

# INEMI Roadmap Webinar: Board Assembly

4 September 2025

Watch the webinar recording :

- YouTube: <https://youtu.be/IRgMTdwMpqk>
- Other video:  
[https://thor.inemi.org/webdownload/2025/Roadmap/Bd\\_Assembly\\_RM\\_090425.mp4](https://thor.inemi.org/webdownload/2025/Roadmap/Bd_Assembly_RM_090425.mp4)

Summary: Board assembly brainstorming session

[https://thor.inemi.org/webdownload/2025/Roadmap/Board\\_Assembly\\_Brainstorming.pdf](https://thor.inemi.org/webdownload/2025/Roadmap/Board_Assembly_Brainstorming.pdf)

Jasbir Bath, Bath Consultancy LLC  
Paul Wang, MiTAC

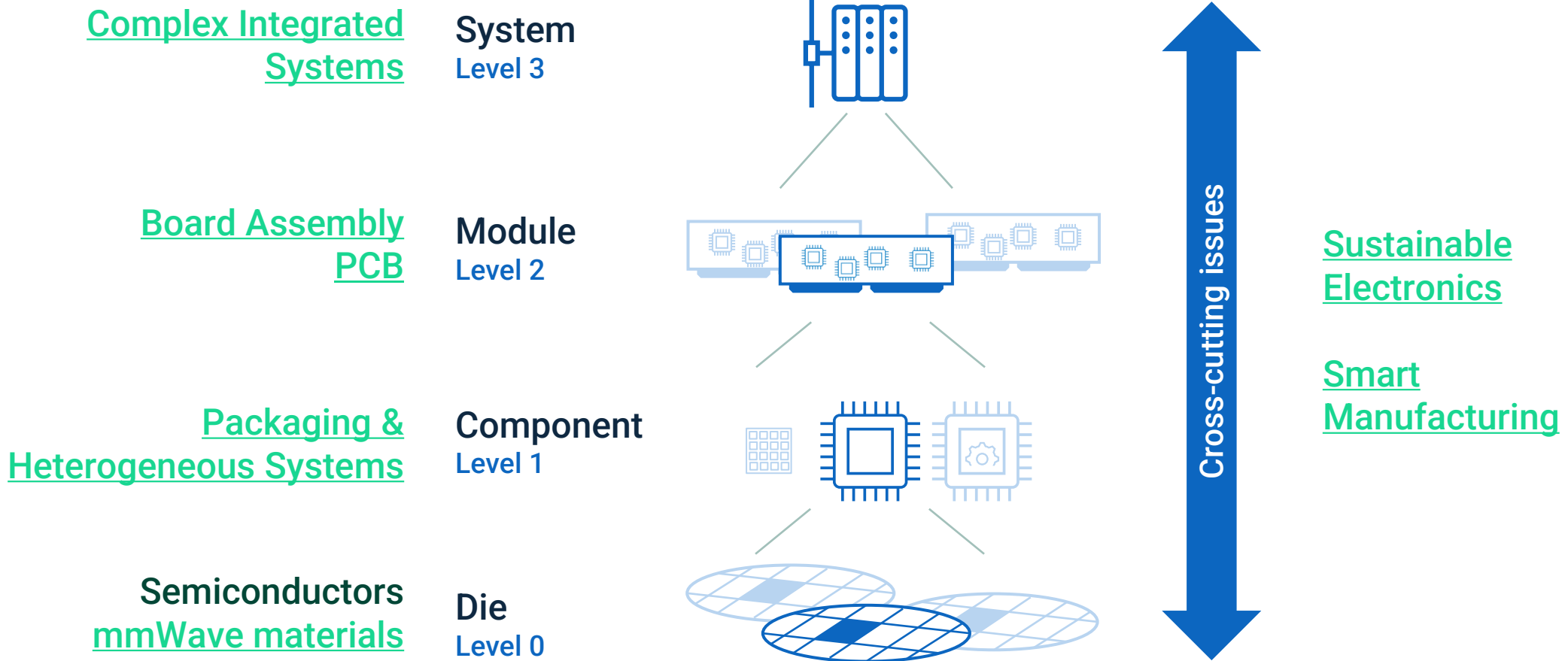


**INEMI**

CONNECTING MINDS  
ACCELERATING INNOVATION

# INEMI Roadmap: Technology Scope

Focus on Manufacturing and Supply-Chain Challenges



# Agenda

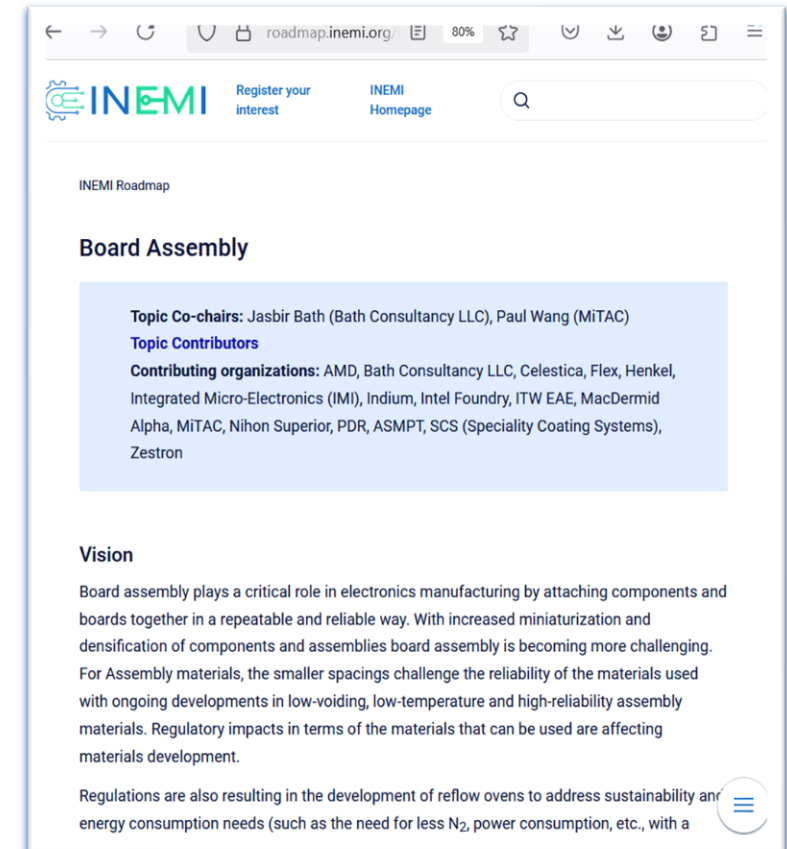
## Review of the INEMI Board Assembly Roadmap

- Published topics: Assembly Materials, SMT, Rework & Repair, CPU Socket Interconnect, and Press Fit
- Presenters:
  - Jasbir Bath, Bath Consultancy LLC
  - Paul Wang, MiTAC
- 45 min

## Brainstorm

- Focus on disruptive, long-term directions
- 15 min

<https://roadmap.inemi.org/ir/board-assembly>



The screenshot shows a web browser displaying the INEMI Board Assembly Roadmap page. The page header includes the INEMI logo, a search bar, and navigation links for 'Register your interest' and 'INEMI Homepage'. The main content area is titled 'INEMI Roadmap' and 'Board Assembly'. A blue box highlights the following information:

- Topic Co-chairs:** Jasbir Bath (Bath Consultancy LLC), Paul Wang (MiTAC)
- Topic Contributors**
- Contributing organizations:** AMD, Bath Consultancy LLC, Celestica, Flex, Henkel, Integrated Micro-Electronics (IMI), Indium, Intel Foundry, ITW EAE, MacDermid Alpha, MiTAC, Nihon Superior, PDR, ASMPT, SCS (Specialty Coating Systems), Zestron

Below this box, the 'Vision' section is visible, starting with the text: 'Board assembly plays a critical role in electronics manufacturing by attaching components and boards together in a repeatable and reliable way. With increased miniaturization and densification of components and assemblies board assembly is becoming more challenging. For Assembly materials, the smaller spacings challenge the reliability of the materials used with ongoing developments in low-voiding, low-temperature and high-reliability assembly materials. Regulatory impacts in terms of the materials that can be used are affecting materials development.'

