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AI for Test: The New Frontier

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March 3, 2025



TestConX 2025

AGENDA

2

Outline

01. Industry trends
02. Technical challenges
03. Innovation opportunities, with one example
04. Remaining challenges, and the journey ahead



01.

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The Trend

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TREND

Important Shifts in the Industry



1

Innovation in 3D

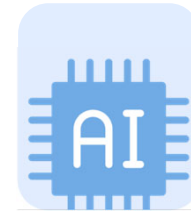
transistors, interconnects,
circuits, chiplets, and
systems



2

Complex Supply Chain

a globally distributed
industry



3

AI for AI

AI technology helping
make AI chips, and vice
versa

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TREND

(Incomplete List of) Hot Test Topics

“

Quality vs. Cost

As the semiconductor industry continues to evolve, the importance of **high-quality testing** will only increase. Advanced and flexible testing strategies, will be crucial in meeting the growing demand for chip performance and reliability in the AI era and beyond.

- *SemiEngineering*

“

Rise of SLT

It is only through **SLT testing** of devices, peripherals, and software together, under real-world conditions, that companies can drive down escape rates to acceptable DPPM levels.

- Laura Peters,
SemiEngineering

“

ATPG / SLT (mis)correlation

Number of transistors doubles with each new node, yet the “percent coverage” of static ATPG (typically 99.5%) and at-speed ATPG (typically 85%) remains constant. This can create situations where emerging lower nodes can drive the number of untested transistors to unacceptable levels.

In system in package devices, even if each IP from different vendors provides 100% yield, combining different IP into a single package does not guarantee 100% coverage.

- Anil Bhalla, *Electronic Design*

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TREND

Managing a Globally Distributed Supply Chain



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Connected Data is Key



quality



reliability



security

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02.

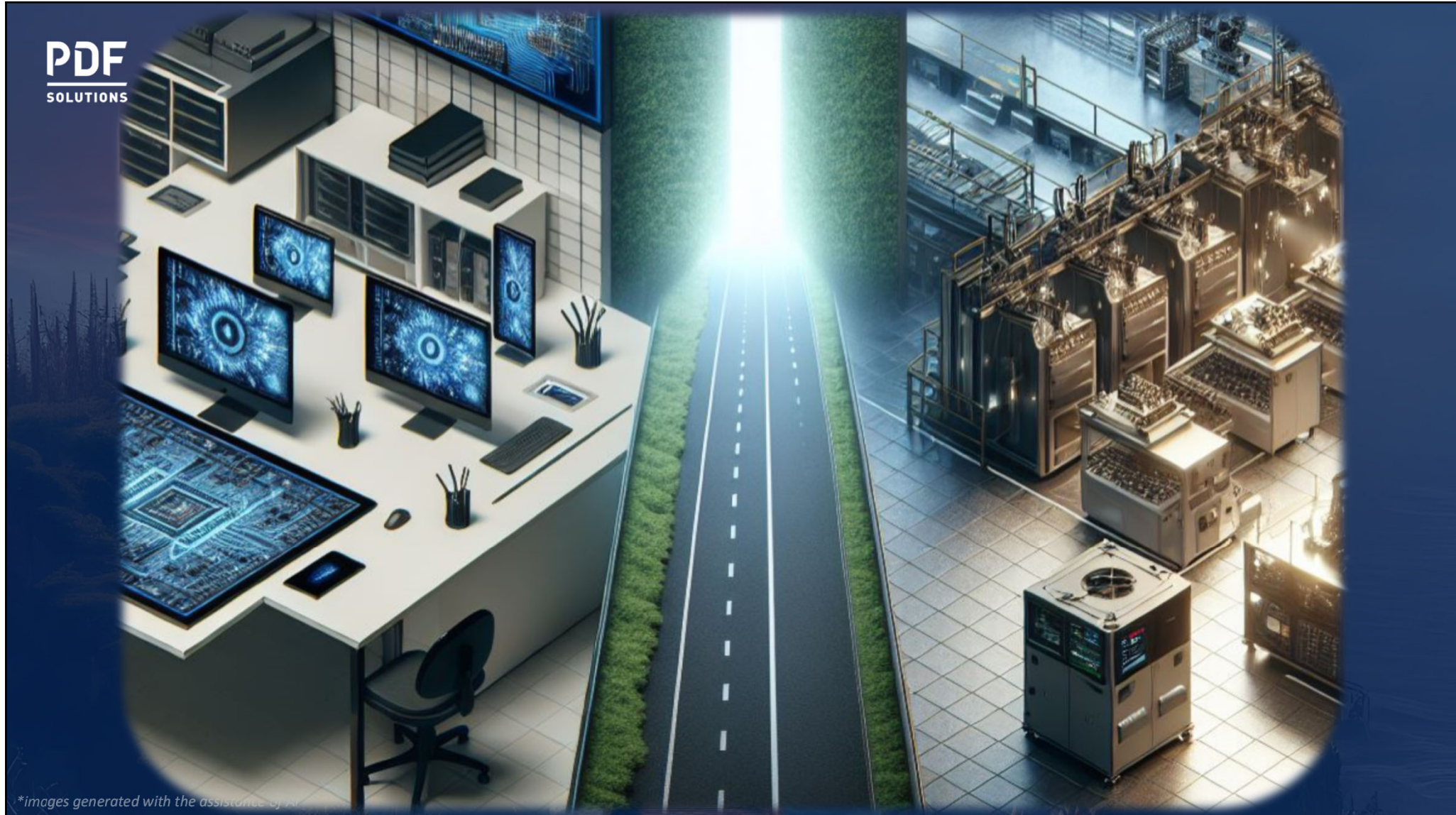
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The Challenge

