



Supply Chain Security Workshop

April 28 & 29, 2021



Amkor Automotive Unit Level Traceability

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April 2021

Outline

- 1 Introduction
- 2 Industry 4.0
- 3 Motivation for Traceability
- 4 Unit Level Traceability (ULT)
- 5 Amkor's Value Proposition

Amkor by the Numbers



Founded in
1968



\$5.1B
Net Sales*



30,000
Employees



\$550M
CapEx*



11,000,000
Square Feet of
Manufacturing Space



Footprint in
11 countries

End Markets



Automotive



Communications



Industrial



Computing



Consumer

*2020 results

Amkor End Markets



Communications

Mobile
Connected Devices
Streaming



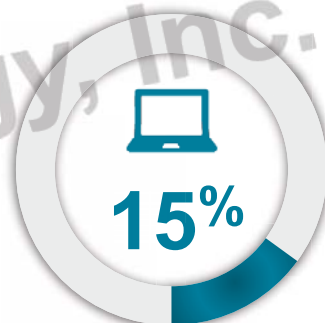
Consumer

Connected Home
Wearables
A/R
Gaming



Automotive & Industrial

ADAS
Infotainment
IoT



Computing

HPC
AI
Data Center
Cloud/Edge

Amkor Automotive by the Numbers

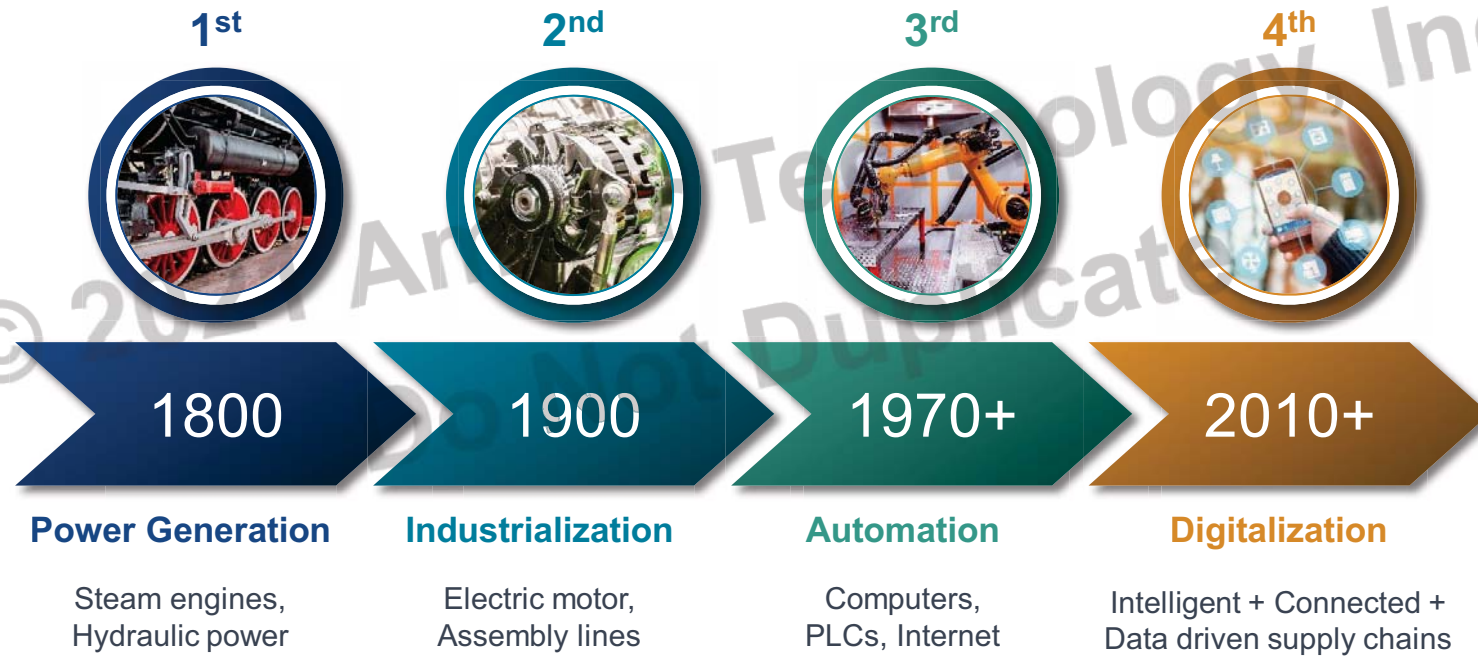




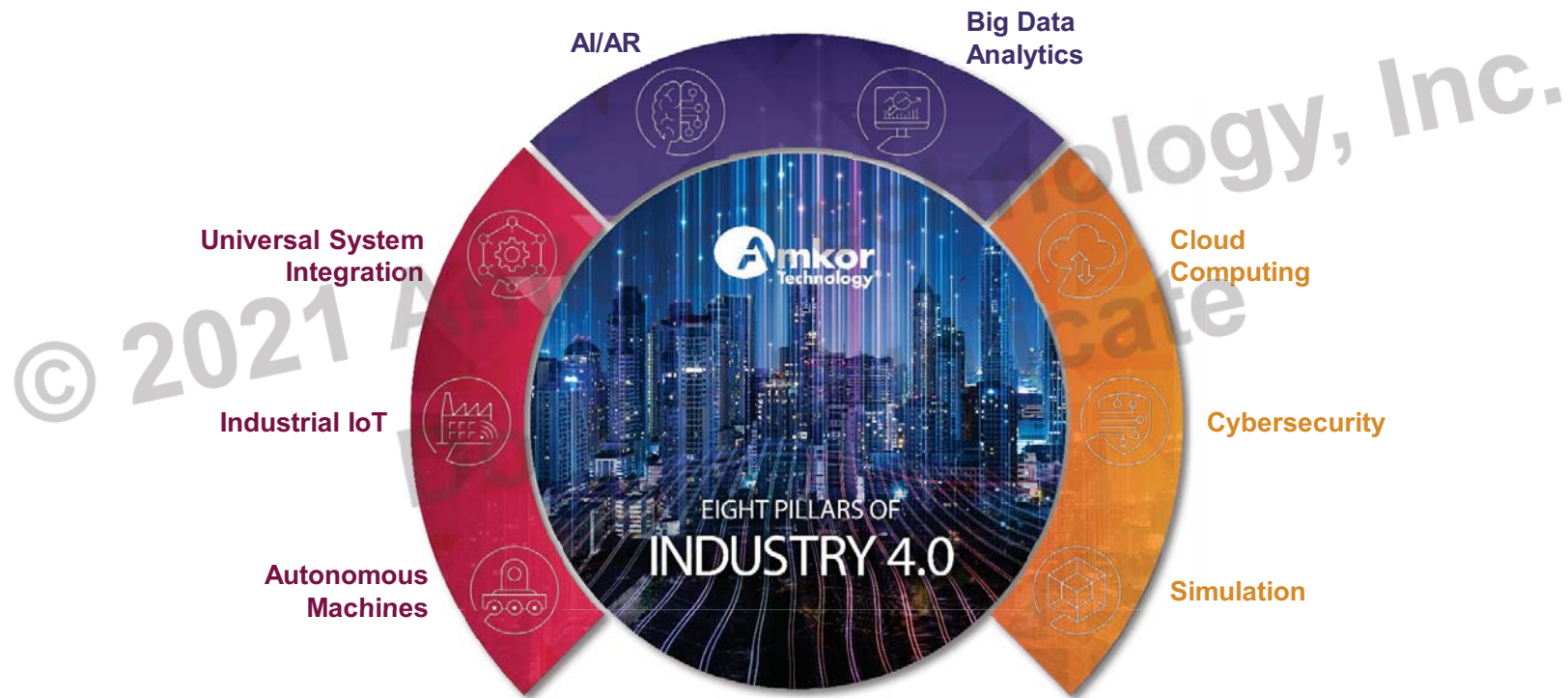
Industry 4.0

What is Industry 4.0?

4th Industrial Revolution



Eight Pillars of Industry 4.0



I4.0 Framework for Amkor

	Pillars	Mechanisms @ Amkor
Automated	1. Autonomous Robots/Machines	1. Fully autonomous equipment 2. Handsfree material handling – transport, loading, unloading, auto packing 3. Paperless manufacturing processes
	2. Industrial IoT	4. eCIM (SECS/GEM or Raspberry Pi) controlled equipment 5. IoT controlled factory environment (air, gases, chemicals, electricity)
