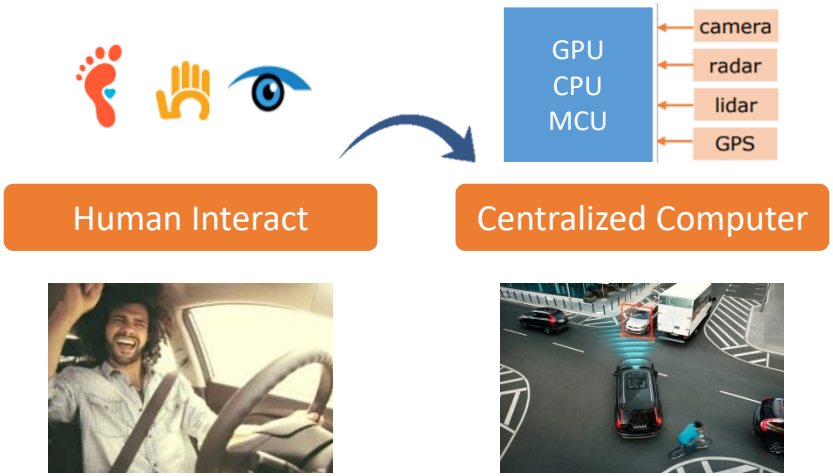
- Both ATV OEM and Tier-1 are facing increasing margin pressure due to automotive market slow down, high tech R&D and capex requirement for new technologies like ADAS and EV.

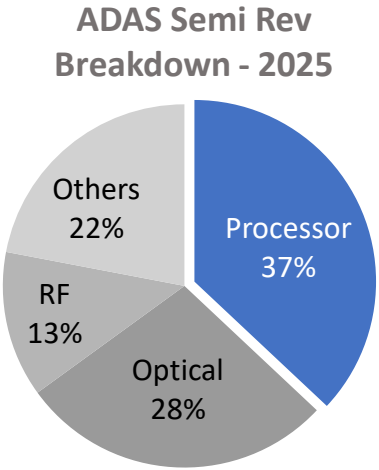


Source: I'HS Gartner, *ASE Estimation 2017

Autonomous Driving Drives Architecture Shift

- Autonomous vehicle car semi TAM will reach >$5Bn by 2022
- Processor content from $100 (ADAS) to $1000 in autonomous vhicles

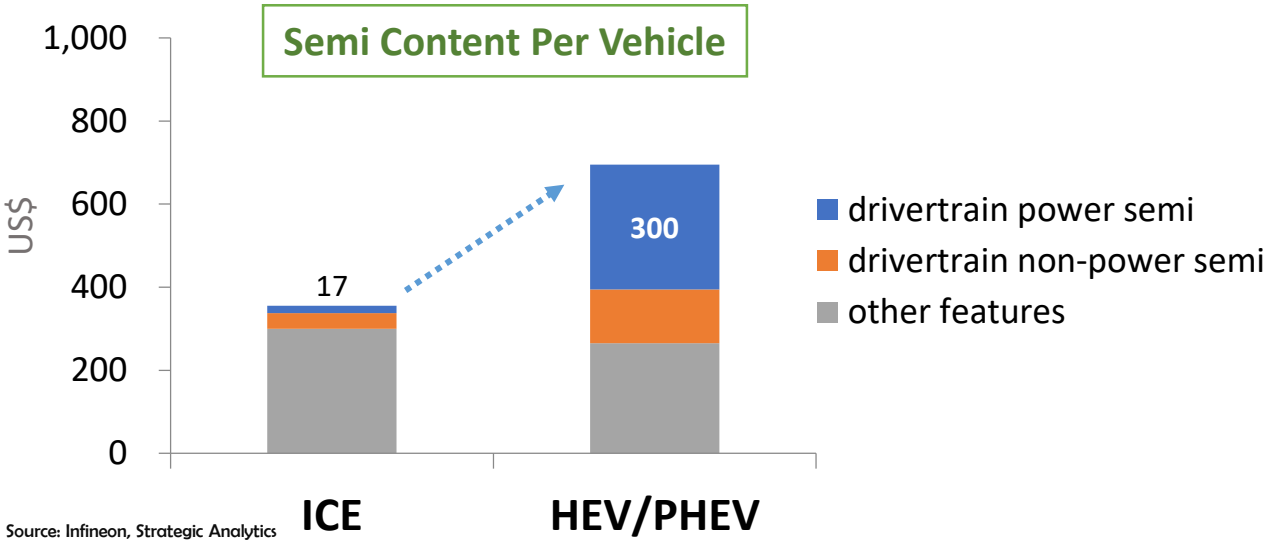




Source: Mckinsey

EV/HEV Drive Power Semiconductor

- Accelerating pure EV growth due to regulation
- Innovative packaging/ module solution
- Zero Defect manufacturing