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TestConX Workshop

www.testconx.org

March 2-5, 2025

CHALLENGE

Industry Challenges: Design and Manufacturing



Design

- Imperfect & heterogenous devices
- Limited early system exploration & optimization
- Rising complexity of verification



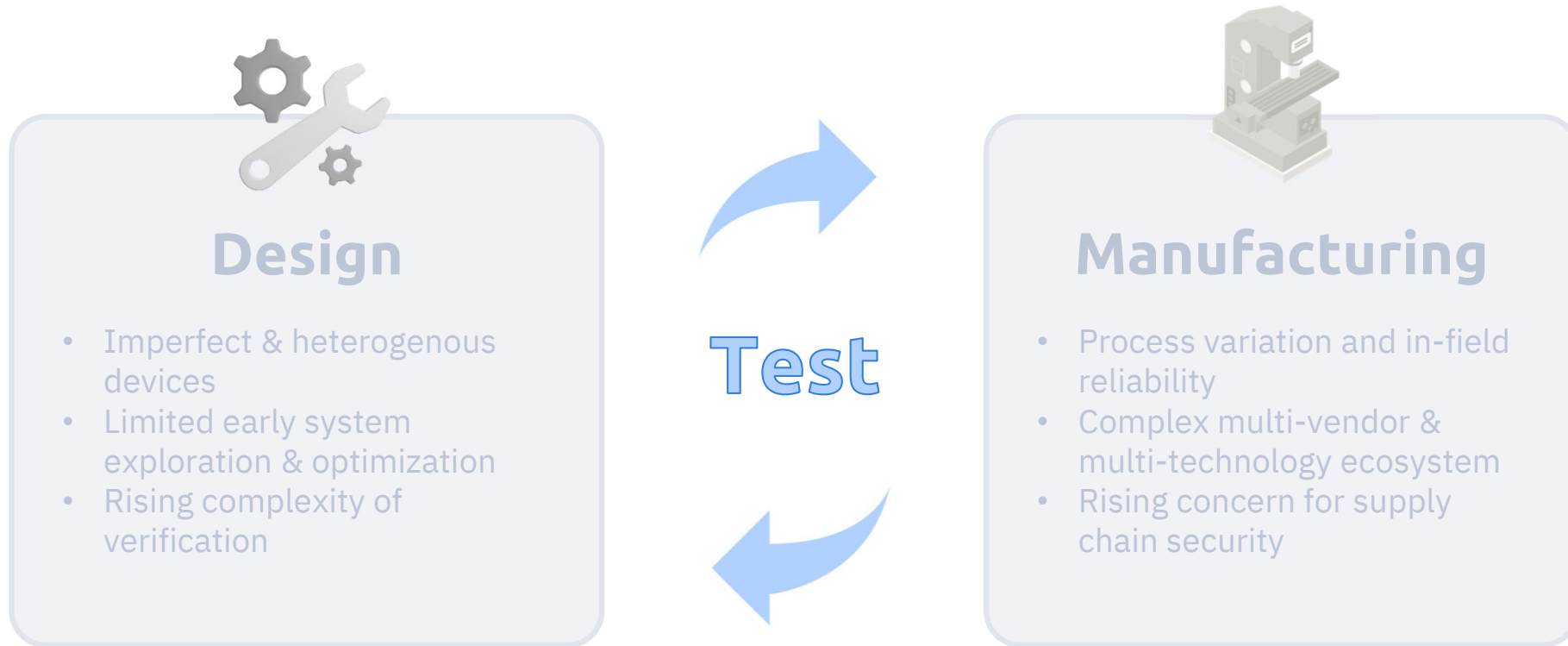
Manufacturing

- Process variation and in-field reliability
- Complex multi-vendor & multi-technology ecosystem
- Rising concern for supply chain security

