Power Electronic Packaging, Co-Design and Reliability

Yong Liu, Corporate R & D

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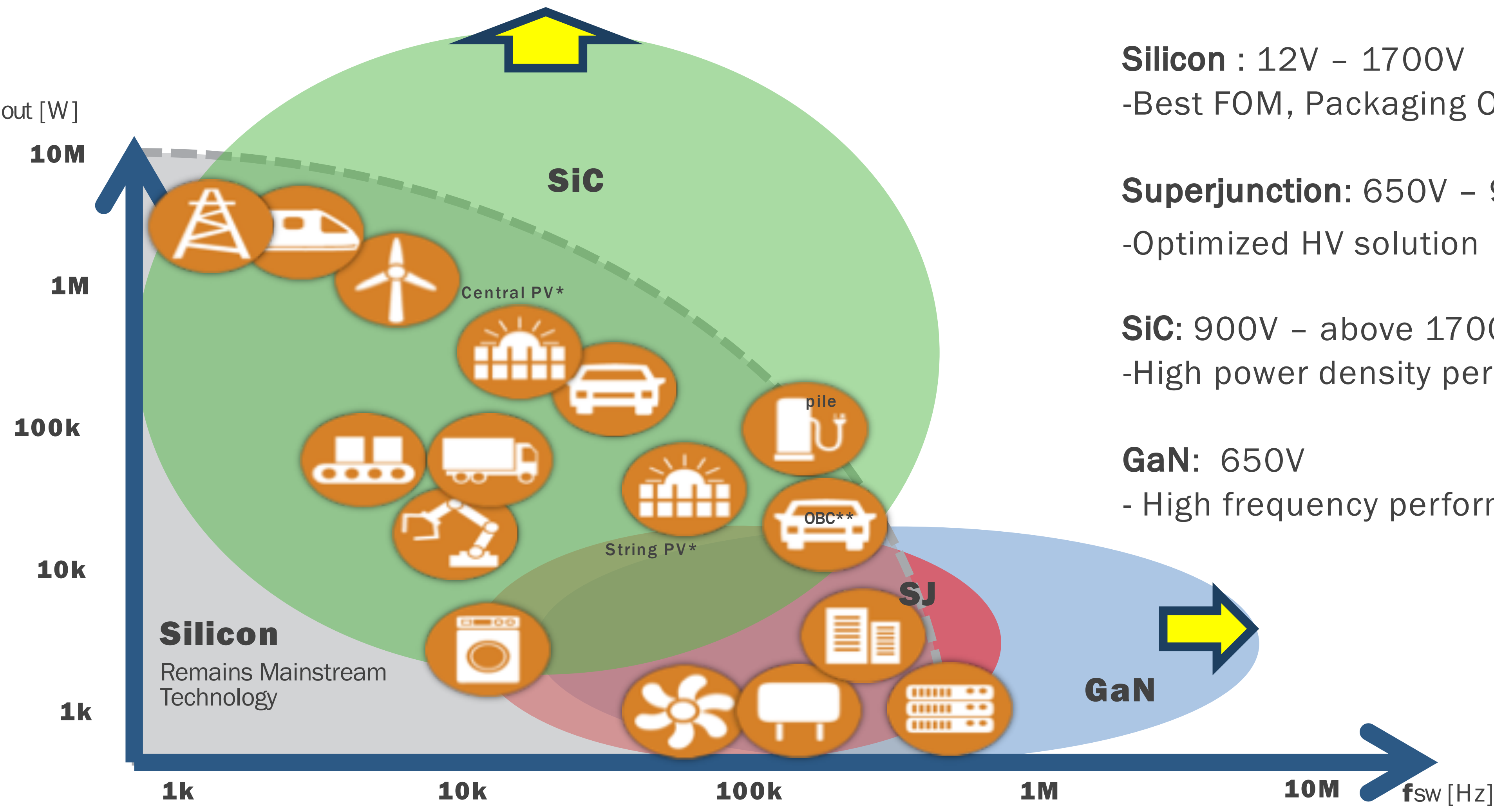
Outline

I. Power Electronics Packaging
II. Current State of Art Co-Design in Power Electronics Packaging
III. Challenges in Co-Design and Reliability
IV. What is the Next?
V. Summary