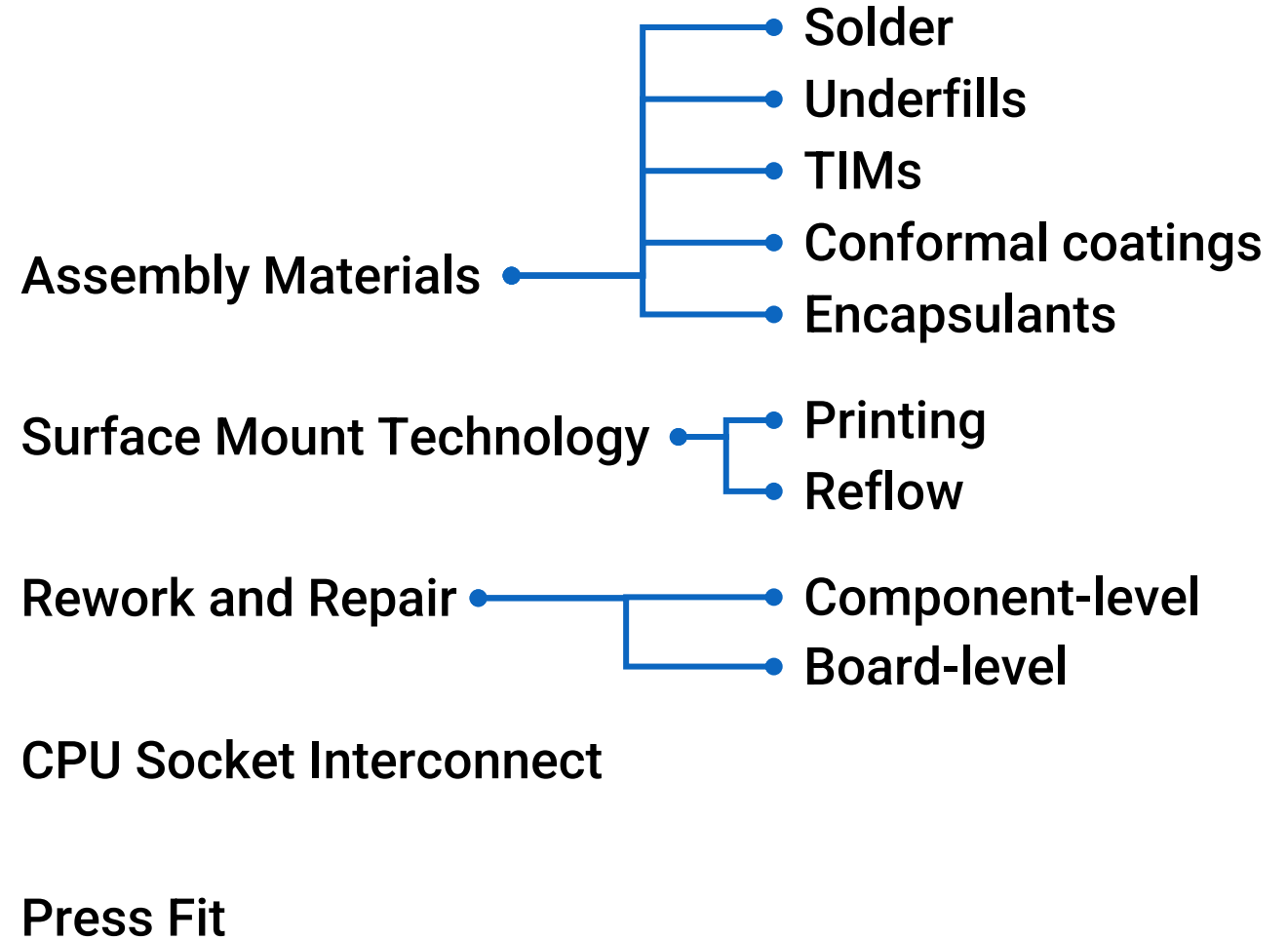
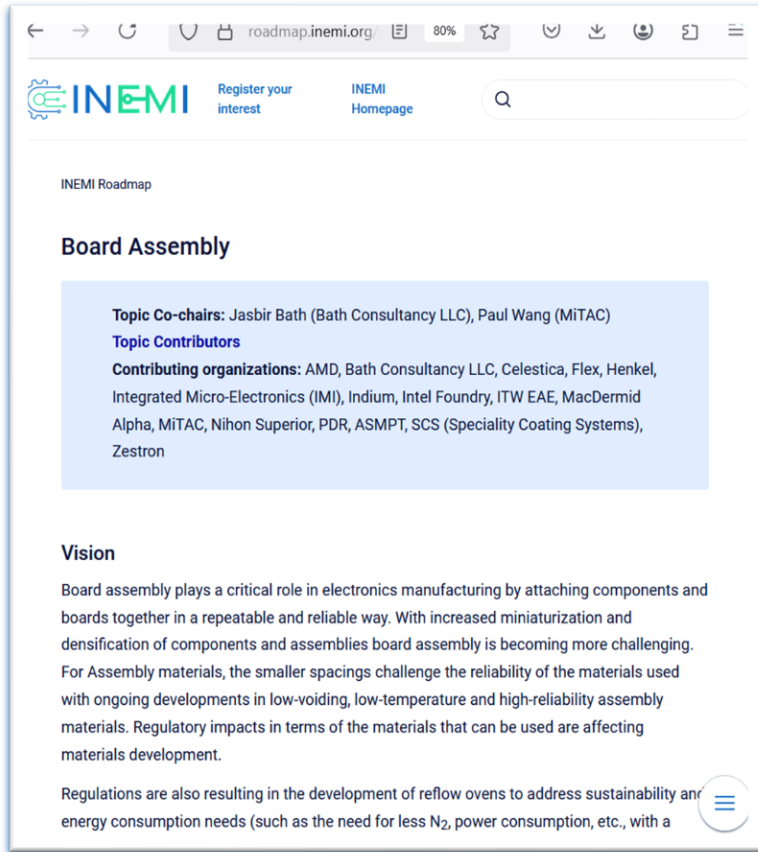
# Contributors

Name	Affiliation
Jasbir Bath (Co-chair)	Bath Consultancy LLC
Paul Wang (Co-chair)	MiTAC
Raiyo Aspandiar	Intel Foundary
Romulo (Moly) Castillo	Integrated Micro-Electronics (IMI)
Oscar Diaz	Flex
Gerjan Diepstraten	ITW EAE
Dave Edwards	Henkel
Keith Howell	Nihon Superior
Tim Jensen	Indium
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Jeff Schake	ASMPT
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Keith Sweatman	Nihon Superior
David White	PDR
Dennis Willie	Flex