	3. Universal System Integration	6. eCIM, MES, ERP and all peripheral execution systems integrated 7. End-to-end visibility and traceability (ULT) 8. Handsfree data entry (mobile scanners, RFID) 9. Handsfree transactions/data transfer (Asteria, RPA) 10. B2B integration with customers and suppliers for near real-time visibility
Intelligent	4. AI/AR	11. AI ML @ AOI 12. AI ML for visual inspection and other operations
	5. Big Data Analytics	13. SPC, APC, FDC – real-time monitoring, analysis and control for select equipment 14. Big data with advanced analytics for OEE – Spotfire, SAS, ML Big Query 15. Predictive maintenance capability for major bottleneck equipment
Secure & Scalable	6. Cloud Computing	16. Cloud Computing – SaaS, IaaS, PaaS as enablers
	7. Cybersecurity	17. Cybersecurity – infrastructure protection from hacks and viruses 18. IP protection – for Amkor & customer IP
	8. Simulation	19. Simul8 models with trained IE for active floor control/CapEx 20. Automated planning, scheduling & dispatching

How We Value I4.0 Projects

Continuous Improvement, Measured Regularly

KPI
1

Quality

Yield and customer feedback

KPI
2

Productivity

Employee efficiency

KPI
3

Cycle time

Manufacturing cycle time

KPI
4

Speed and quality of decision making

Time saved in engineering data analysis and in-line decision making

KPI
5

Asset utilization

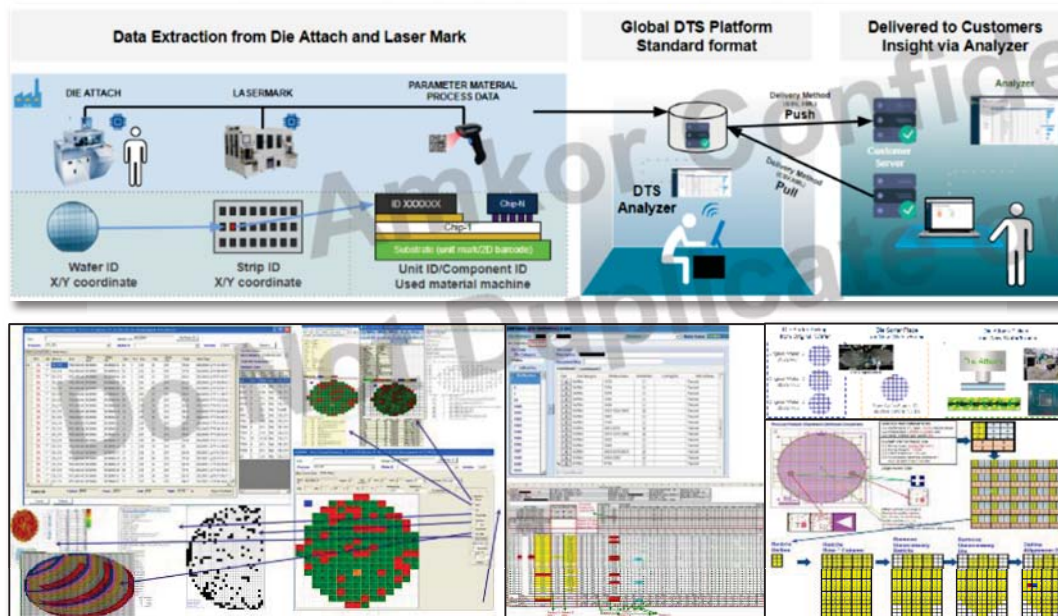
Utilization of assets for productive use

KPI
6

Cost

Competitive pricing

End-to-End Visibility and Traceability (ULT)