I. Power Electronic Packaging: Driven Capability



Silicon : 12V – 1700V
-Best FOM, Packaging Options

Superjunction: 650V – 900V
-Optimized HV solution

SiC: 900V – above 1700 V
-High power density performance

GaN: 650V
- High frequency performance

* PV = photovoltaic inverter; ** OBC = onboard charger

I. Power Electronic Packaging: GaN & SiC Applications

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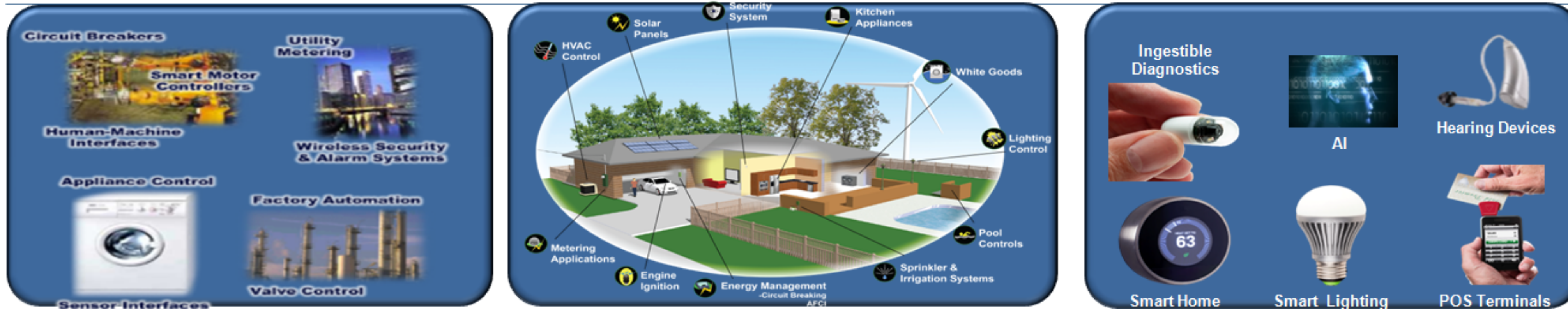
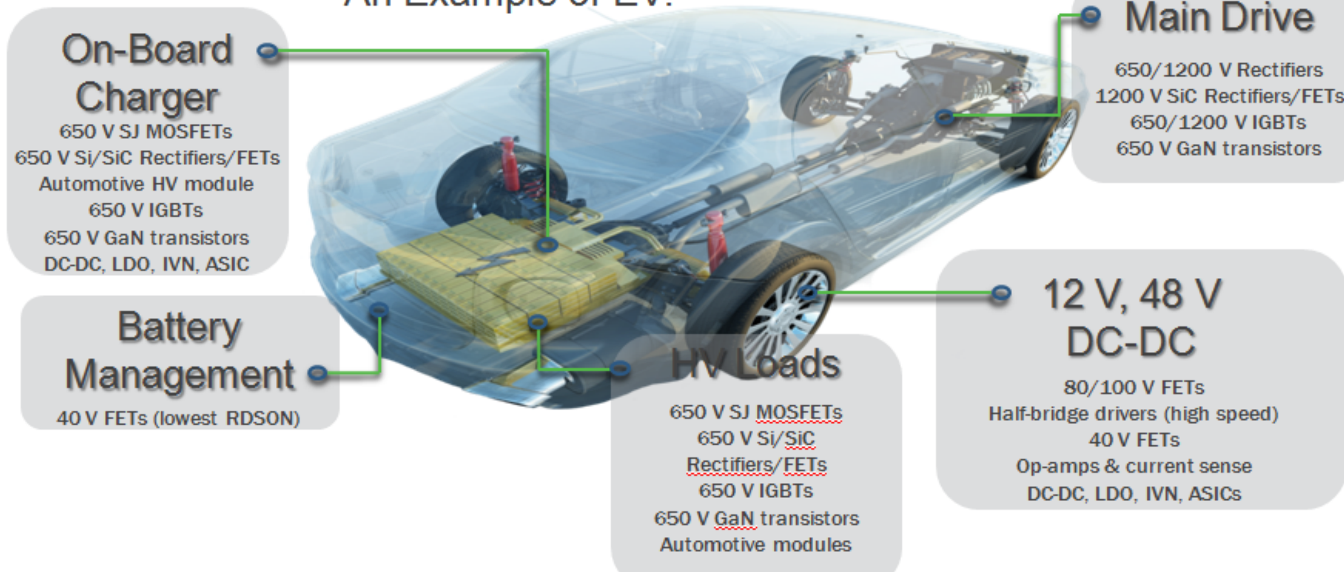