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CHALLENGE

Bridging the Gap through Innovations in Test



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CHALLENGE

What Makes **AI** for Semiconductor Different and Difficult



**Complex Data
Model**



**Model
Maintenance**



**Complex
Interactions**



**Diverse
Use Cases**



**Edge
Deployment**



**Data
Drift and Shift**



**Disparate
Deployments**



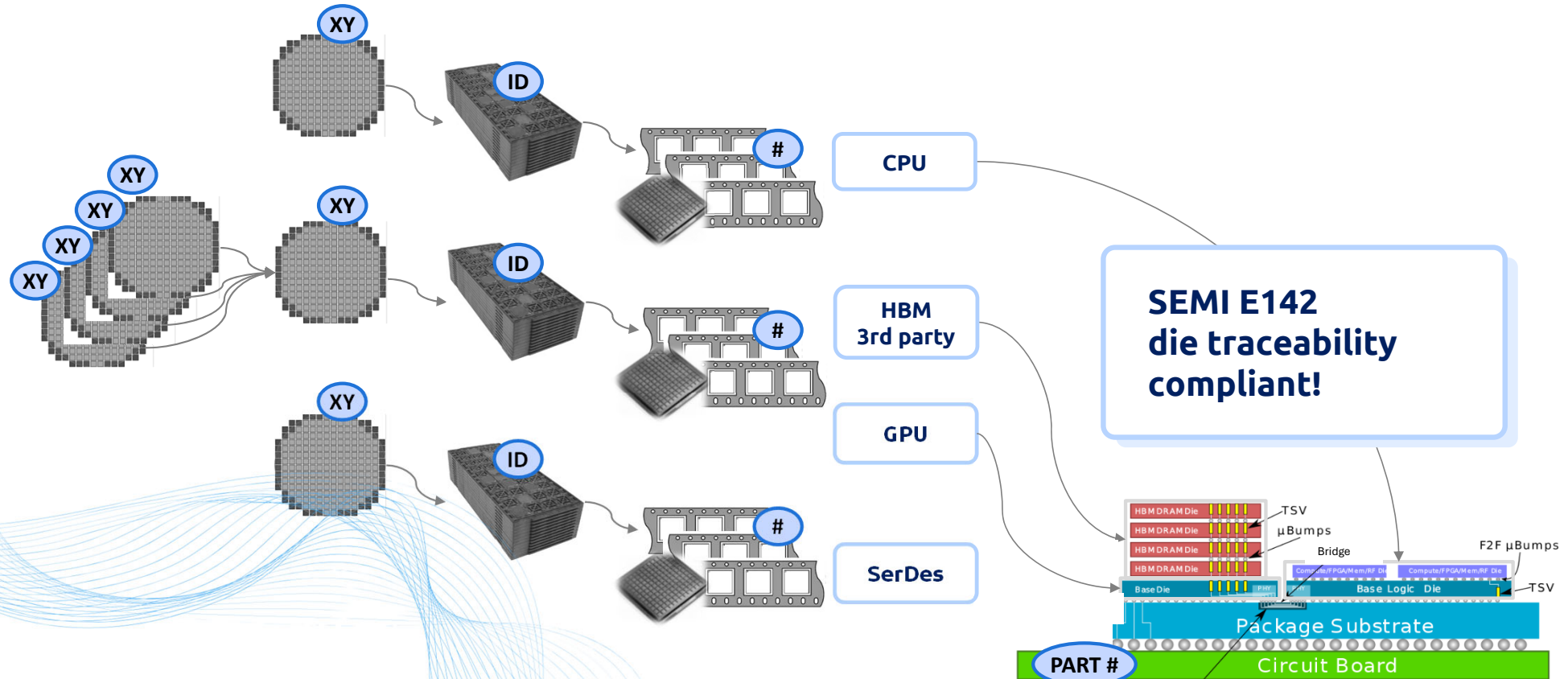
**Security
and IP**

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CHALLENGE

Data Complexity of Advanced Packaging



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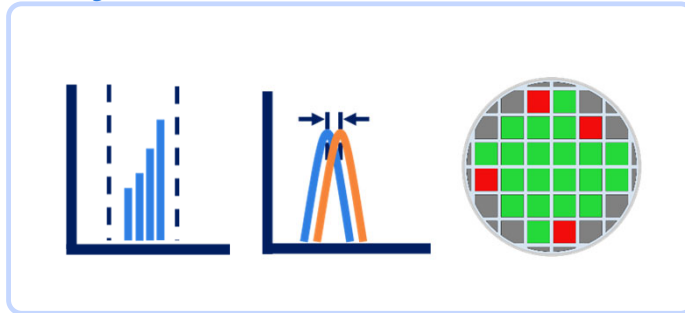
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CHALLENGE

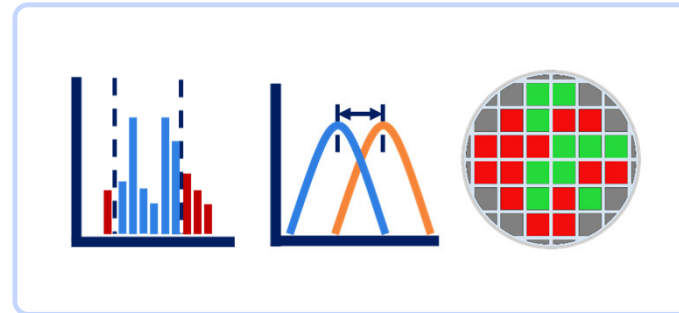
The Interface Variation Problem

ATE equipment, probe card, test socket, manufacturing sites

Is your model, trained on this data,



still valid when data has skewed?