Source: Infineon, Strategic Analytics

Package Need in Automotive

- **Driving Force: Electrification, Autonomy, connectivity, Comfort.**
- **7% CAGR for automotive sales. Around 30% growth for OSATs used in automotive packaging.**
- **Power applications need more power in the same footprint, thus development of a higher power density is crucial, and so thermal management becomes more important.**
- **For many applications, electronic devices are outside of the cabin in a harsher working environment e.g. high temperature and high humidity, and so reliability becomes a critical factor.**

Infotainment/Comfort	Powertrain	Safety	Lighting	Connectivity
				
Grade 3 and 2 -40°C to +105°C	Grade 1 and 0 -40°C to +150°C	Grade 1 -40°C to +125°C	External: grade 1 -40°C to +125°C Internal: Grade 3 and 2 -40°C to +105°C	Grade 3 and 2 -40°C to +105°C

Source: Yole, 2019

ASE Group Product coverage in Automotive Electronics

Safety
- Airbag Control Module
- Airbag Crash Sensors
- Event Data Recorder

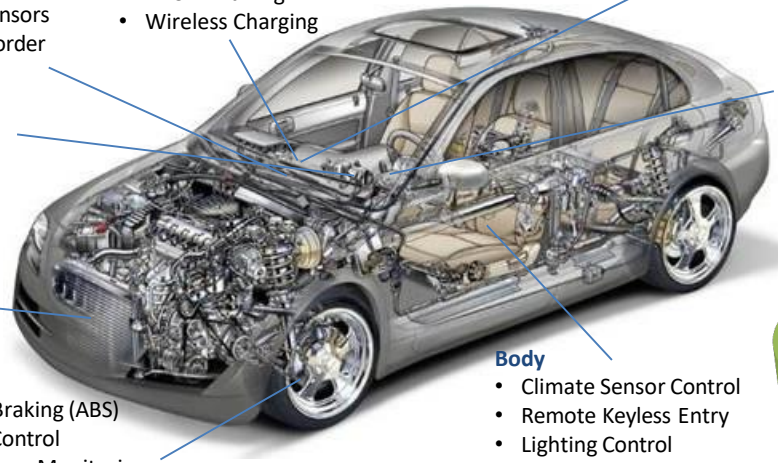
Infotainment
- Fixed Navigation Systems
- Rear Seat Entertainment
- NFC BT Pairing
- Wireless Charging

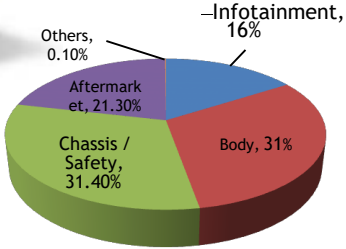
Powertrain
- Engine Control Module
- Transmission Control Module

Instrumentation
- Instrument Cluster
- Head-Up Display

Aftermarket
- Portable Navigation Devices
- Audio Head Units
- Video Recorders

ADAS
- ADAS Control Module
- Camera Modules
- Sensor Modules
- V2X Communications





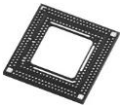
Chassis
- Antilock Braking (ABS)
- Stability Control
- Tire Pressure Monitoring
- Steer/Brake-by-Wire

Body
- Climate Sensor Control
- Remote Keyless Entry
- Lighting Control
- Position / Angle Sensors
- Electronic Control Units

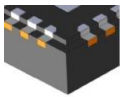
SOP
Grade

LQFP, TQFP
Grade 0

SQFN
Grade 1



aQFN
Grade 2



Wettable QFN
Grade 1

BGA
Grade 1

Open Cavity
QFN 1

FCCSP
Grade 1

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Modularization/SiP Trend

Infotainment

- Audio Head Units
- Fixed Nav. System
- Infotainment Head Units
- Rear Seat Entertainment