# Board Assembly Roadmap

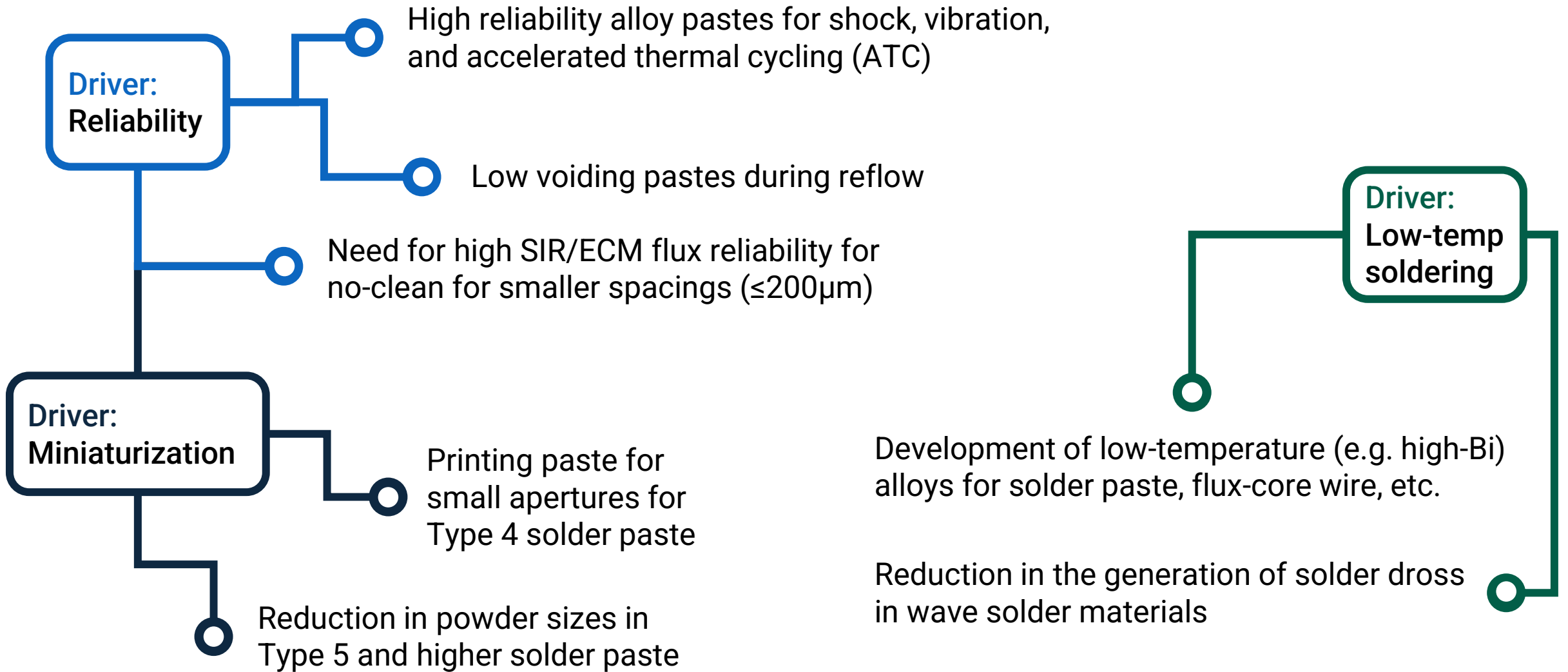
<https://roadmap.inemi.org/ir/board-assembly>





## ASSEMBLY MATERIALS

# Assembly Materials: Solders



# Assembly Materials: Conformal Coatings

Driver:  
Miniaturization

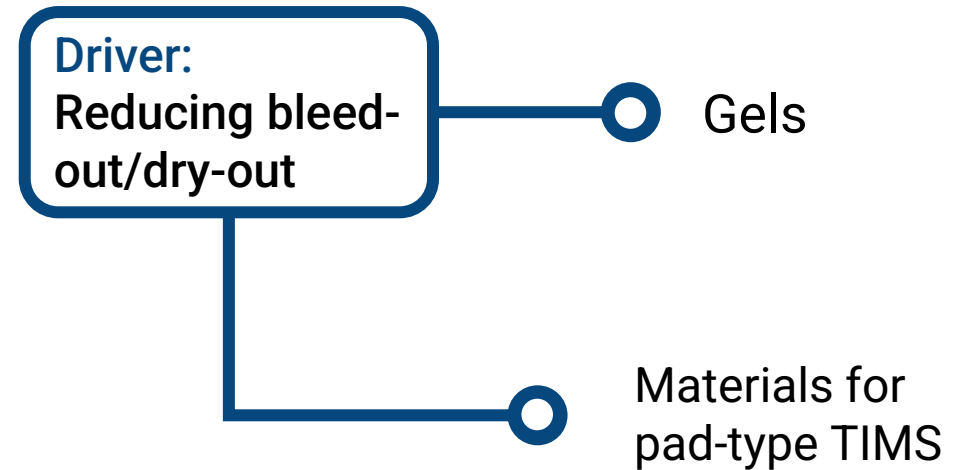
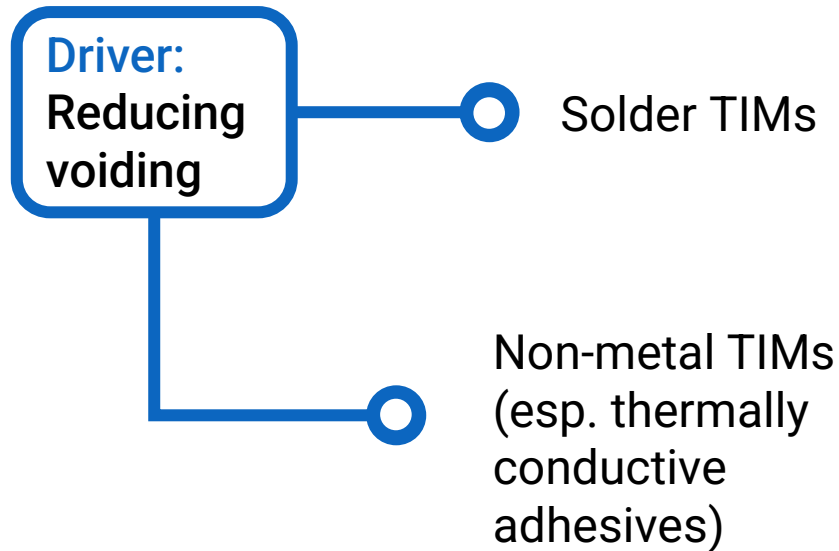
Need more uniform conformal coatings for the low thicknesses

Driver:  
Sustainability

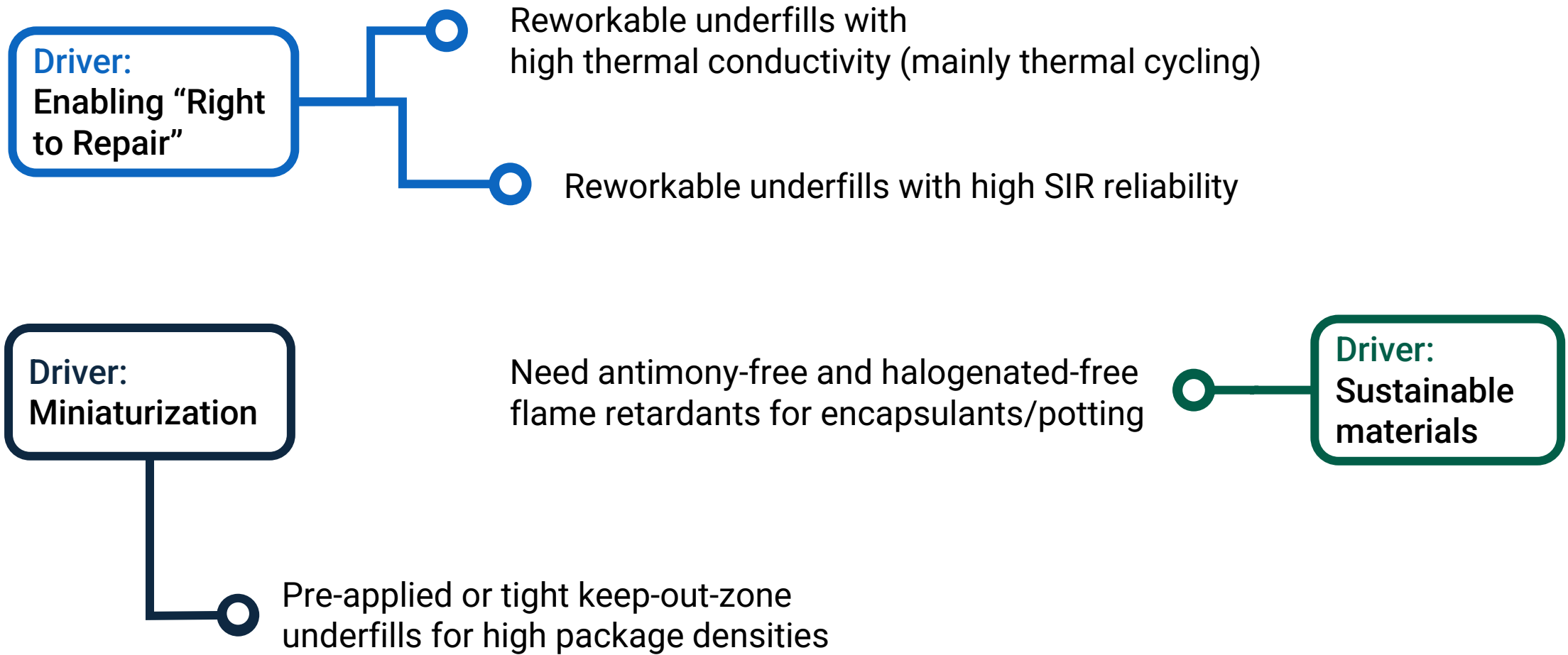
Need non-fluorinated high temperature conformal coatings, substituting for PFAS materials