Provide traceability from wafer to unit for all process steps and materials

Offers end-to-end visibility via analyzer



Motivation for Traceability

Mission Critical Safety Systems



Electronic Stability



Lane Departure



Anti-lock Braking



Adaptive Cruise



Traction Control

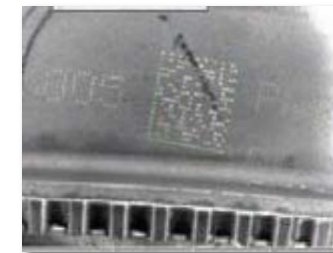
Complex Electronic
Components



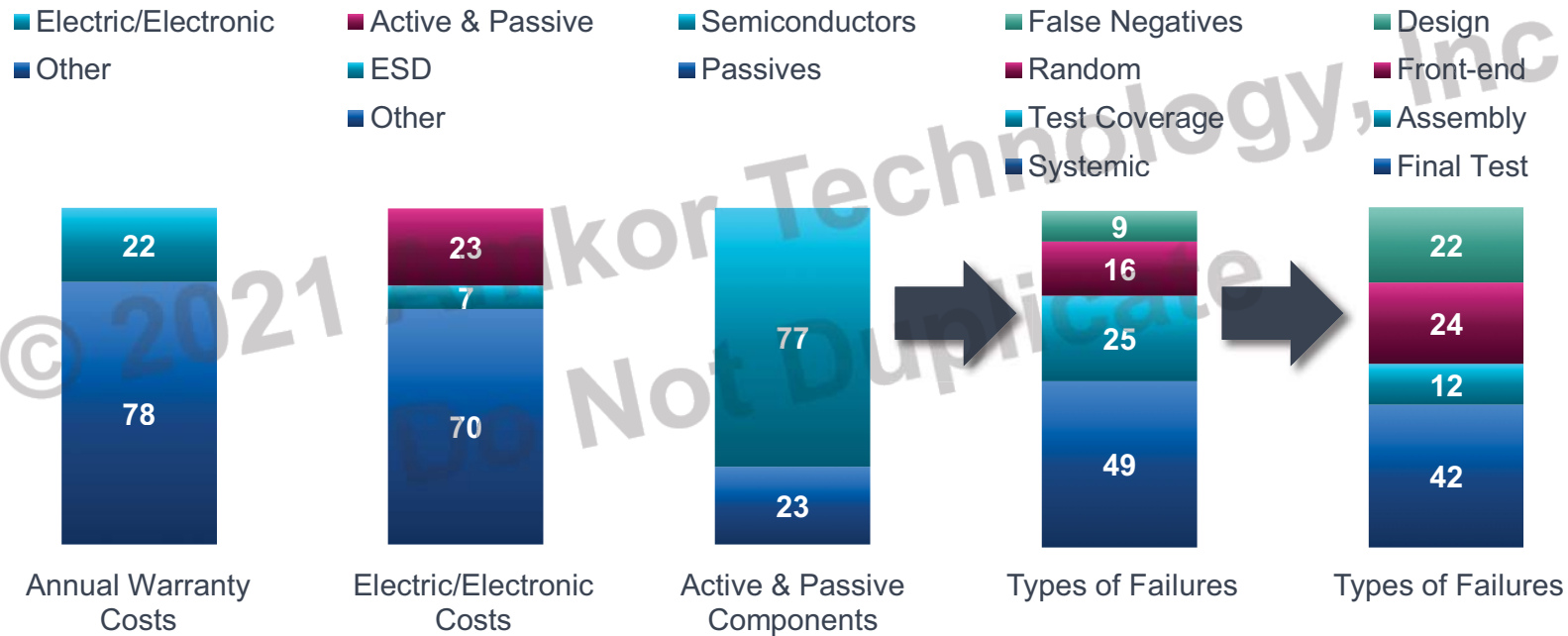
- ▶ High-speed processors
- ▶ Memory
- ▶ Controllers
- ▶ Sensors

Automotive Traceability

- ▶ Direct part marking on mechanical or electronics components
 - ▷ 1D or 2D barcodes or RFID
- ▶ Traceability evolved from defensive mindset of 'minimizing recalls' to offensive posture of 'compliance'
 - ▷ TREAD act requires reporting to NHTSA on safety excursions
- ▶ SEMI Collaborative Alliance for Semiconductor Test (CAST) is working on standardization
 - ▷ Traceability of devices, including die, leadframe, epoxy, bond wires and PCB



Annual Automotive Warranty Costs Breakdown

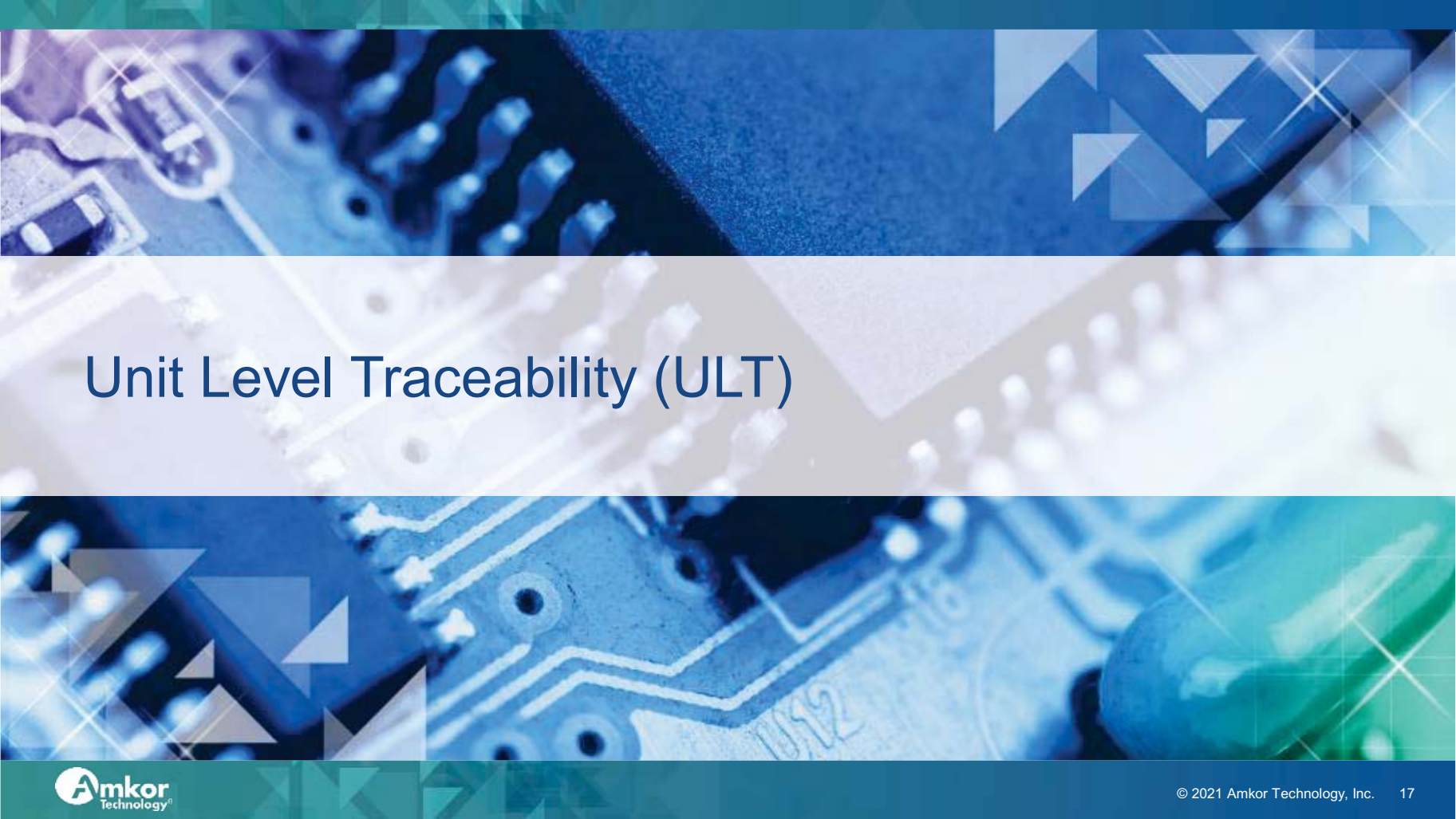


Source: Data presented by ELES Semiconductor at Automotive Electronics Reliability Workshop, courtesy of Semiconductor Management at BMW Group

Case for Unit Level Traceability (ULT)

- ▶ Reputation loss and strained relationships in supply chain
- ▶ Automotive OEMs require an 8D in <10 days if field, 0 km or 0h failures occur that are safety related
- ▶ Unit level traceability can help
 - ▷ Prevent further failures
 - ▷ Determine root cause and commonality
- ▶ Process improvement tool for Amkor





Unit Level Traceability (ULT)

What is Unit Level Traceability (ULT)?