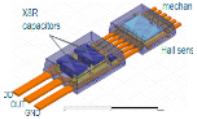
Body

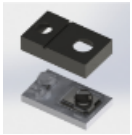
- Climate Control
- Remote Keyless Entry
- Lighting
- Electronic Control Units

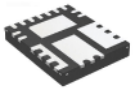
ADAS

- ADAS Control Module
- Camera Modules
- Sensor Modules
- V2X Communication

Automotive System-in-Package







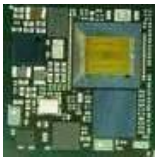
Power

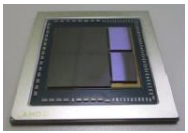
Sensors

ASE
ATV
SiP

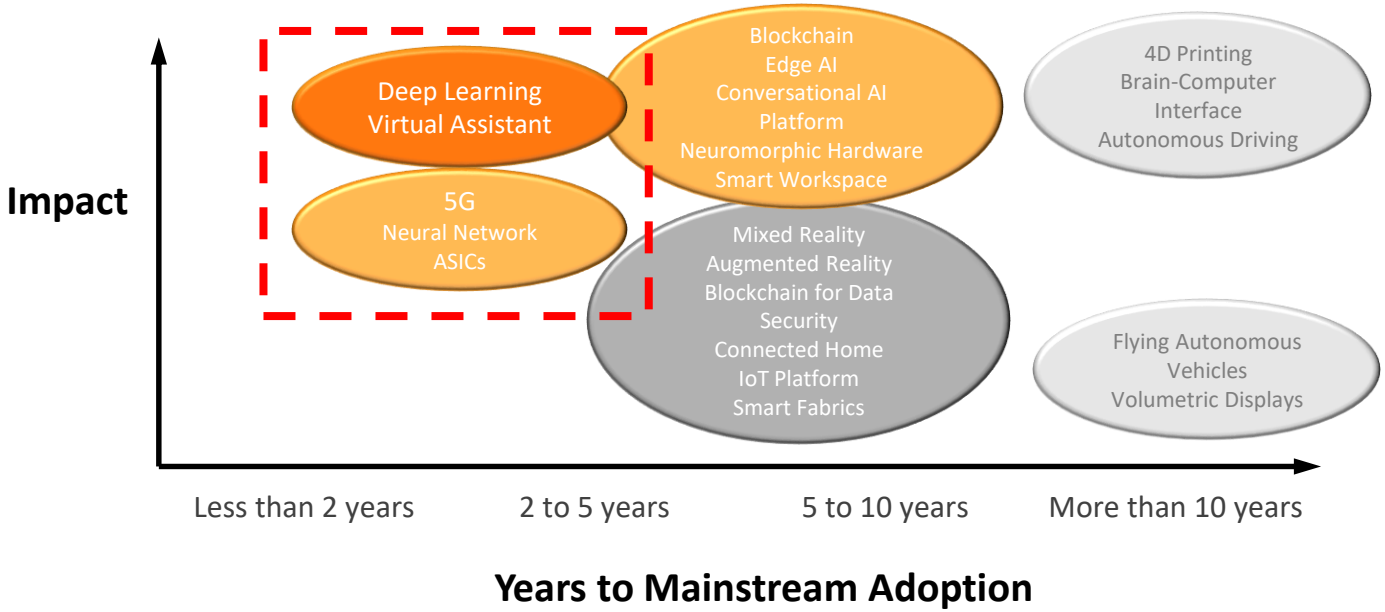
RF connectivity

Computing - AI





Emerging Technologies – Maturity



Source: Priority Matrix for Emerging Technologies 2018, Gartner

At the Edge: rising demand for integrated solutions

IoT and Cloud create the need for edge computing where data collecting & processing occurs in part at the network edge, rather than completely in the cloud.

Edge devices must manage complex operations, including sensing, compute, power management, and localized AI.

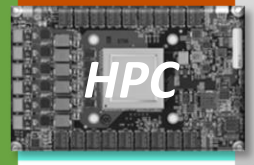
Edge compute can address latency, battery life, bandwidth costs, security, privacy, to allow timely decision & 1st level data analysis.

Heterogeneous integration provides a platform for multiple die from multiple sources to be packaged together, offering huge performance, power and footprint advantages.

At the Core: growing need for processing power

Power delivery innovation is needed to address increasing SOC / AI accelerators & power consumption: optical solutions provide high bandwidth bridge within AI solutions.