An Example of EV:



- High Efficiency
- High Reliability
- Low Power Loss

I. Power Electronic Packaging: Evolution

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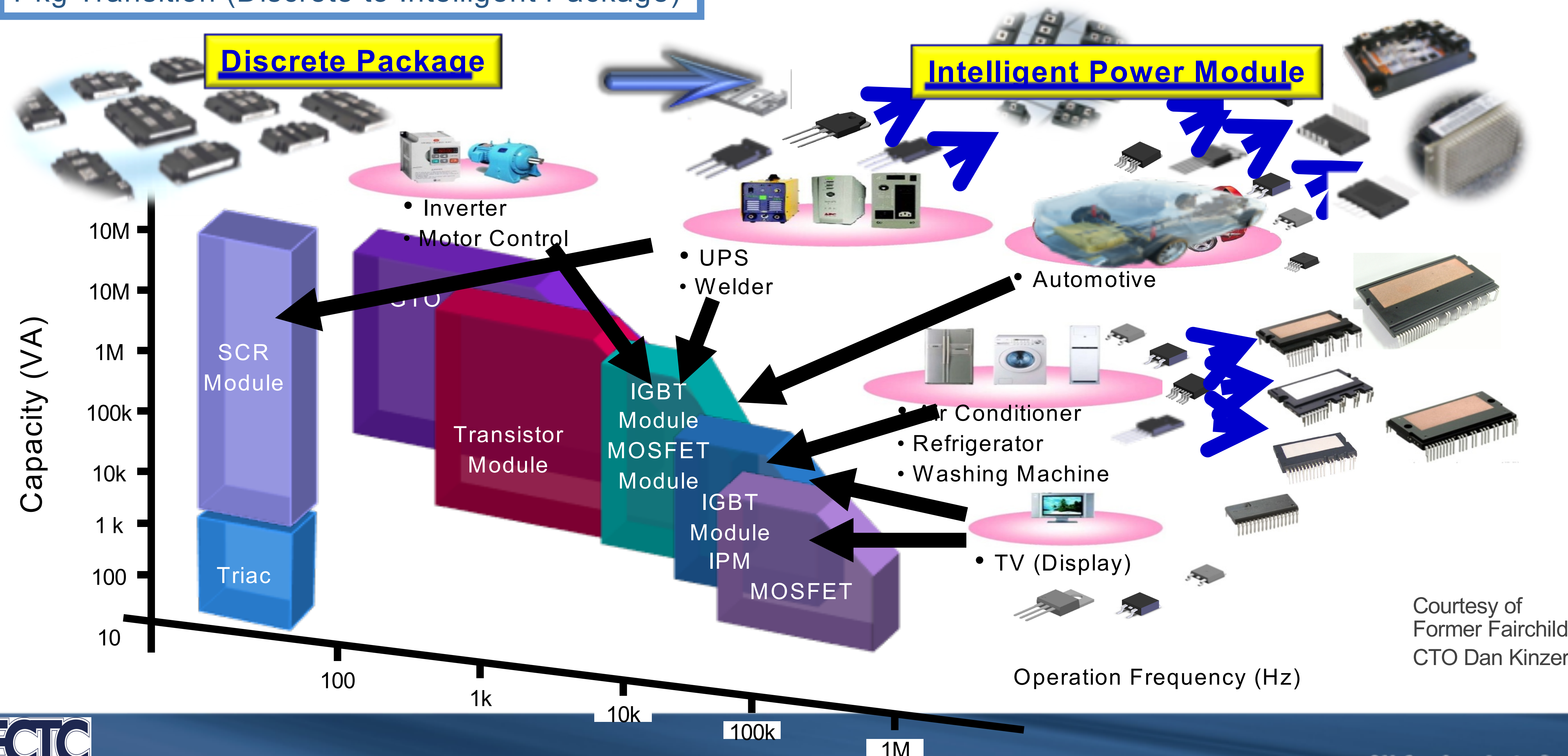
Pkg Transition (Discrete to Intelligent Package)