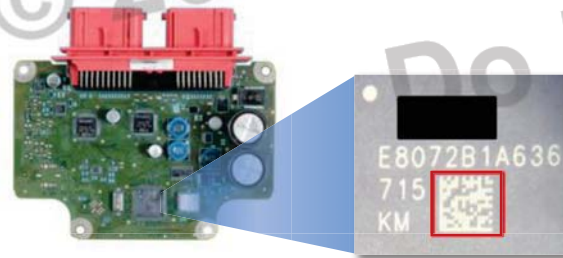


- ▶ Ability to collect and report, through marking (2D barcode), key device data elements
 - ▷ Die information – wafer ID, XY position on wafer
 - ▷ Substrate or leadframe strip information – substrate ID, XY position on strip
 - ▷ Equipment used, process time, etc.
- ▶ Service can apply to any package family, based on customer request
 - ▷ Note: Not all lines will have same capability
- ▶ Amkor's traceability services include data collection and transmission

Use Case 1 – Detecting Failure Commonality



Field Failure 1



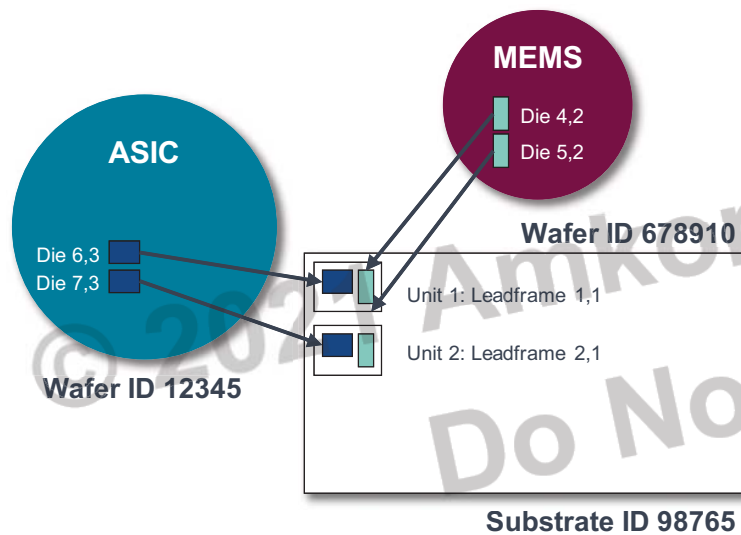
Field Failure 2

	Die		Substrate	
	Wafer ID	XY Position	Substrate ID	XY Position
Unit 1	12345	6,3	98765	1,1

Both failed units are from same wafer

	Die		Substrate	
	Wafer ID	XY Position	Substrate ID	XY Position
Unit 2	12345	12,7	78251	5,2