Processor memory integration saddled by memory bandwidth bottleneck: possible solution is SOC HBM packages such as CoWoS, EMIB, 2.5D.



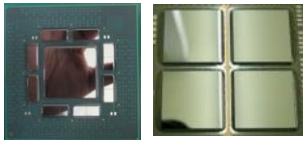
AI accelerators such as TPUs and neural ASICs enable the industry to have a comprehensive AI ecosystem.

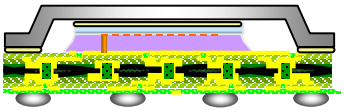
Skyrocketing data volume demands dramatic increase in processing power and performance, achievable through new innovation in technology integration.

HPC Package Integration Solutions

FCBGA MCM

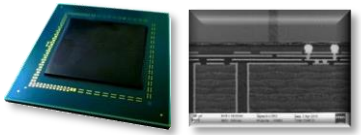
- Interconnection through substrate
- D2D Interconnection: ~1K
- L/S 10/10
- Max qualified pkg size: 75x70 FCBGA
- Min die to die gap: 60 um

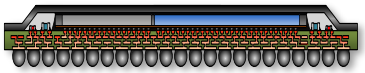




FOCoS

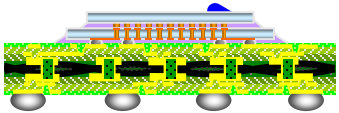
- Interconnection through fanout RDL
- D2D Interconnection: ~10K
- L/S 2/2
- Max fanout die size: 26x33
- ASIC+HMB: Engineering
- Chip last solution for > 3 die fanout



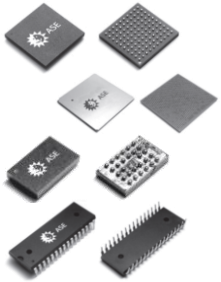


2.5D

- Interconnection through silicon
- D2D Interconnection: ~100K
- L/S 0.4/0.4
- HBM; Hetero/ Homogeneous die partition
- Interposer: 1400mm2
- Available on cavity lid, stiffener and



Group Synergies Leading to Disruptive Innovation



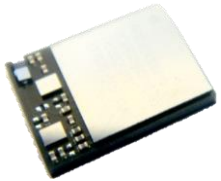
Advanced packagin
for semiconductor IC

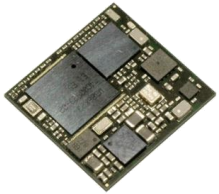
USI

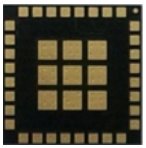
PCBA, module assembly
and system assembly

Smartest package solution
for IoT, mobile, ATV etc… !