Deploy

- Holdout for validation
- Re-bin on missing data
- Phased prediction sampling

Monitor

- Drift in key input parameters
- Change in prediction distribution
- Inference Engine exit code
- Model performance analytics

Action

- Alarm (default)
- Deploy backup model
- Retrain and Re-deploy

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03.

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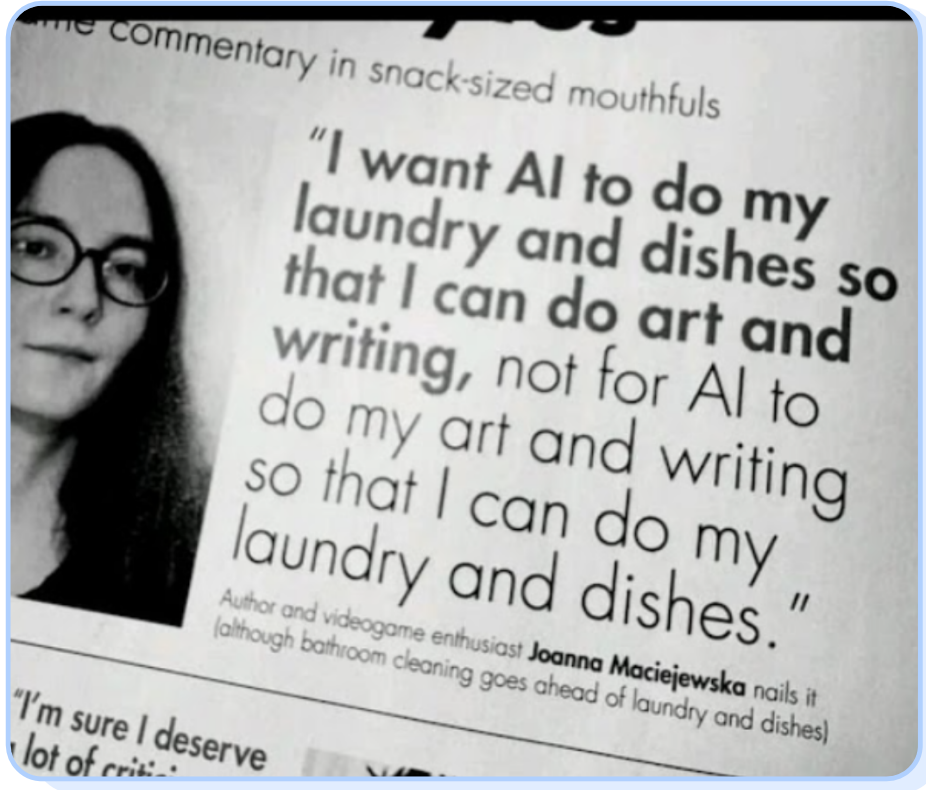
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The Opportunity

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OPPORTUNITY

Opportunity: AI for Test



Source: Joanna Maciejewska, LinkedIn

data



infrastructure

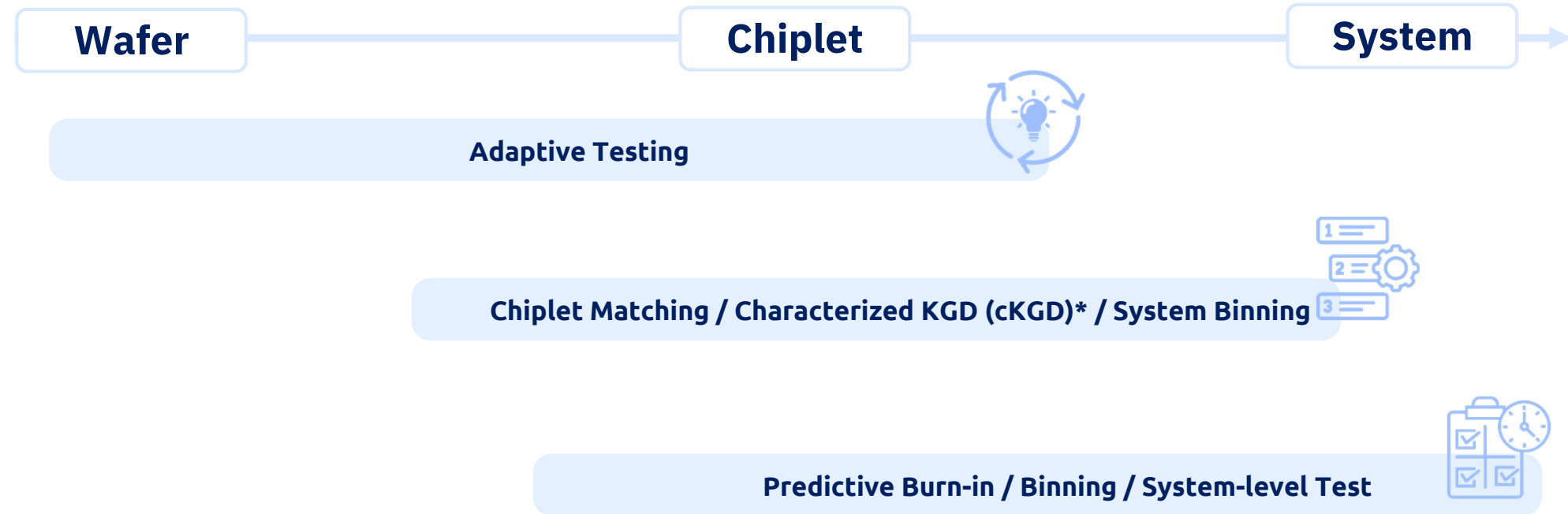


model

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Market: System Quality, Cost, Differentiation