Need commercial non-silicone conformal coatings that can withstand 150°C to 175°C (for automotive applications)

# Assembly Materials: Thermal Interface Materials (TIMs)



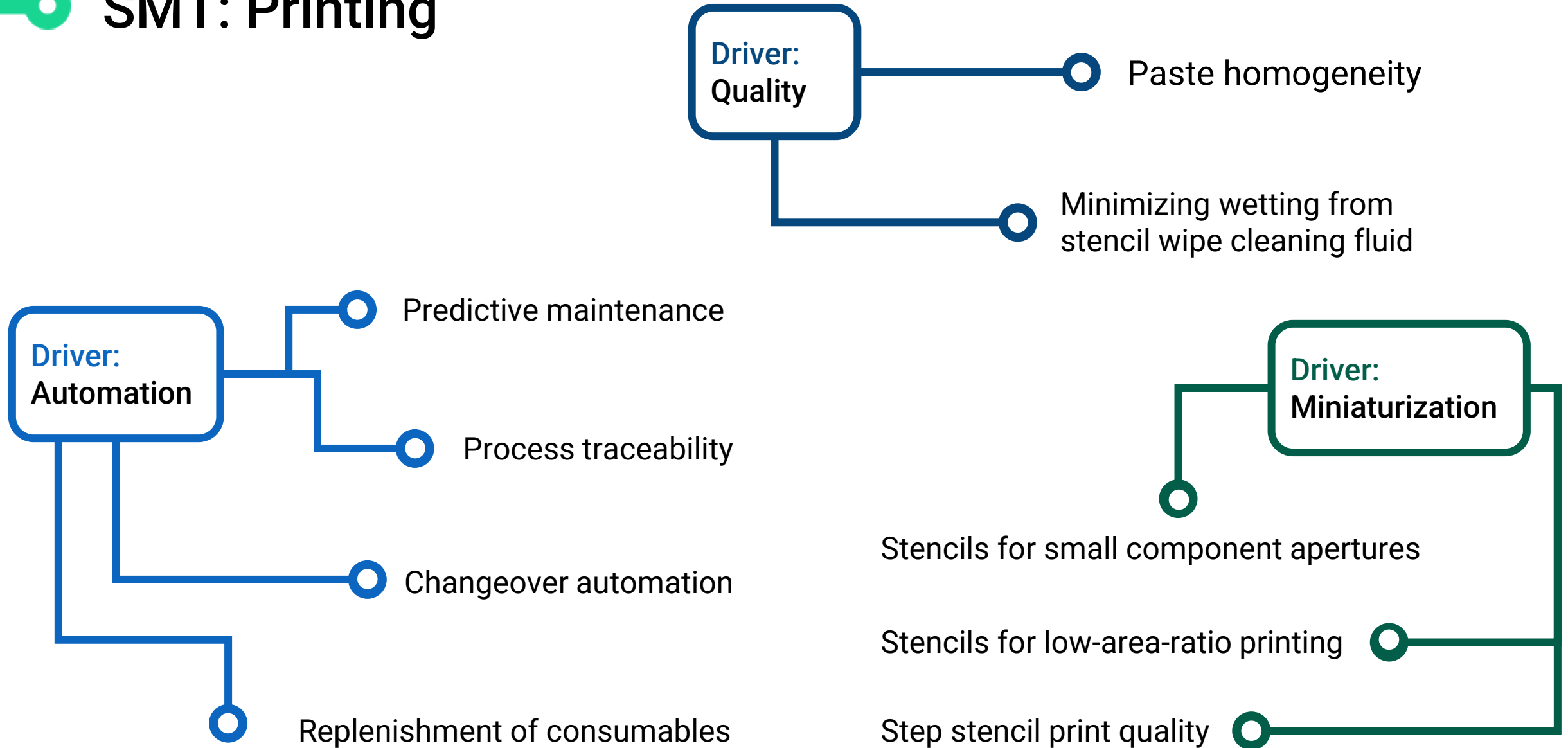
# Assembly Materials: Underfills and Encapsulants





## SURFACE MOUNT TECHNOLOGY

# SMT: Printing



# SMT: Reflow

**Driver:**  
Reduced  
maintenance

Improved flux collection and extraction

Equipment capable of using different flux materials to reduce maintenance intervals.

**Driver:**  
Larger  
components

Heating large-sized components

Addressing  $\Delta T$  between large and small components

**Driver:**  
Increased  
throughput

Faster conveyors + longer multi-zone ovens

**Driver:**  
Reduce  
operational costs

Need more efficient heating and reduced temperature loss while maintaining production volumes

Standardization of oxygen level used in oven, enabling reduced  $N_2$  consumption.



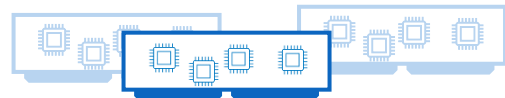
**REWORK AND REPAIR**

# Rework and Repair: Needs and Challenges

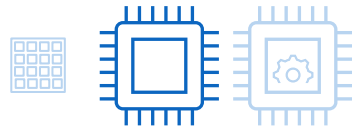
System  
Level 3



Module  
Level 2



Component  
Level 1



Die



## Challenges

- Mirror-imaged components on top and bottom sides
- Boards with both very large and very small components
- Increased density of components
- Single-piece RF shields
- Temperature-sensitive components
- Fine-pitch and small components

**ROADMAP TIMEFRAME**

**TECHNOLOGY  
ISSUE**

**COMPONENT-LEVEL ISSUE #6: BGA socket and SMT connector rework (high input/output (I/O) and fine pitch and temperature related issues for connector plastic body)**

**COMPONENT**

**NEEDS**

- **Need less warpage of the component: Materials development for component. Warpage becomes worse as socket size increases and socket height decreases.**
- **Single site rework will require higher thermal limit connector/ socket materials.**

**NEED**

**BGA socket sizes: 100-120mm sockets, 9000 I/O, 2.5-3mm socket height**

**BGA socket sizes: 130mm sockets, 10000 I/O, <2mm socket height**

**BGA socket sizes: 150mm sockets, 150000 I/O, <1.5mm socket height**

**CURRENT  
TECHNOLOGY**

**CURRENT  
TECHNOLOGY  
STATUS**

**Solutions need optimization**

As parts get bigger, it will become more critical to have higher temperature plastic

on sides  
components

# Rework and Repair: Solutions



## Design for Manufacturing

- Design rules
- Design software
- Thermal modelling for DfM



## Equipment

- Improved thermal management equipment
- X-ray inspection
- Specialized reball equipment
- Mini-stencils, dippable solder paste



## Productivity

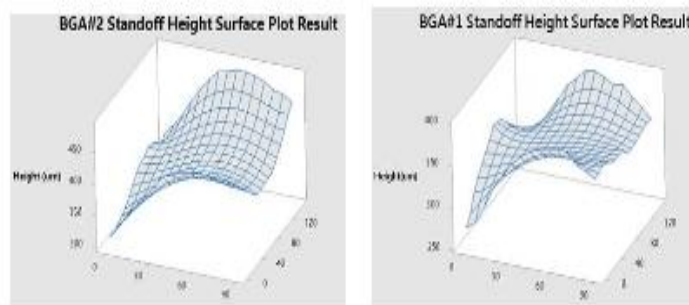
- Training programs for BGA/BTC rework
- Automation of rework processes
- Improved component data (e.g. internal structures, materials)



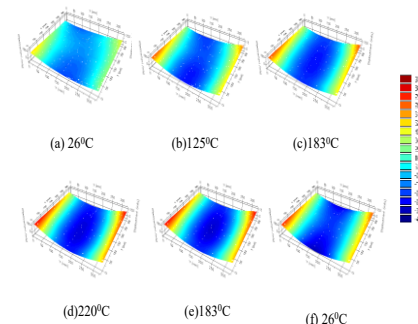
## CPU SOCKET INTERCONNECT

# Soldering integrity from socket interposer vs. DSA

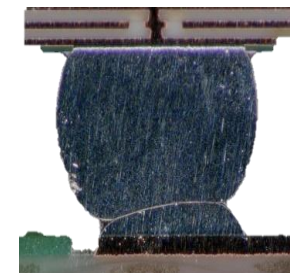
- Socket Interposer vs. Direct-Solder Attach (DSA) Interconnect
- 3-D contour plot of solder bump standoff indicated large impact from correlated warpage of package and PCB.
- The consequence of this substantive large correlated warpage from package induce large soldering defect such as head-in –pillow (HiP) or solder bridge.
- As contrary to the “compliance/buffer effect” from socket interposer.