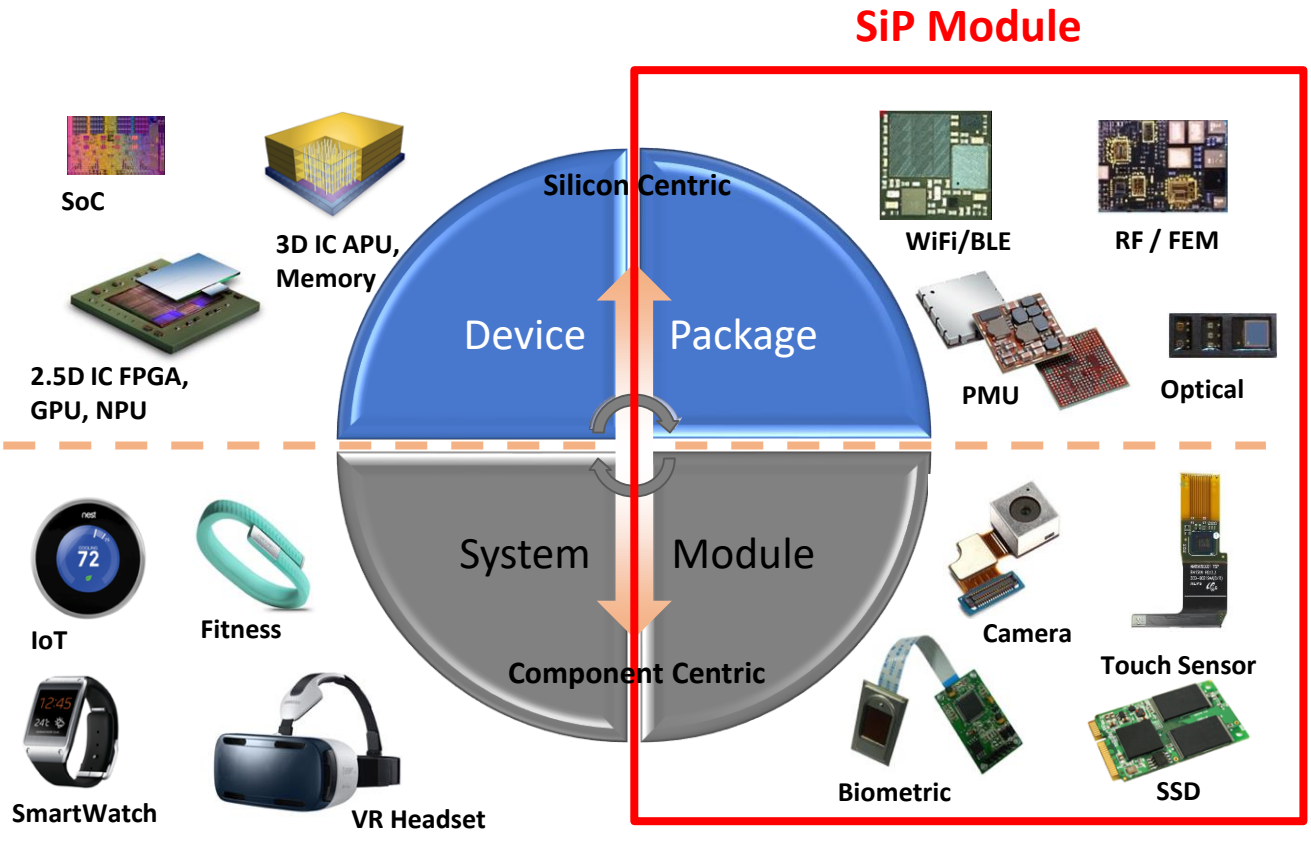
SiP / SiM with HD integration







Device Integration: Bridging OSAT & EMS



Enabling Technologies for SiP/SiM

ENG
HVM
Qualified

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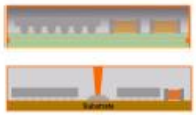
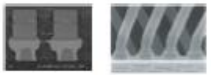
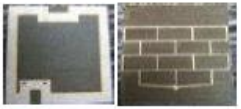


Shielding
- Conformal
- Compartmental



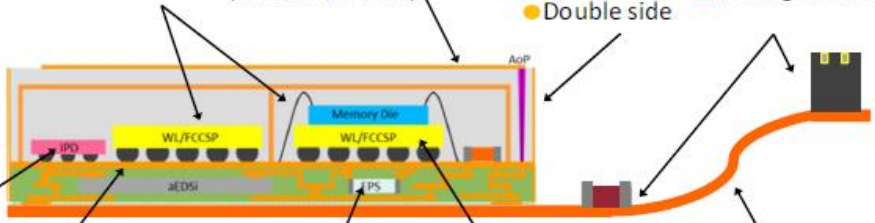
Interconnection
- Flip chip bond
- Wire bond



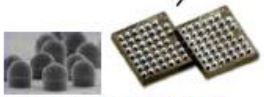
Antenna
- Package integration (2.4G/5G/60GHz)

Molding
- MUF
- Exposed die
- Double side

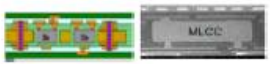
SMT
- Passives / IPD
- WLCSP / FC Die Bond
- Package Bond



Passives / IPD
- 0201 / 01005
- 008004
- Silicon IPD
- Glass IPD



Wafer Bumping / WLP
- Leadfree / Cu Pillar
- WLCSP
- FOWLP



Embedded Technology
- Passive component
- Active device (L/F)
- Active device (Sub.)
- SESUB

Die / Pkg Stacking
- Die thinning
- Die stacking
- Package stacking

Mechanical Assy
- Laser welding
- Flex bending

ASE SiP Package Solution Focus

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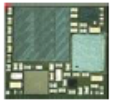
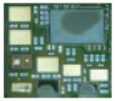


Connectivity

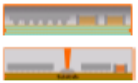


RF / FEM

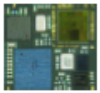
-Wearable
-Beacon
-LED & MESH Controller