Courtesy of Former Fairchild CTO Dan Kinzer

I. Power Electronic Packaging: Core Technology

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II. Current State of Art Co-Design in Power Electronic Packaging

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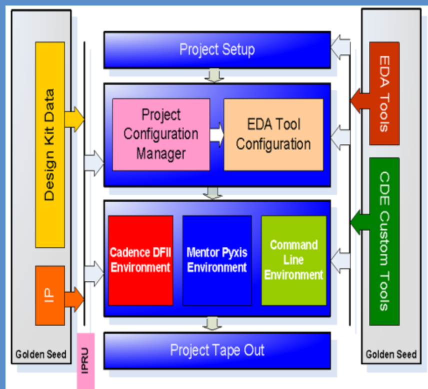
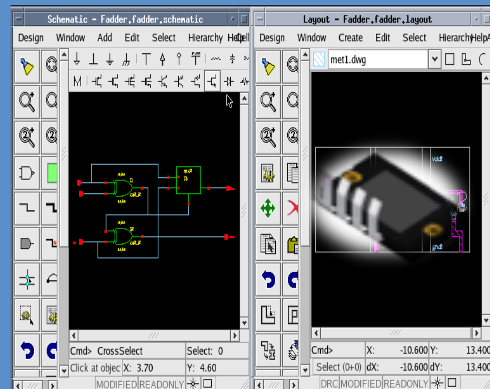
- To Provide Differentiating & Cost Effective Co-design Infrastructure for Power Electronics
- Current Co-Design Platform Includes:

Explore/Design + Simulation + Design Verification + Methodology + Development/Share

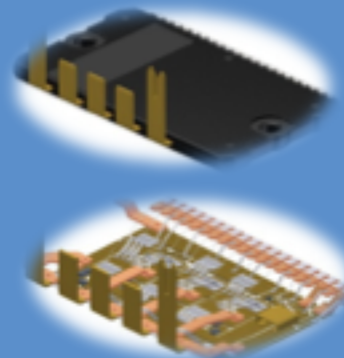
Weakness: Case by Case
Not strong in design sensitivity, optimization and probability
Not Yet Ready for virtual prototyping