BGA and PCB correlated warpage in DSA case

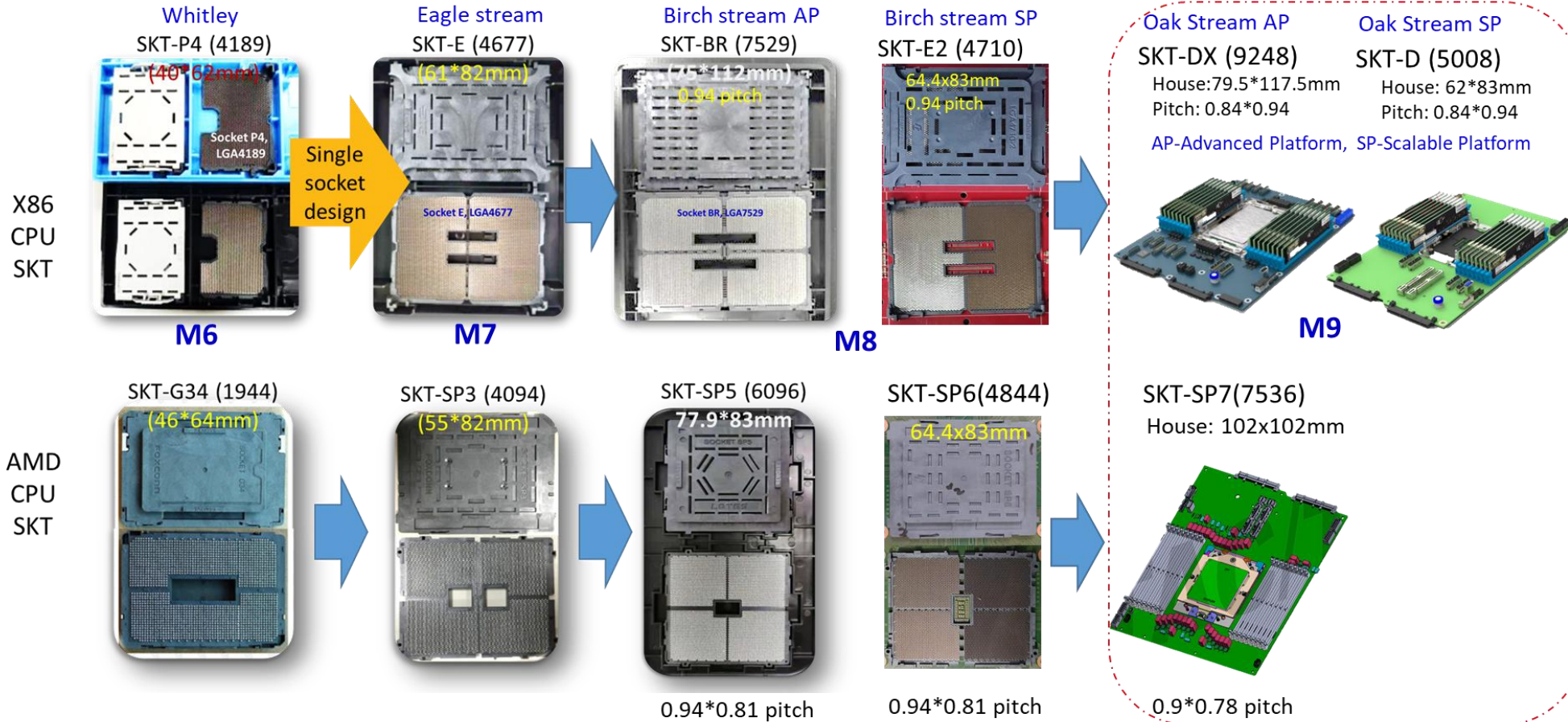


Dynamic warpage of PCB by Moiré



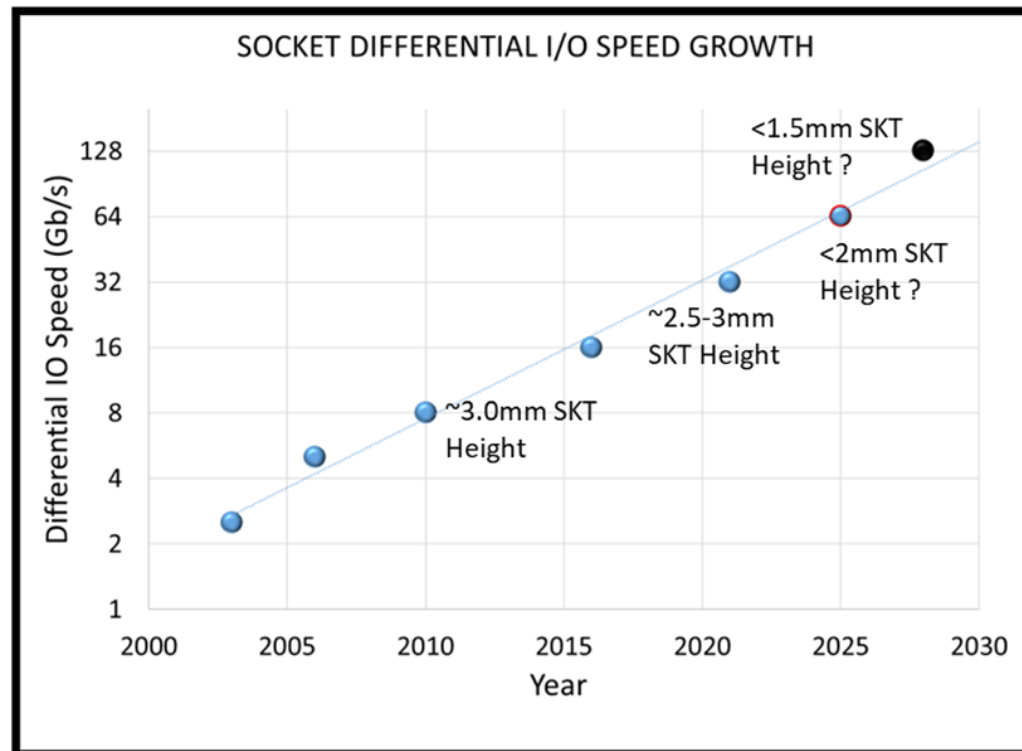
HiP

# Server CPU Socket Interconnect Development Roadmap



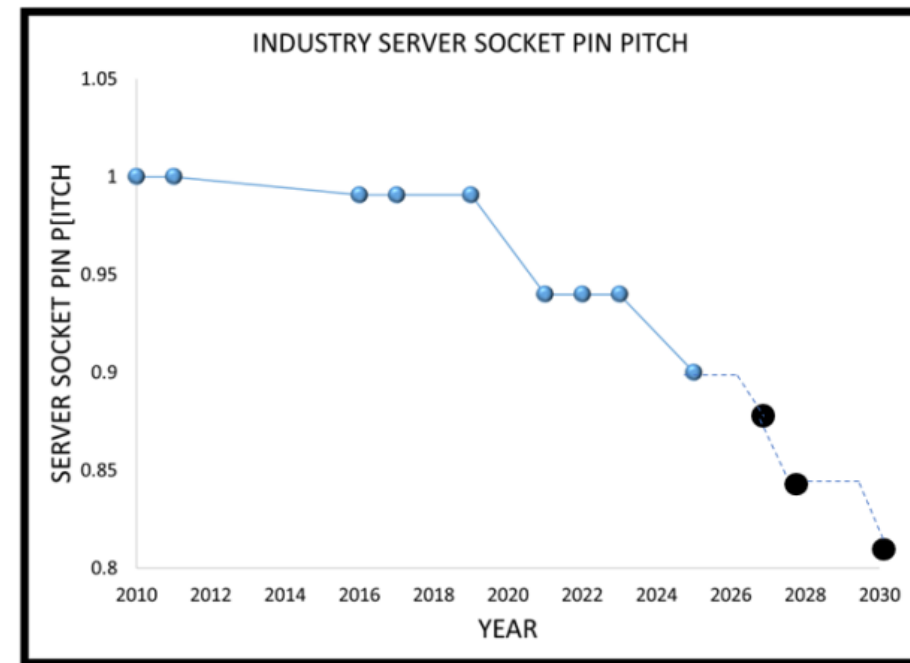
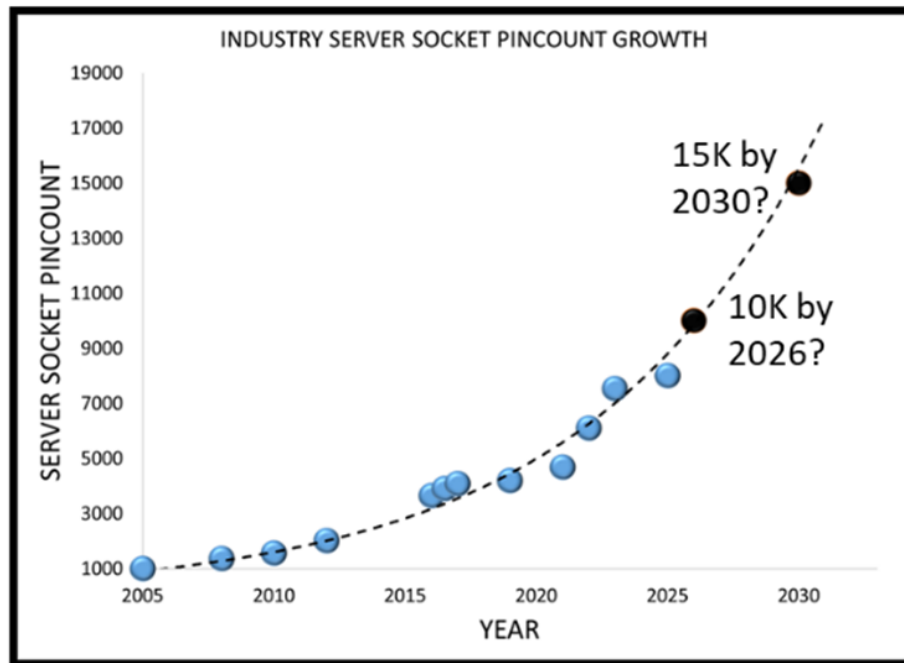
# INEMI CPU Socket Technology Roadmap

- Exponential increase in data speed rate ( 32 to 128Gb/s) forcing lower socket height (2.5 to 1.5mm) over next 10 years