BLE+MCU+AoP

DC-DC

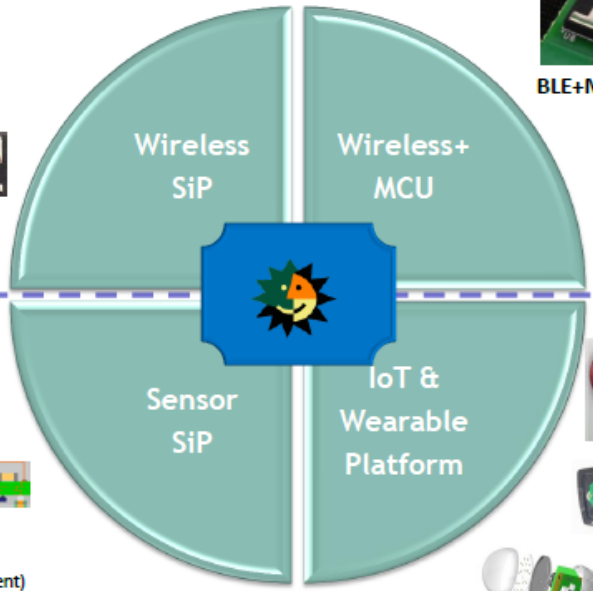


C/S, CPS, AoP



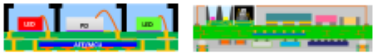
-Smart Home &
Home Automation
-In-Door Position & Navigation

WLAN+MCU



Sensor SiP for Personal

-RF+MCU+Sensors (Motion, Physiological)
-Application:
Personal Body Motion, Gesture & Physiological Sign Sensing

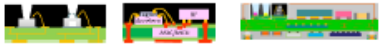


-Pedometer with BLE+MCU SiP
-Beacon with BLE+MCU SiP
-In-Door Navigation w/ BLE+MCU SiP

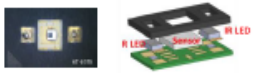
-ECG Strip by BLE+MCU SiP

Sensor SiP for Home

-RF+MCU+Sensors (Motion, Environment)
-Friendly Development Kit(Ardurion)
-Application:
Remote Security, Energy Harvest and White appliance remote control,
Indoor Position & Navigation, Elder/Children Telecare with Fall/Gait Detection

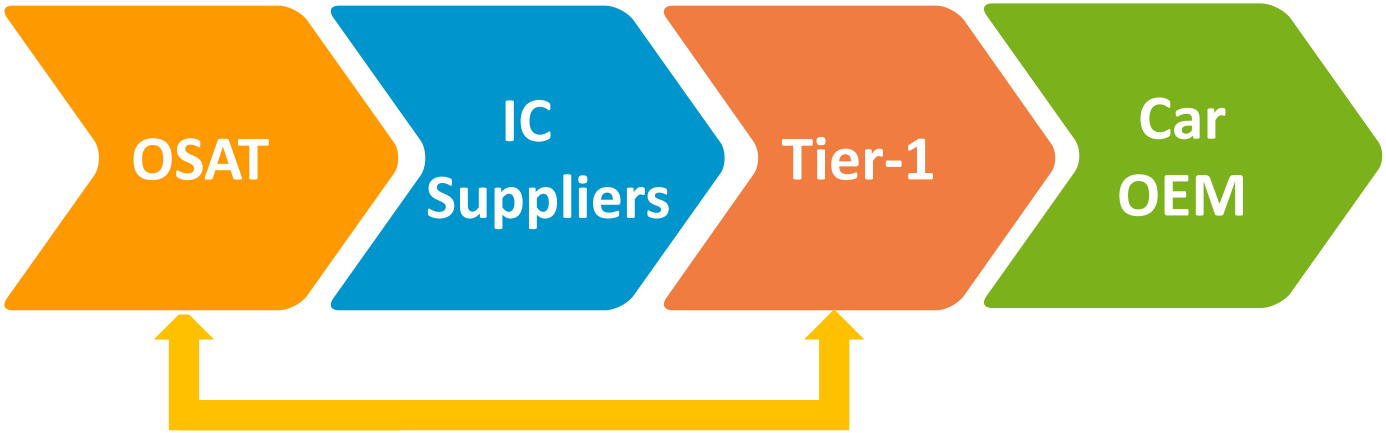


-Smart LED by BLE/WLAN+MCU MESH SiP



-HRM/SpO2 with MCU+Optical SiP

Food for Thought:
Supply Chain Consolidation



Innovation

Manufacturing Partners

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