* **Source:** Intel, ERI Summit 2023

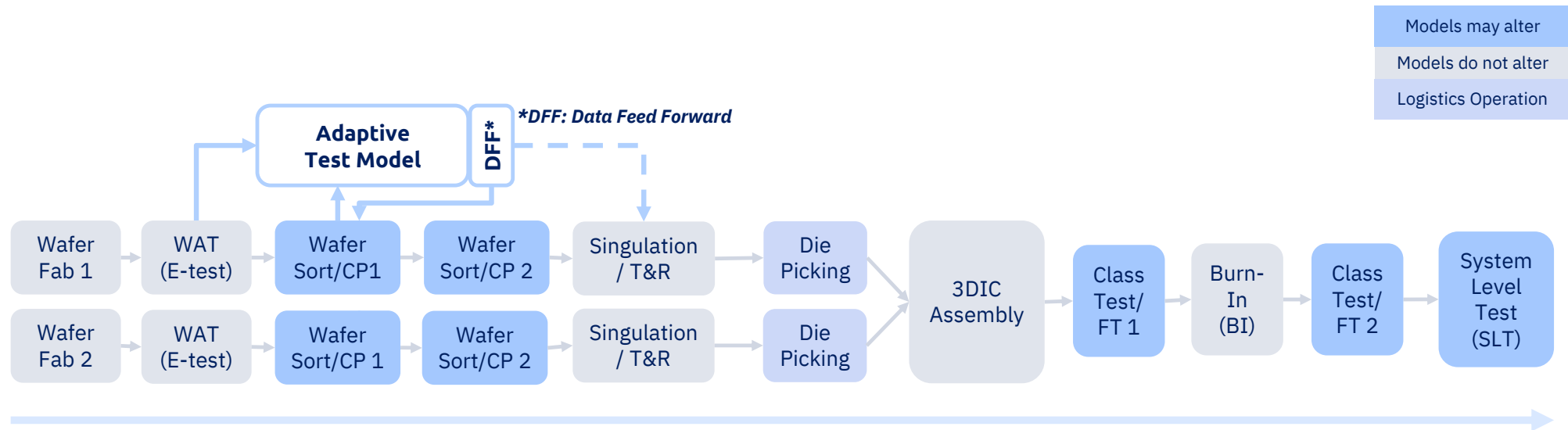
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Problem: Data Overload and Infrastructure Gaps



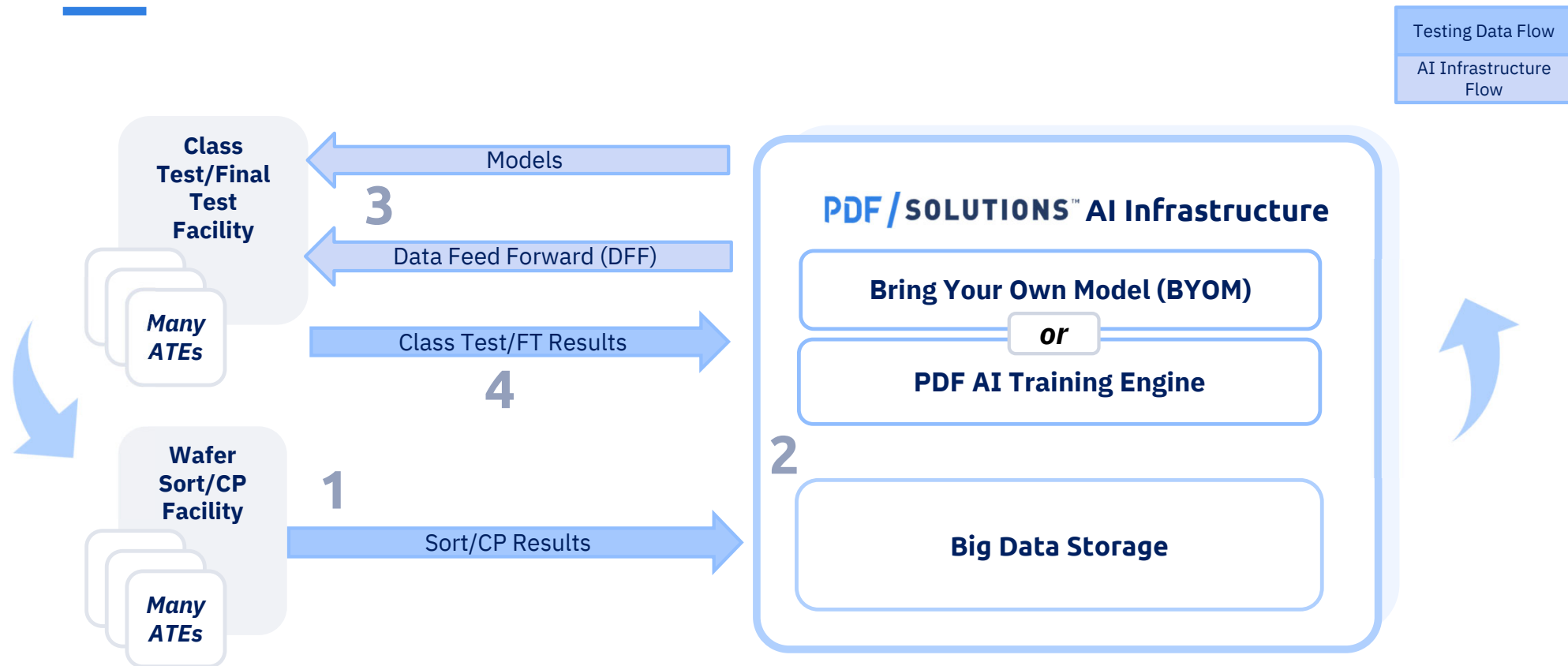
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Solution: AI Model Deployment at Ramp (NPI) and at Production (HVM)