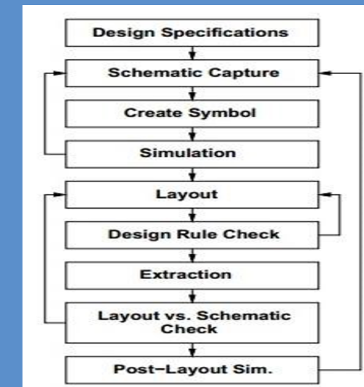
Design Platform



Simulation Tools



Design Verification



Design Methodology

Development/Share

III. Challenges in Co-Design and Reliability

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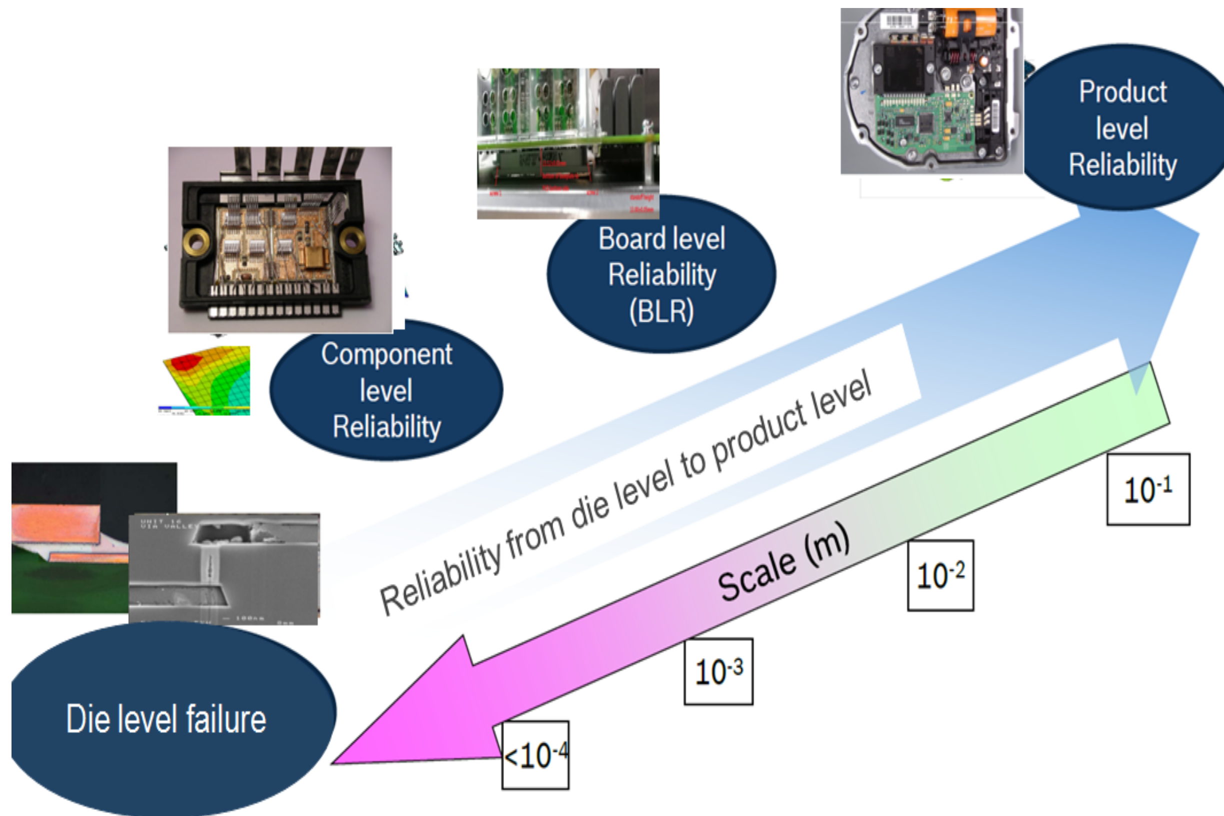
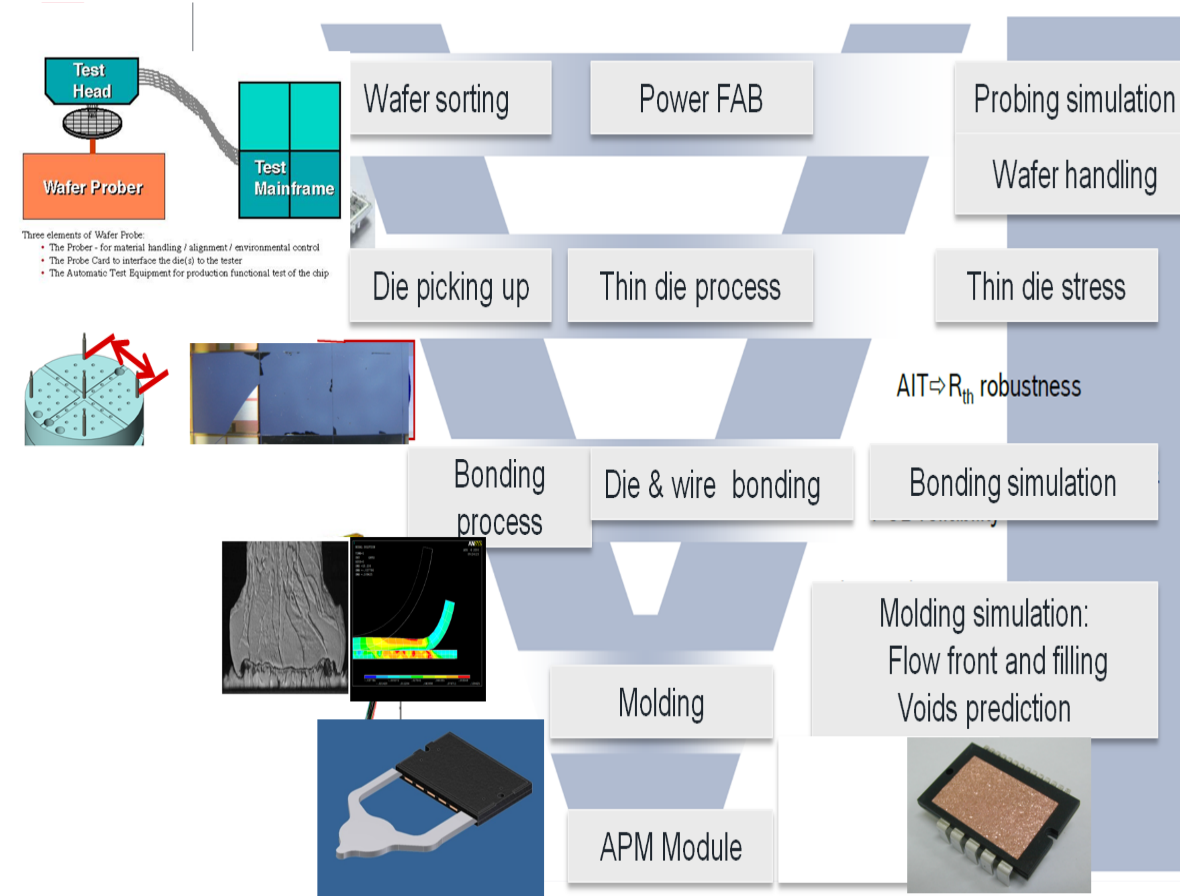
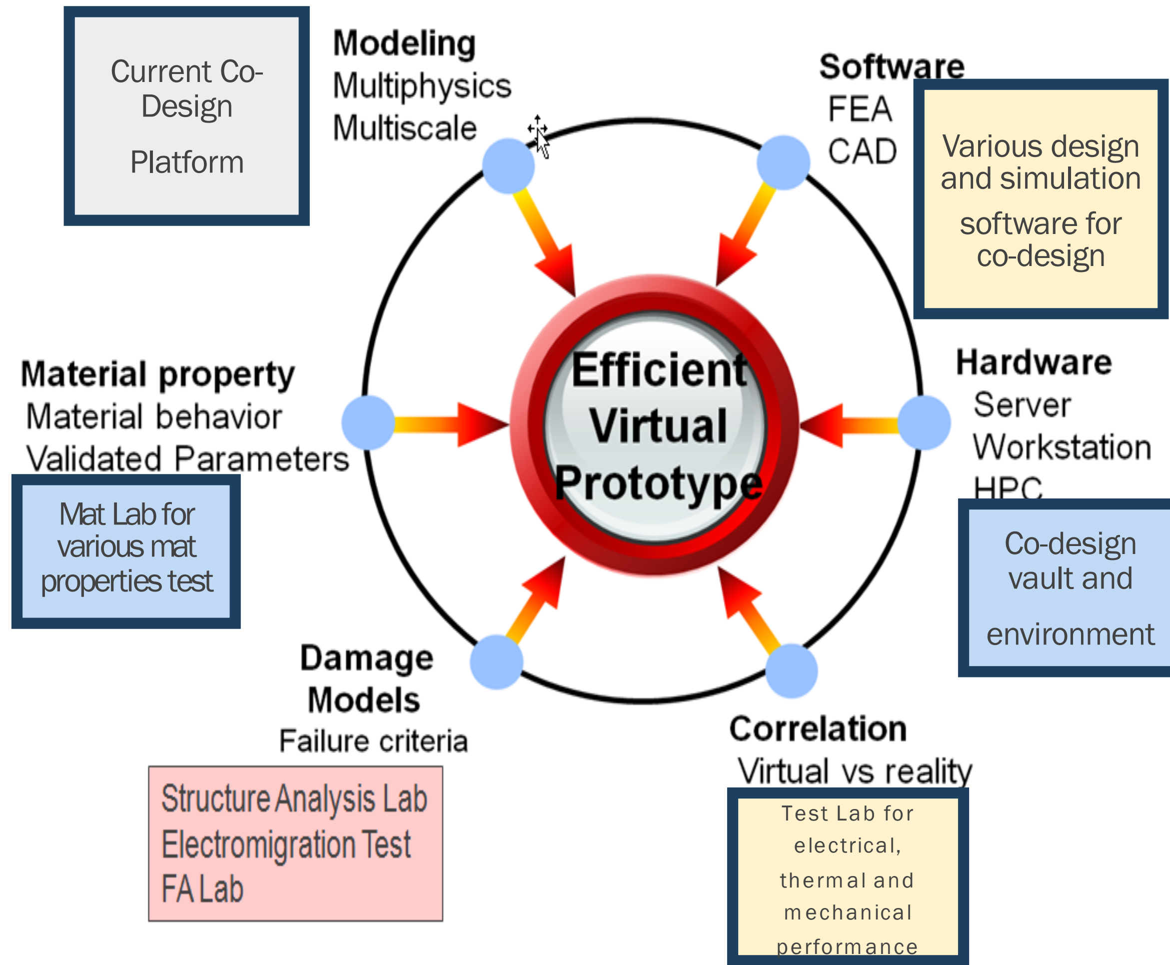
Multi-Scale and Multi-Physics in Co-Design/Reliability:
Reliability from Die design to system