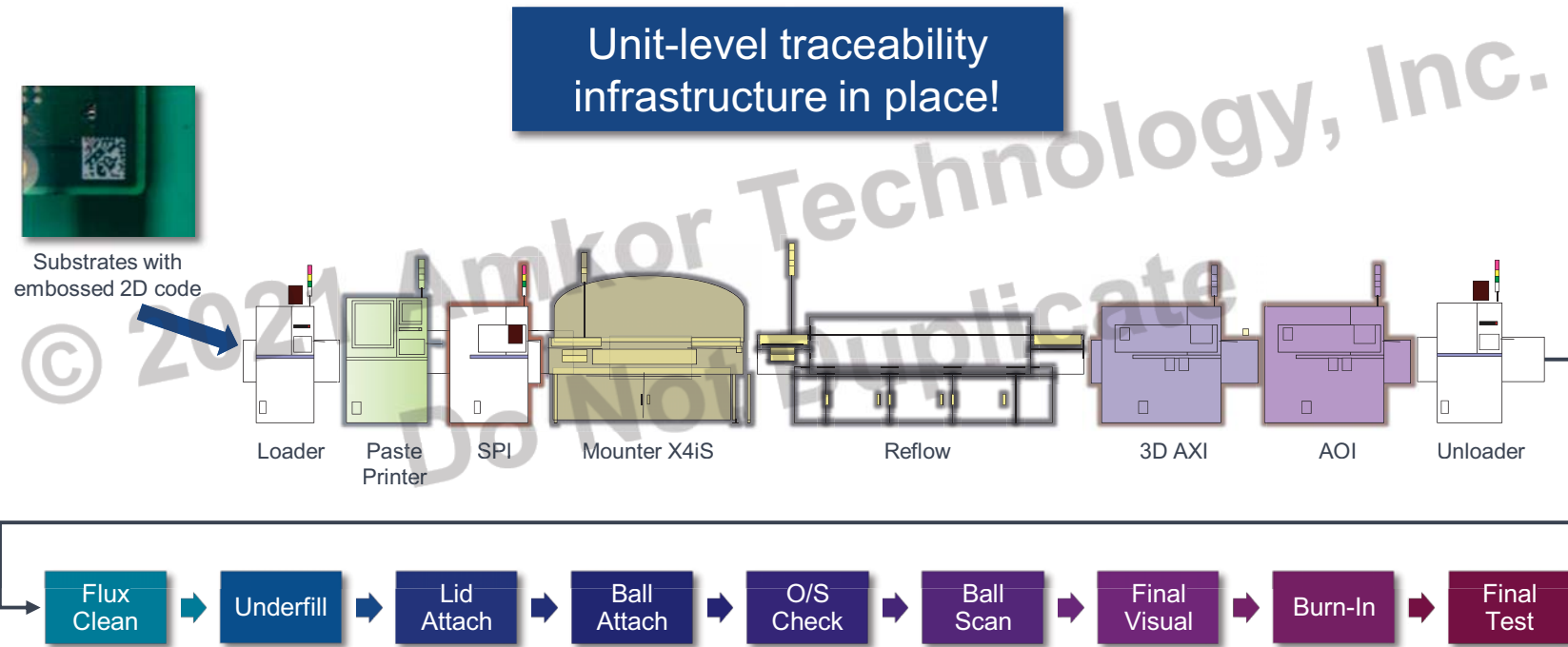
Use Case 2 – ULT Without 2D Mark



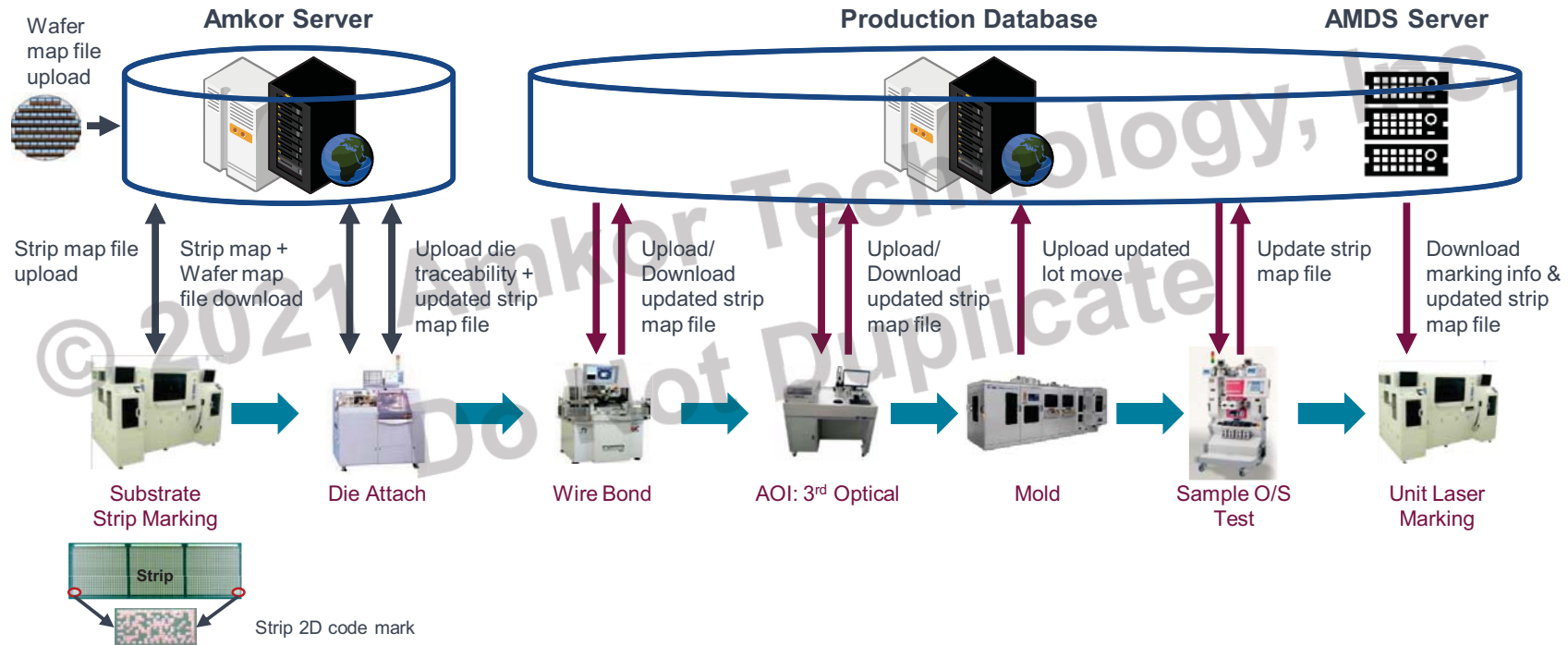
	ASIC Die		MEMS Die		Substrate	
	Wafer ID	XY Position	Wafer ID	XY Position	Substrate ID	XY Position
Unit 1	12345	6,3	678910	4,2	98765	1,1
Unit 2	12345	7,3	678910	5,2	98765	2,1

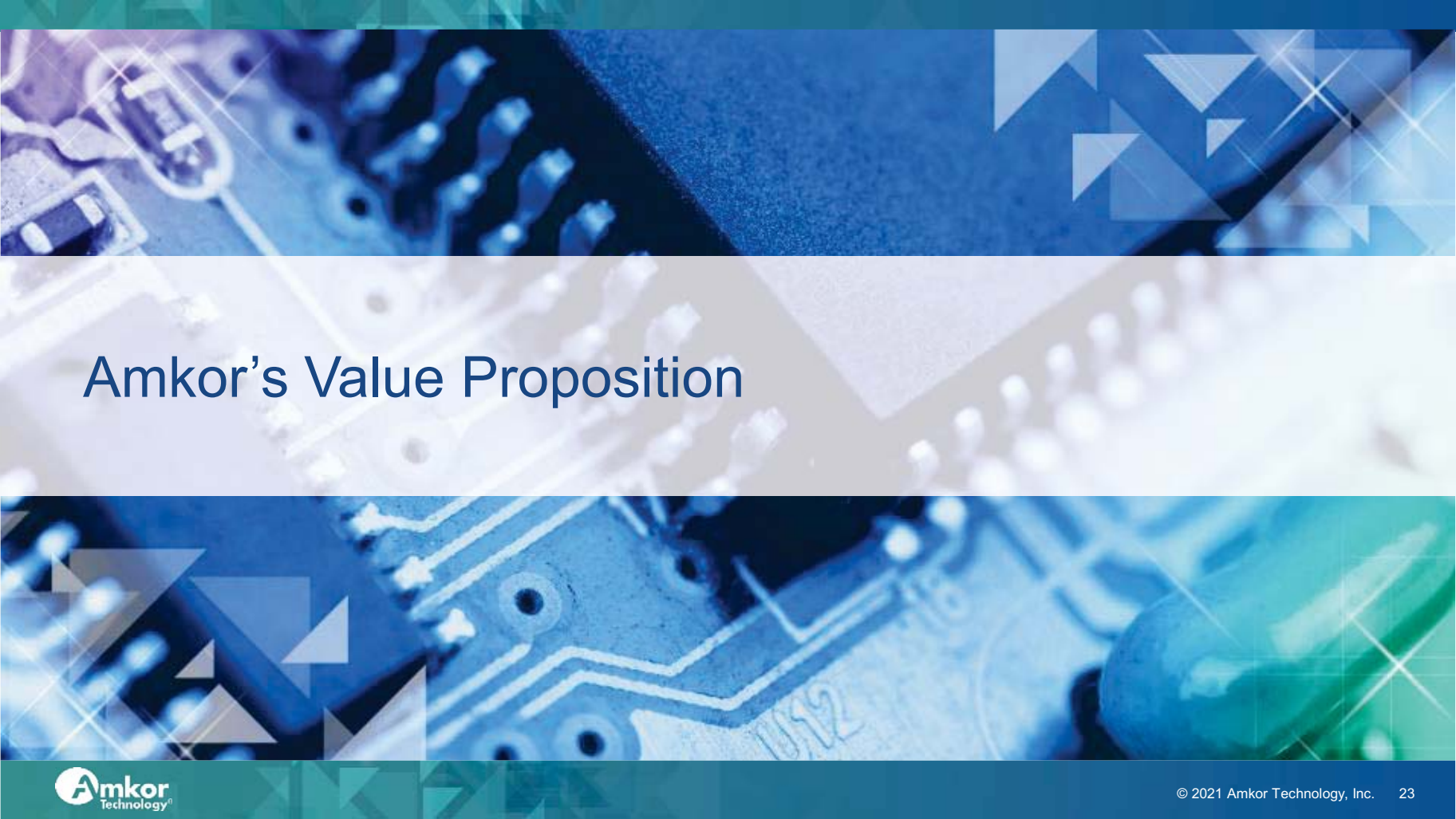
- ▶ ASICs have capability to be read electrically, however MEMS may not be
- ▶ Amkor provides ASIC, MEMS and substrate pairing information via shared database
- ▶ ASIC die is read electrically; corresponding MEMS and substrate information can be pulled from database