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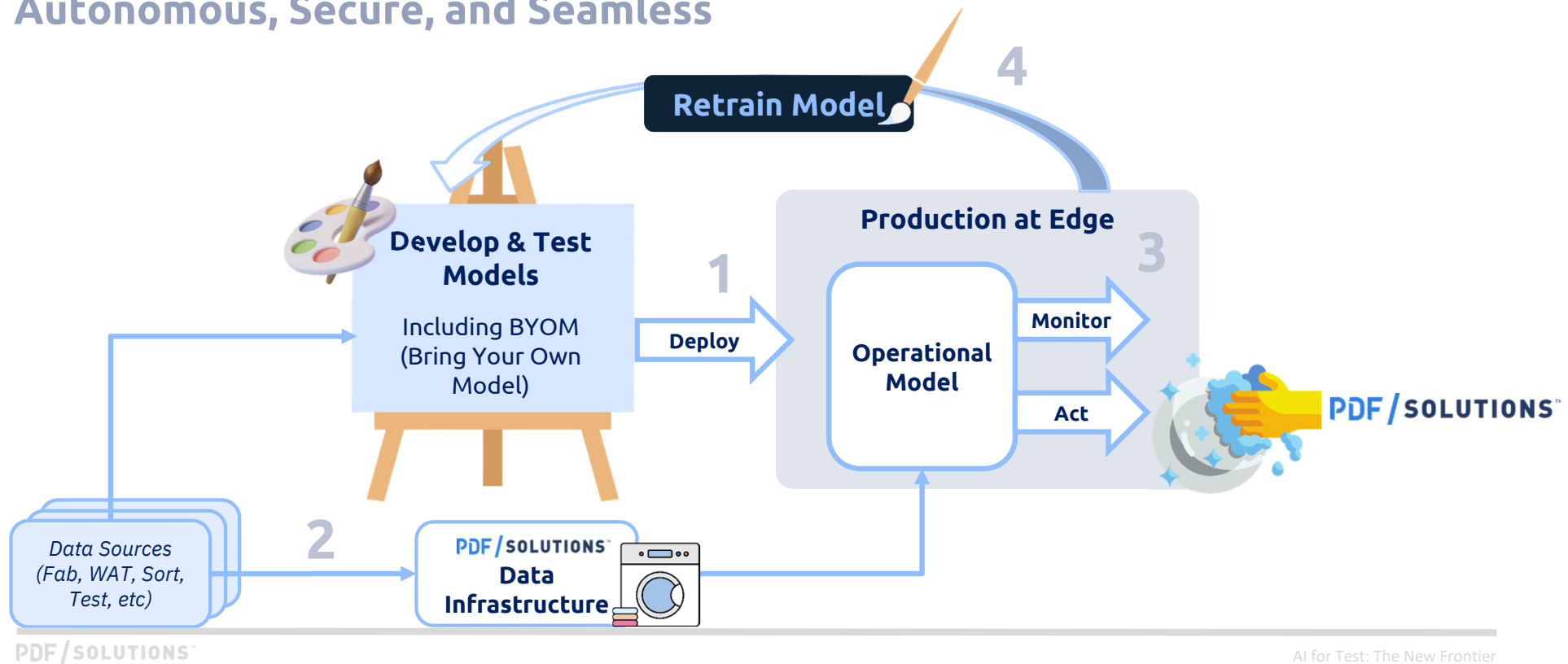
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OPPORTUNITY

PDF/SOLUTIONS™ AI Infrastructure: Create, Manage & Control Models Across Lifecycles

Autonomous, Secure, and Seamless



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Use Case Example: Adaptive Test on High Volume Product