- Induce potential warpage issue in LGA (solder bridge and HiP)



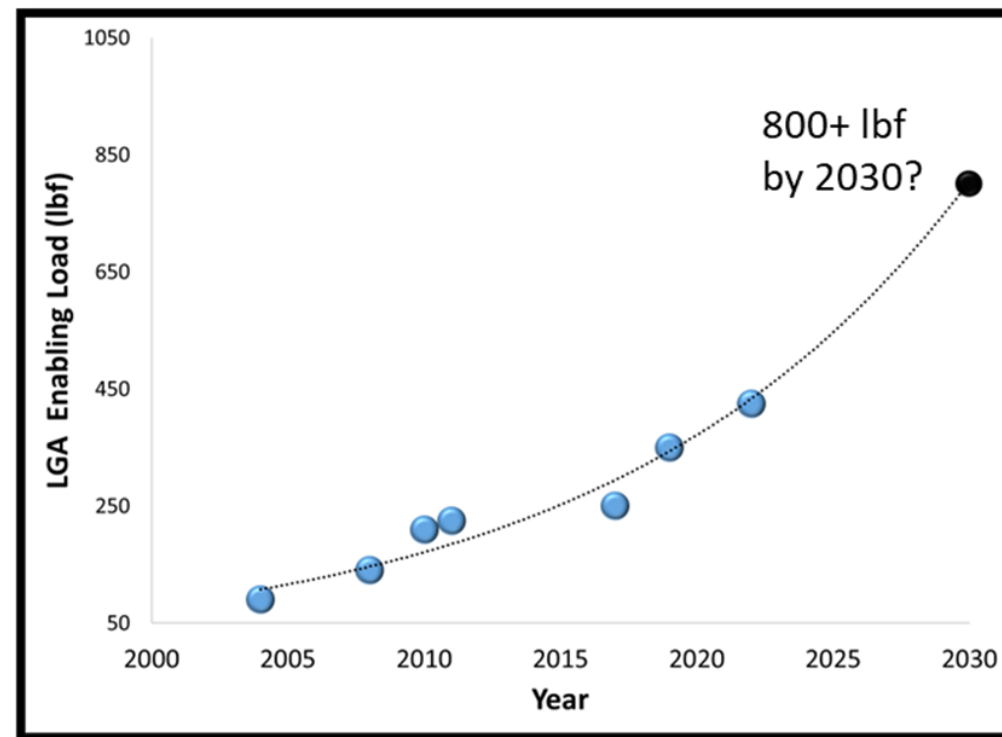
# INEMI CPU Socket Technology Roadmap

- Exponential increase in data speed rate ( 32 to 128Gb/s) will drive higher computer power, memory and I/O signaling bandwidth over time
- Socket pin count drastically increase from 6500 to 15,000
- PCB pad pitch will drop from 1.0mm to 0.8mm by 2030

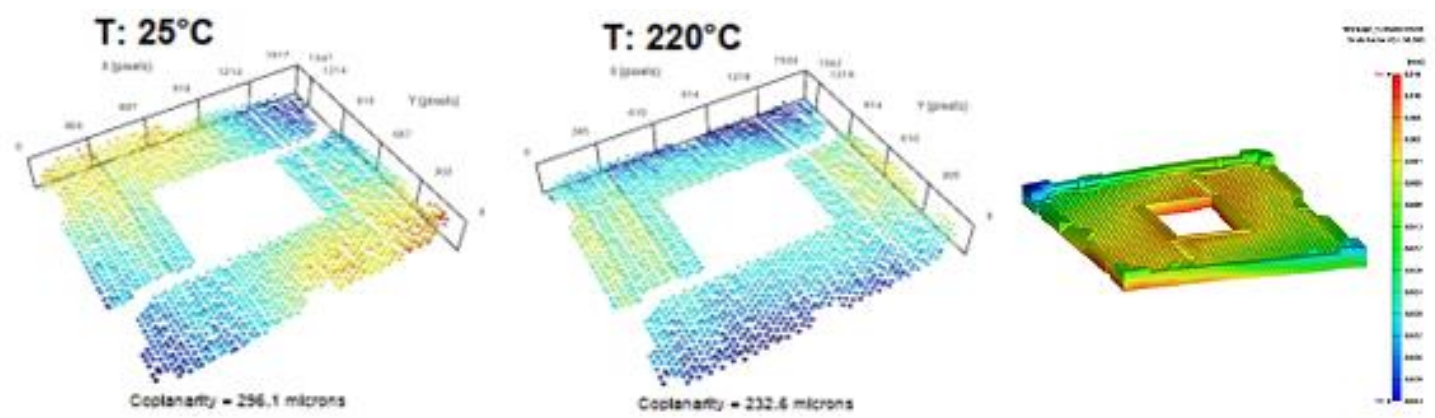
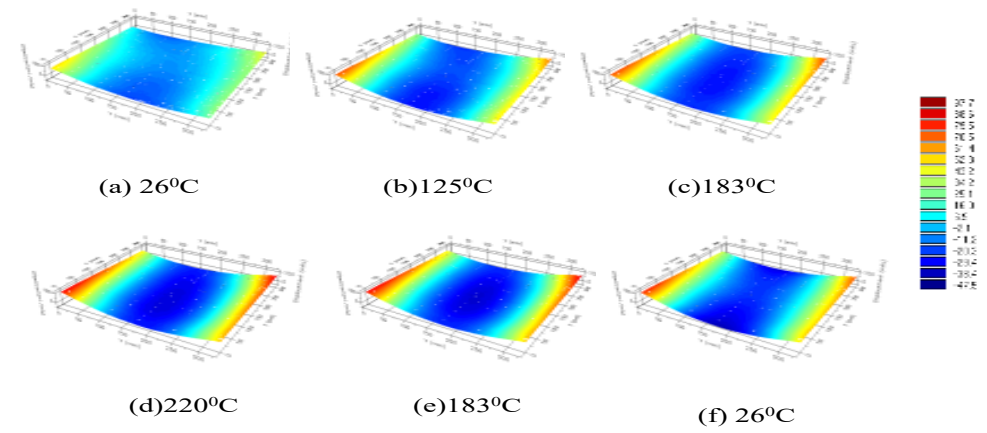