Assembly Reliability:
Multi-Step Process/Variation/Probability

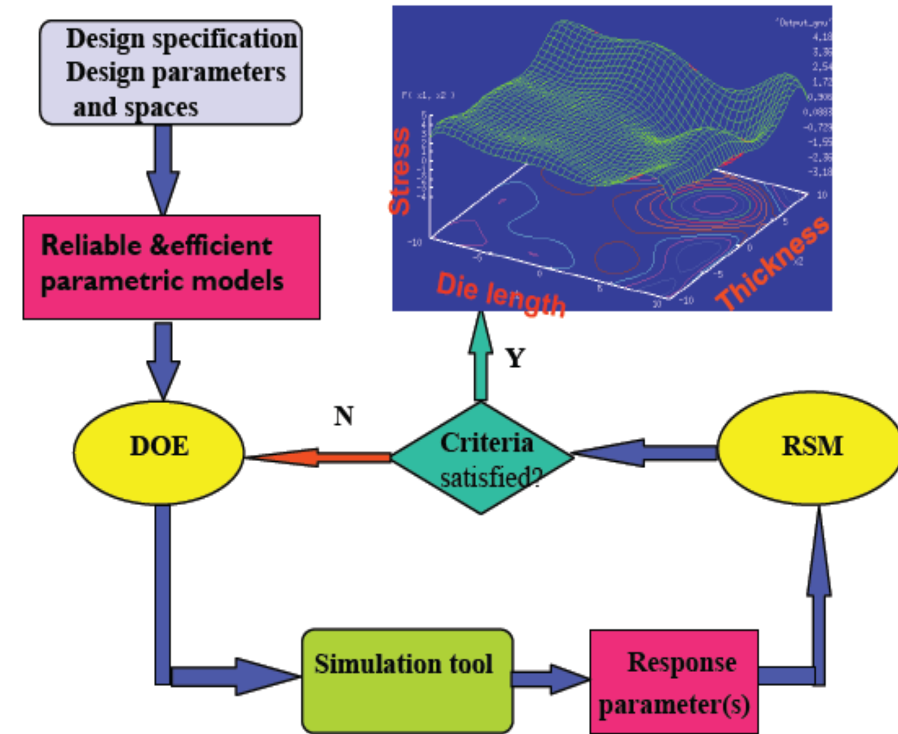


IV. What is the next: Co-Design Ecosystem for a Efficient Virtual Prototype



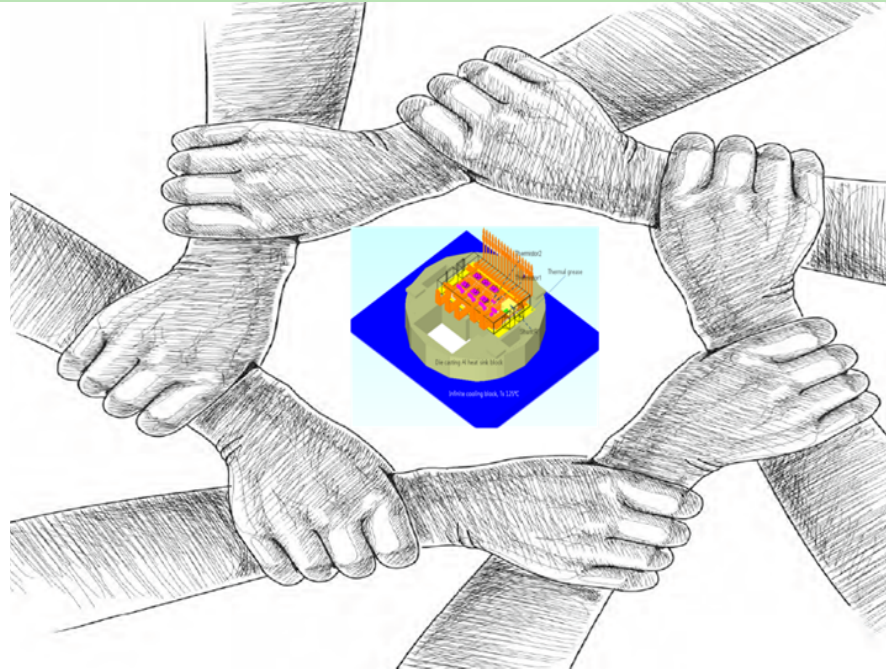
The system will target:

- Multi-scale and Multi-physics in Design
- Sensitivity/Optimization/Probabilistic Analysis in Design, Assembly Process and Reliability

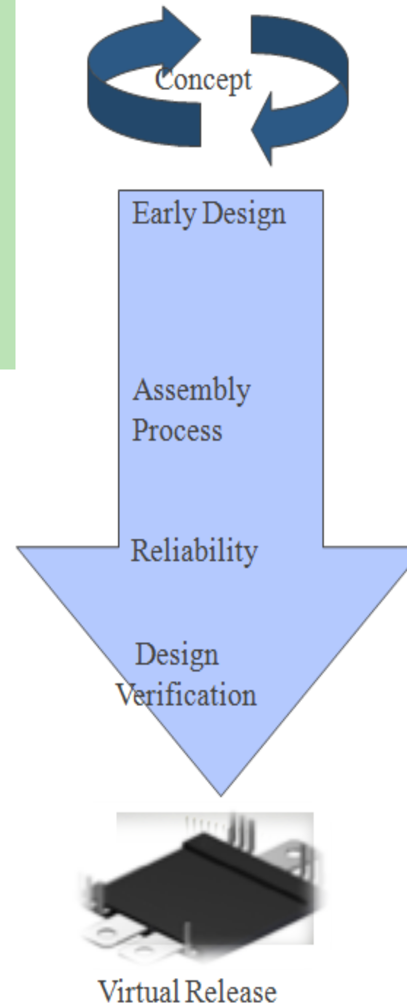


V. Summary

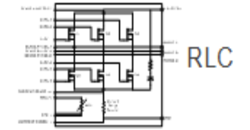
- Current state of art Co-Design includes Explore/Design + Simulation + Design Verification + Methodology + Development/Sharing
- Key Challenges in Co-Design/Reliability include Multi-Scale and Multi-Physics, Multi-Step Process/Variation Probability
- Co-Design Ecosystem & Virtual Prototyping will happen soon in Power Electronics Industry

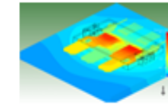


Virtual Prototyping

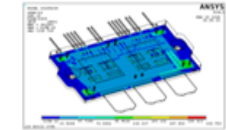


Early design phase
- Electrical simulation
- Thermal simulation

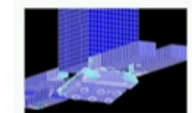




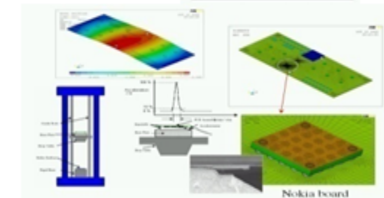
Virtual characterization
- Thermal and mechanical stress simulation for typical performances



Assembly Process Modeling
- Typical assembly process
- Mold flow simulation
- DFM



Reliability
- Virtual BLR
- DFR



Customer support
- Thermal simulation
- PQA simulation support
- Mounting process simulation