Desire

Remove tests at Final Test (FT) **without impacting DPPM**

Method



Predict FT failures by **Machine Learning** on Wafer Sort (WS) parametric data



Use **Data Feed Forward** (DFF) to skip tests on predicted-pass units

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Use Case: Results Summary

Results

- **5 / 7 tests** can be skipped with **0 DPPM**
- **Product decision needed** for the other 2 tests with **near-zero DPPM impact**
- Skip rates (fraction of units where test can be skipped) **above 88%**



Target	Current Failure Rate (PPM)	DPPM (with ML)	ML Fail Captured%	ML Skip %
FT_Test_A	82	0.0	100.00%	99.26%
FT_Test_B	88	0.0	100.00%	98.49%
FT_Test_C	220	0.0	100.00%	96.63%
FT_Test_D	839	0.0	100.00%	95.98%
FT_Test_E	540	2.9	99.43%	95.25%
FT_Test_F	584	0.0	100.00%	94.64%
FT_Test_G	255	0.9	99.60%	88.14%

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The

Remaining Challenges

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REMAINING CHALLENGES



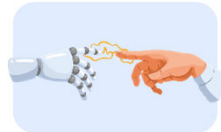
Manufacturing execution through a complex and distributed supply chain



Learning from small amount of data



Learning across factories and designs



Balancing AI/ML with human knowledge

Integrate and Control Contracted Manufacturing Operations with a **Virtual MES**



Manufacturing execution through a complex and distributed supply chain

Features

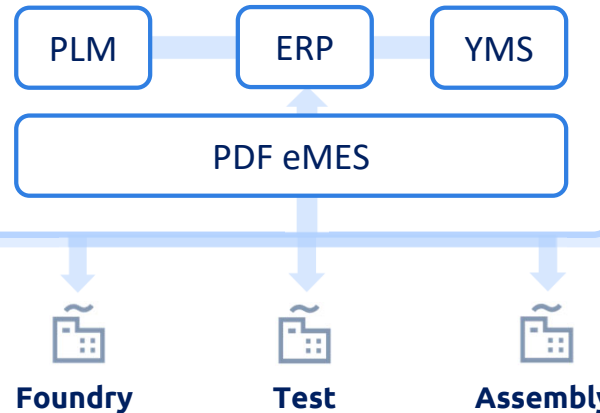
- **Integration** at manufacturing node
- **Real-time** tracking & management of **WIP**
- **Real-time** tracking of **quality**
- **Centralized management** of manufacturing **process & test**
- **Cross-system Integration** with PLM, ERP, YMS