# INEMI CPU Socket Technology Roadmap

- Drastically increase in pin count will need to increase total mechanical load in insert CPU to socket to maintain higher signal fidelity and low contact resistance with the package

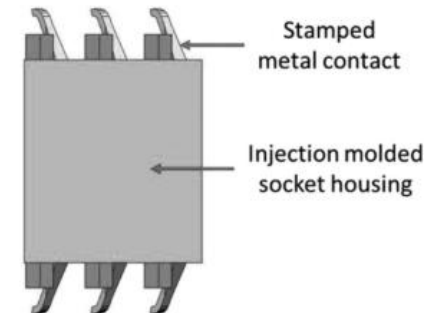


# Early-stage FEA Simulation And Moiré Emulation



# CPU Sockets Interconnect: Potential Solutions

- From current non-isotropic LCP to new socket material with more uniform CTE and lower  $T_g$
- Mixed signal and ground pin design
- Multi-piece socket to mitigate warpage issue
- Dual-compression interconnection, at CPU and PCB interfaces
- Process optimization and micro-T controllable mold design

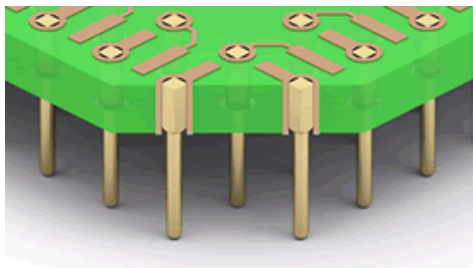




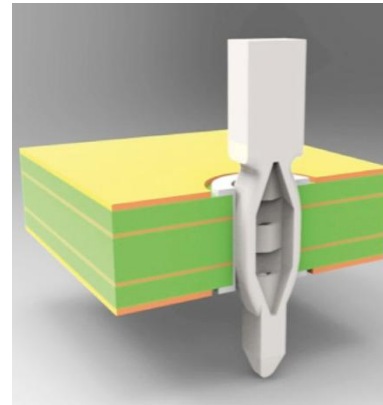
PRESS FIT

# Press-Fit Introduction

- Contact terminal pressed into plated through hole (PTH)
- Solid pin vs. compliant pin\*

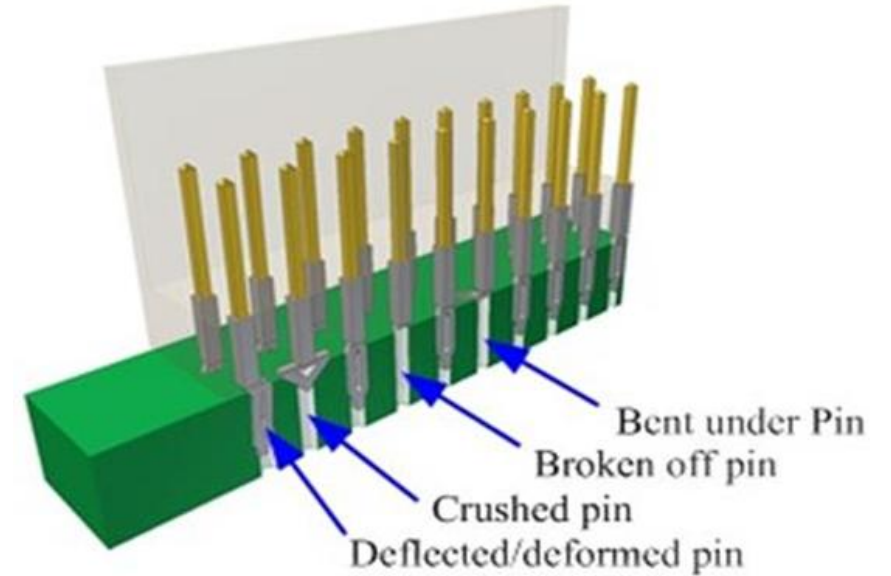


Solid pin



Compliant pin

\*TE Connectivity white paper  
 Joakim Mattsson, Thorsten Callies, Bart Kerckhof



- Press-fit process common defects

# Press Fit: Drivers and Technical Needs [1/2]

**Driver:**  
High speed connectors

Today, >25GHz; three years, >40GHz;  
five to ten years, transition to optical

Minimize EMI from protruding pins

**Driver:**  
Asymmetric-design PCBs  
with inherent warpage

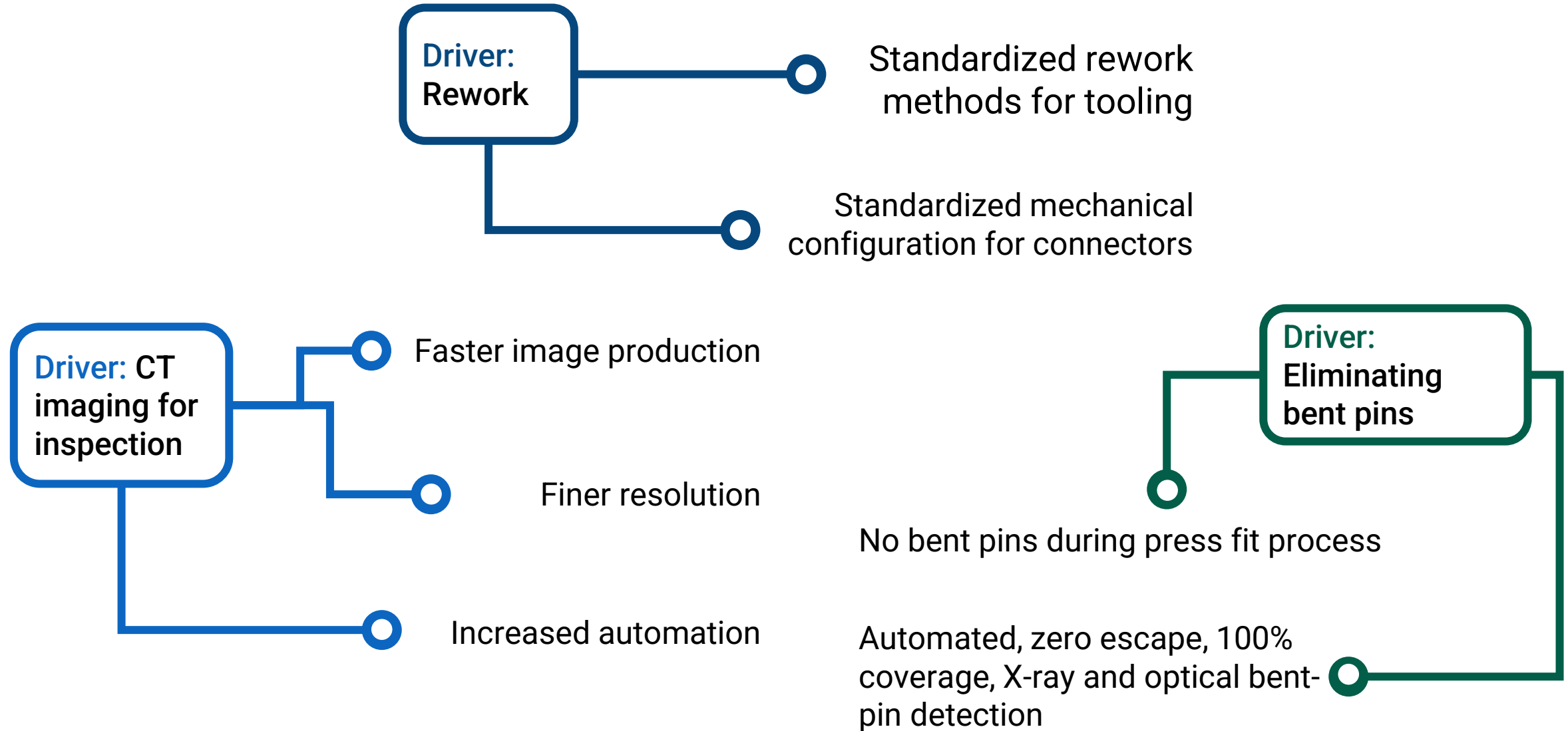
Need improved guaranteed pin retention force