Automotive SiP Line Configuration and Flow



Unit Level Traceability System (ULT) Flow



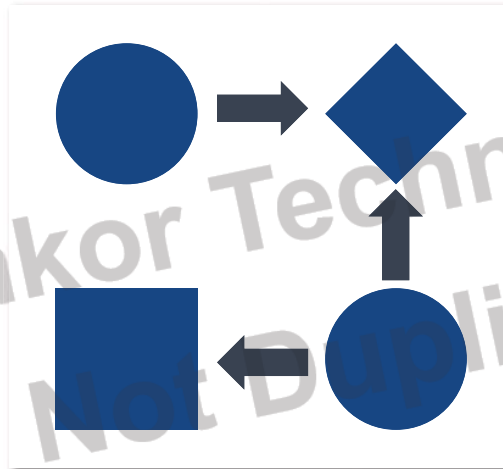


Amkor's Value Proposition

High Level Customer Expectation



Unique unit 2D barcode



Process, material and
equipment history at
every step



Real-time retrieval of
information

ULT Standard 44 Data Elements

Lot Details	Die Attach/Chip Attach/WLFO	Laser Marking
Factory ID Site ID	Wafer ID	Serial Number
Machine Name	Starting_Point	Unit ID
Strip Out DateTime	Origin Location	Unit Attached Time (D/A, C/A)
Amkor ID Sub ID	Wafer Flat Notch	Dimension Data
Customer Lot Number DCC code	Wafer X Wafer Y	Unit ID on Chip (DPS, Pkg)
Operation Code	Wafer Bin Code	KeyNo
Source Device Target Device	Substrate ID	Engrave 2D on Frame
Date Code Trade Code	Substrate X Substrate Y	
PDL	Substrate Bin Code	
Assy Lot# Lot Type	Die Bin Tracking	
Customer #/Name		

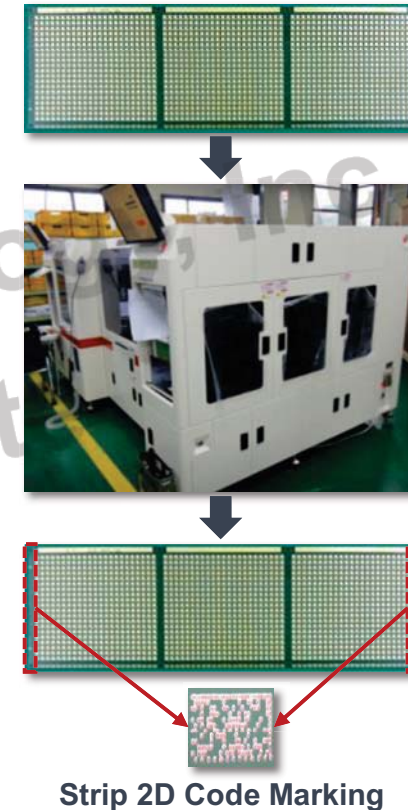
Amkor ULT Capability Catalog

Process	Leadframe	Laminate	
		Unit	Strip
Common	Device #, Assembly lot #, Process time, Customer lot #, Lot type, Amkor ID, PDL, Customer #/name		
Die Bin (Non-std process)	N/A	Die bin tracking	
ID Marker	Engrave 2D ID on frame	Engrave 2D ID on unit	Engrave 2D ID on strip
C/M	N/A	Supplier lot # , Manufacturing date	
D/A, C/A	Wafer ID, Frame ID, X/Y position, Wafer map, Component ID, Die ID	Wafer ID, PCB ID, Wafer map, Component ID, Die ID	Wafer ID, Strip ID, X/Y Position, Wafer map, Component ID, Die ID
M/K	Engrave 2D on unit (1 except for laminate lid)		
Other Process	Unit ID, Package dimension		
Format	CSV/XML/JSON Format		
Storage	B2B Under customer FTP		
Retention	5 years (Commercial), 15 years (Automotive)		

Capable but need investment for capacity. **Expandable** need investment to cover new customer/capacity.

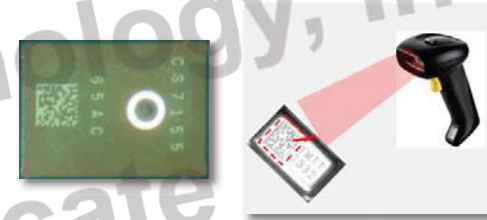
2D Strip Marking

- ▶ 2D code on the leadframe or substrate strip
- ▶ Prevents strip-level product mixing post-mold
 - ▷ Logging of process failures at each assembly station
 - ▷ Generate individual output map for each lot per assembly process
 - ▷ Integrate 3rd Optical AOI and sample OS with strip and unit/die traceability
 - ▷ Automate unit rejection to improve lot handling
 - ▷ Improved data analytics
- ▶ Strip mapping of defects found at AOI and OS
- ▶ Being implemented at ATP for automotive leadframe products



Die Traceability

- ▶ 2D code on the unit
- ▶ Track location of unit on wafer and strip
- ▶ Access to data for engineering problem solving or unit failures
 - ▷ Lot transaction history, BOM, yield and defect breakdown
- ▶ Capability exists today for certain products
 - ▷ MEMS dual die products
 - ▷ FCBGA with lid marking

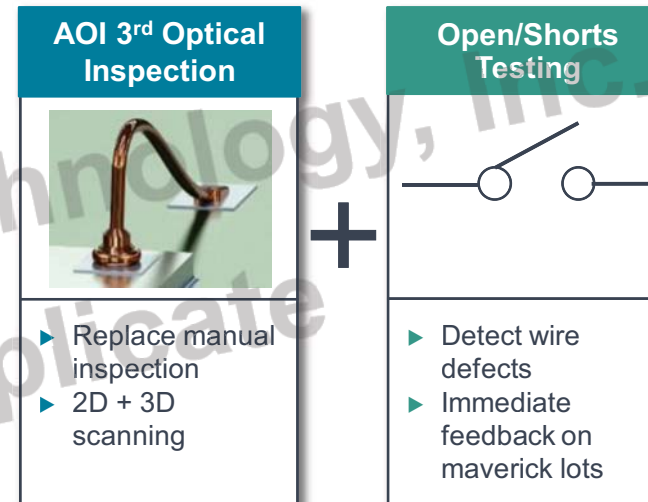


Data analytics for engineering problem solving

1. Strip map and wafer map/die location
2. eCIM Data (transaction history)
3. Bill of Materials
4. Yield and defect breakdown
5. eSPC and eStandroll