Inventory
Reduced

Yield
Improved

On Time
Delivery

Fabless / IDM-Lite

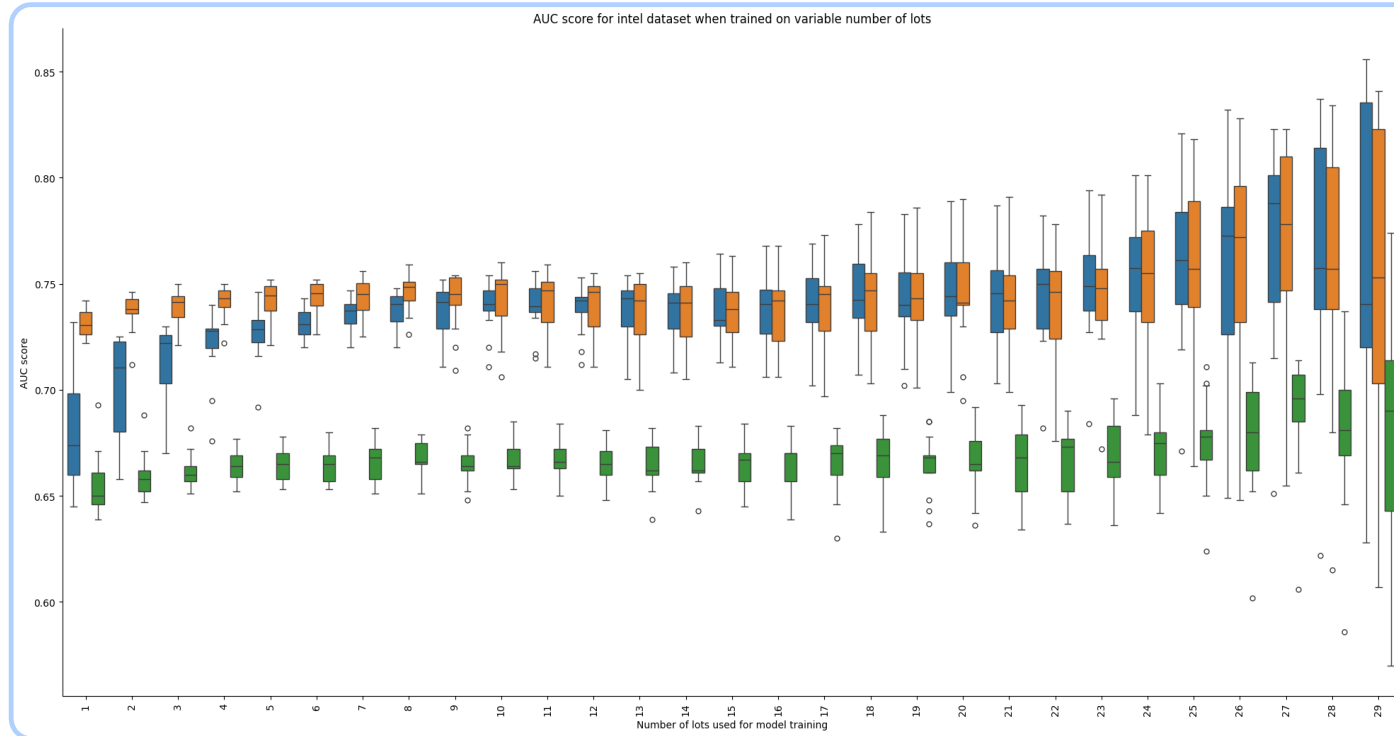


REMAINING CHALLENGES

Manage Small Volume of Data through Model Selection



Learning from **small amount** of data



Plot of AUC scores for 3 different models when trained on 'x' lots and inferred on the remainder.

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REMAINING CHALLENGES

Get Models into Production Faster through Transfer Learning



Learning across factories and designs

Learning Across Packages, Products, and Factories

Starting Model
"Product Zero"

Identical Die, Different Packages

Same Die, Different Fab

Different Die, Same Family

Similar Function, Same Process Node

INCREASING DIFFICULTY

INCREASING BENEFIT

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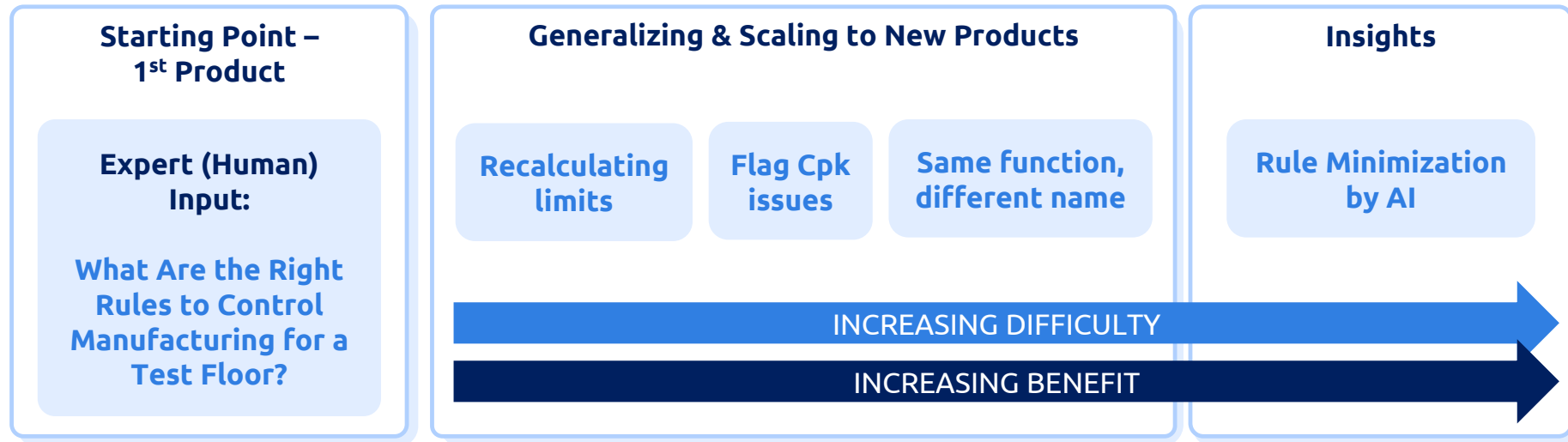
REMAINING CHALLENGES

Automate and Routinize Workflows through Co-Pilot



Balancing AI/ML with human knowledge

Example: Automated Rule Creation



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REMAINING CHALLENGES

Key Takeaways

AI for test is a continuum of data, model, and infrastructure



Semiconductor-specific data, over space and time



Connected view of a globally distributed supply chain



AI across the design, manufacturing, and test lifecycles

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From Data to Action:

Your trusted platform for semiconductor manufacturing



quality



reliability



security

REMAINING CHALLENGES

PDF in the News

PDF Solutions to Acquire secureWISE to Expand the Reach of its Semiconductor Manufacturing Data Platform

POSTED ON FEBRUARY 19, 2025 BY PDF SOLUTIONS

SECURE, REMOTE ACCESS, MONITORING, AND CONTROL FOR MANUFACTURING EQUIPMENT AT NEARLY 200 SEMICONDUCTOR FACTORIES WILL BE ADDED TO THE PDF SOLUTIONS DATA NETWORK

“

As the semiconductor industry becomes more **globally distributed**, and as advanced devices rely on the integration of multiple chiplets into a single package, **more collaboration and integration are required** across the semiconductor industry. This collaboration needs to be executed securely with each participant controlling access to its intellectual property.

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Thank You



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