**Driver:**  
Automation

Automated pick, inspect, place & press process with standardized package trays or feeders

Need standardized connector packaging, press methods and tool automation

# Press Fit: Drivers and Technical Needs [2/2]



# Press Fit: Connector Pin Acting As Antenna

Press-fit connector pin act as antenna during high-speed signal transmission creating electromagnetic interference (EMI) crosstalk

## Need in 2024:

Designs using shorter compliant pins to minimize antenna length, reducing crosstalk.

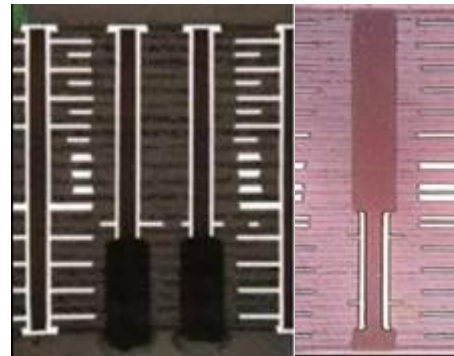
## Need in 2029:

Various length pins on a hybrid connector corresponding to PCB back drill depth pattern to eliminate crosstalk.

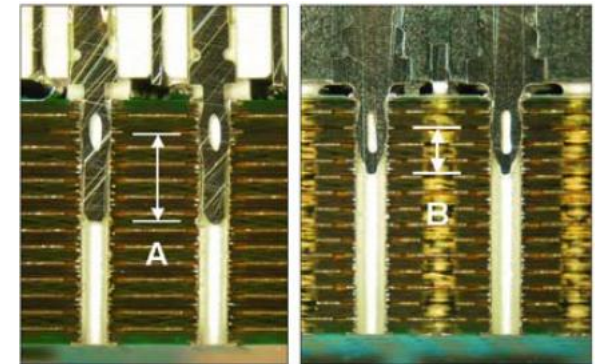
## Need in 2034:

Various length pins on a *customized* hybrid connector corresponding to PCB back drill depth pattern to eliminate crosstalk.

Overview of back drilling, Franz Gisin and Alex Stepinski



Back drilling example



Residue stub with various compliance pin lengths

TECHNOLOGY ISSUE	POTENTIAL SOLUTIONS	EXPECTED TRL LEVEL			
		TODAY (2023)	3 YEARS (2026)	5 YEARS (2028)	10 YEARS (2033)
<b>Issue #8: Press fit tail acts as an antenna during high signal transmission</b>	Back drilled holes and shorter compliant pins would be required to eliminate the antenna effects for high-speed circuits. There are still technical challenges such as the precision of the back drill depth. At the same time, the retention force should be maintained for the shorter pins.	2	4	6	8



## BRAINSTORMING: FUTURE DIRECTIONS

# Brainstorming

## Questions:

### In the 5- to 10-year time horizon:

- What will be the technical challenges for board assembly?
- What disruptive technology solutions might arise?

A [link](#) is also in the chat.



# Board Assembly Roadmap Publication Schedule

**Release 1  
4Q24**

Assembly  
Materials

Surface Mount  
Technology

Rework and  
Repair

Press Fit

CPU Socket  
Interconnect

**Release 2  
4Q25**

Component  
Placement

Wave-  
Selective  
Soldering

**Release 3  
2026**

Long-Term  
Disruptions

If you wish to be part of the team,  
please contact [fmullany@inemi.org](mailto:fmullany@inemi.org).

# Opportunity: Co-chair of the Board Assembly Roadmap

The INEMI Board Assembly Roadmap maps out the key drivers, needs, challenges and technology solutions for the future of

- assembly materials
- SMT
- rework and repair
- press fit and CPU socket technology

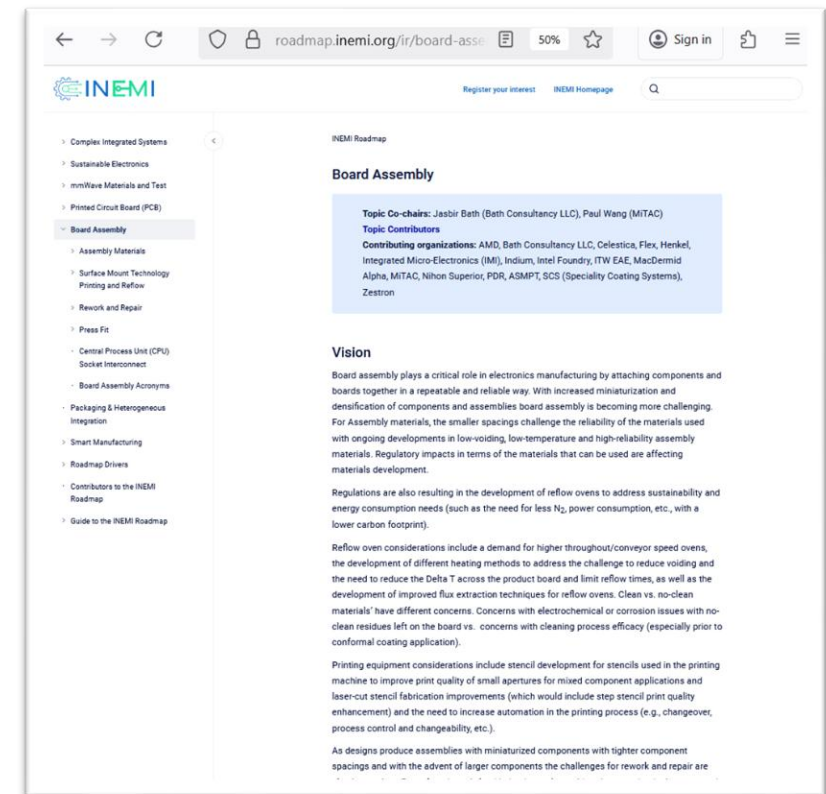
with on-going work in wave-selective soldering and part placement.

We are looking for one or two new co-chairs to help lead and expand the contributor team, provide strategic technical direction, and chair technical discussions.

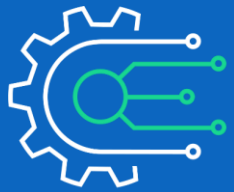
Commitment level: Roughly 5 to 10 hours a month.

This is a career growth and networking opportunity to lead a roadmapping effort that is unique in the industry.

<https://roadmap.inemi.org/ir/board-assembly>



Contact [fmullany@inemi.org](mailto:fmullany@inemi.org) if you or a colleague might be interested in this role.



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## WHERE TO FIND MORE INFORMATION

### Website

- [iNEMI Project information](#)
- [iNEMI upcoming events](#)
- [iNEMI Roadmap](#)

### Social

- [iNEMI TV on YouTube](#)
- Follow iNEMI on [LinkedIn](#)

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