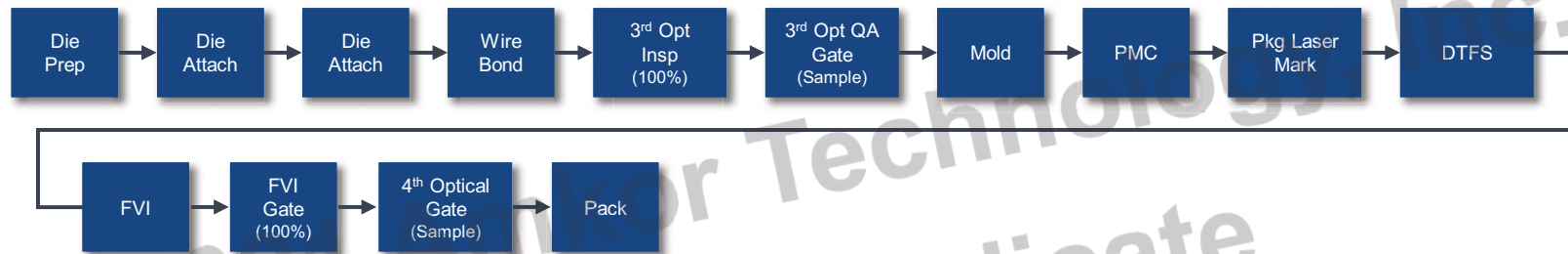
AOI + Sampling O/S

- ▶ AOI replaces 100% manual 3rd optical inspection for automotive customers
- ▶ Provide fast feedback on Maverick lots
 - ▷ Lots with yield more than 3 sigma from the average
- ▶ OS Sampling to catch wirebond defects after AOI
 - ▷ AQL 0.1 or 125 units/lot (lot size of 3.5k~10ku)

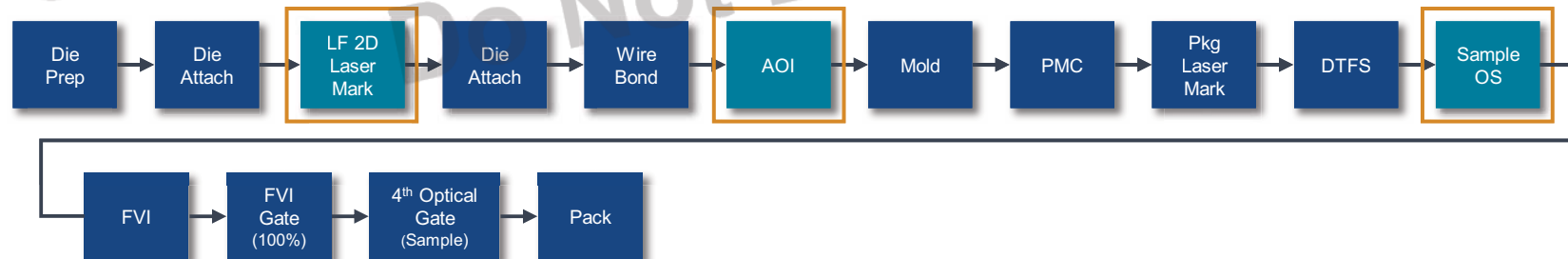


Assembly Process Flow Comparison

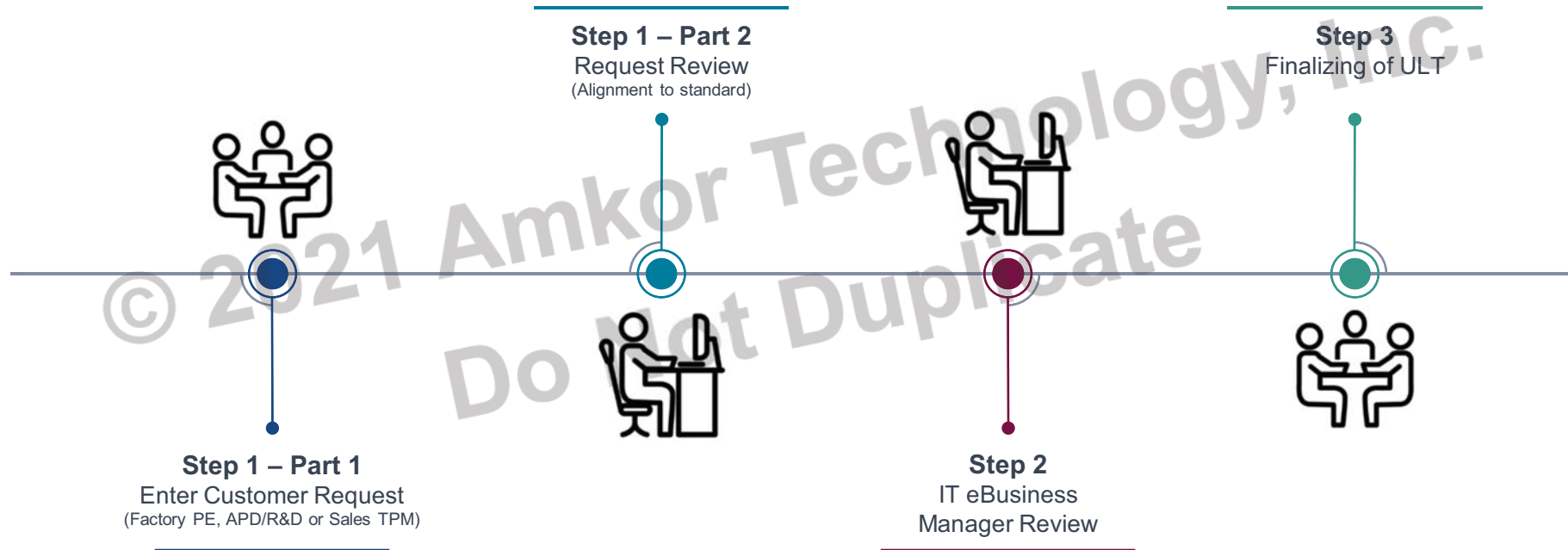
Current Flow



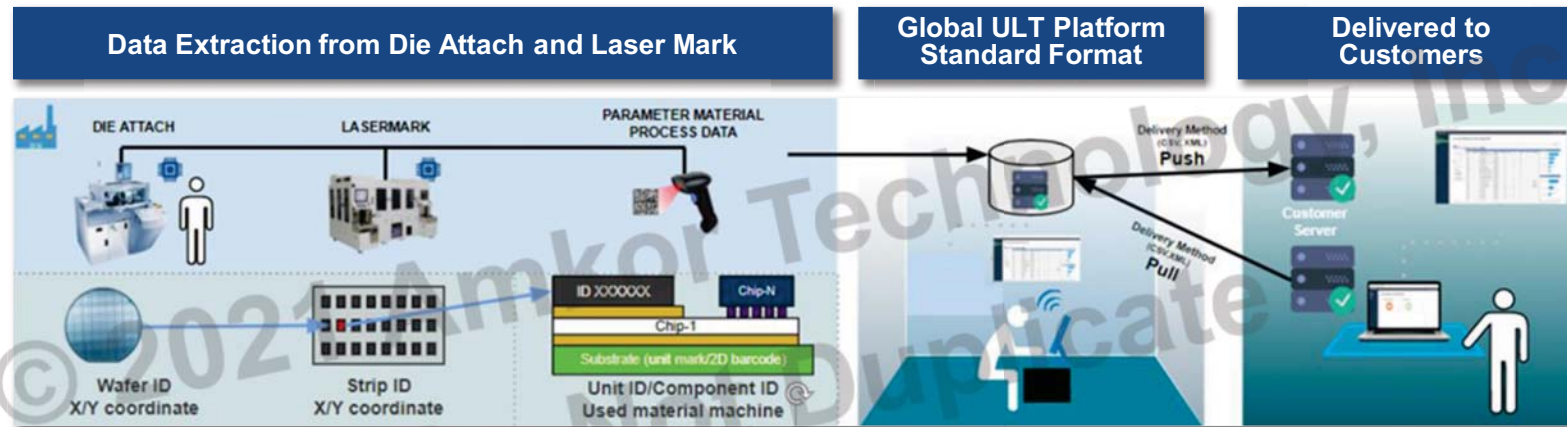
New Flow



How to Request ULT Service



IT Global Data Extraction Platform



- ▶ System developed to collect and report data
 - ▷ Enables push/pull of traceability data
- ▶ Requests entered by sales or factory



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Amkor's Differentiators



Technology

Advanced Packaging Leadership
Engineering Services
Broad Portfolio



Quality

QualityFIRST Culture
Execution
Automation



Service

Design & Test Through Drop Ship
Manufacturing Footprint
Local Sales & Support

Global Companies Rate Advantest THE BEST ATE Company 2020



Advantest receives highest ratings from customers in annual VLSIresearch Customer Satisfaction Survey.

Advantest received an overall score of 9.5 out of 10, with highest ratings in categories of:

**Technical Leadership – Partnership –
Uptime – Commitment – Trust in Supplier –
Quality of Results – Product Performance –
Recommended Supplier**

“Year-after-year the company has delivered on its promise of technological excellence and it remains clear that Advantest keeps their customers’ successes central to their strategy. Congratulations on celebrating 32 years of recognition for outstanding customer satisfaction.”

— **Risto Puhakka**, President VLSIresearch

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Virtual Event Schedule

Join us for two online sessions

Wednesday	April 28, 2021	8:00 - 11:00 am PDT
Thursday	April 29, 2021	8:00 - 11:00 am PDT

Your personal Zoom link is the same for both days.
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Speakers April 28



[Saverio Fazzari](#)

Booz Allen Hamilton

**Supply Chain Challenges
for Defense Systems**



[Sridhar Swamy](#) & [Akash Malhotra](#)

Advanced Micro Devices

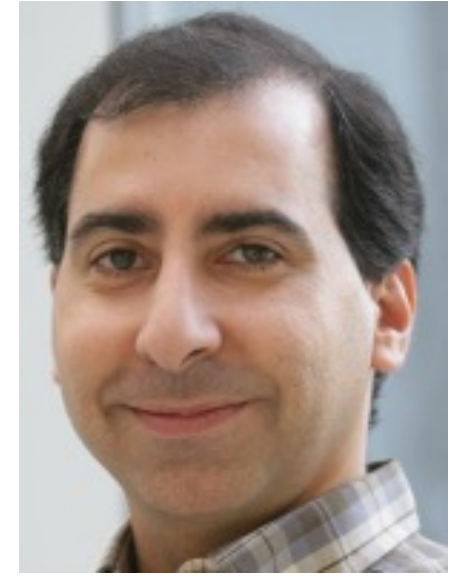
Securing Supply Chain



[Nader Sehatbakhsh](#)

University of California
Los Angeles (UCLA)

**Hardware and
Supply Chain Security
in the era of Advanced
Heterogenous Integration**



[Michael Azarian](#)

University of Maryland

**Hardware Trojans and
Counterfeit
Microelectronics:
Detection and Diagnosis**

Speakers April 29



[Matthew Arenó](#)

Intel

**Identifying Supply Chain Threats –
An Honest Assessment**



[Ajay Sattu](#)

Amkor Technology, Inc.

**Automotive Semiconductor Unit Level
Traceability**



[Navid Asadi](#)

University of Florida

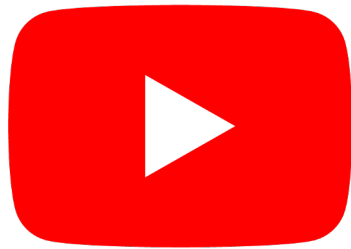
**Physical Assurance and Inspection of
Electronics**

Reminders

Slides & Videos will be posted next week

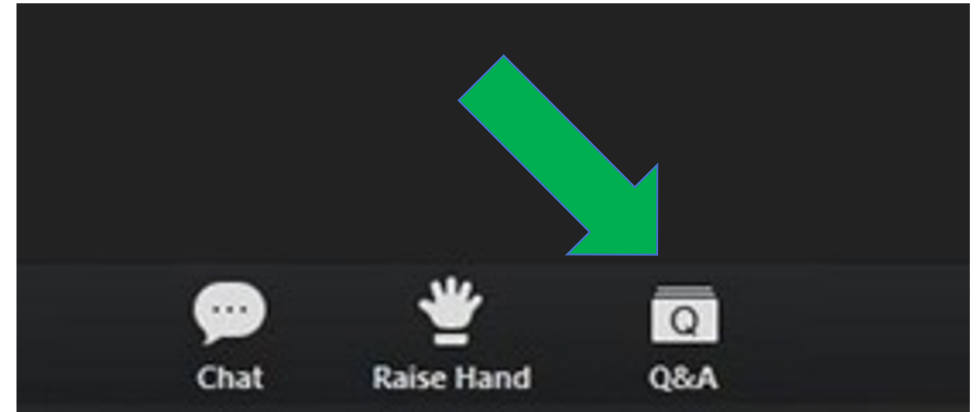


[http://events.meptec.org/
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youtube.com/MEPTECpresents

Please use the Q&A window for your questions



Speakers April 29



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