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Smart Manufacturing

Edge Computing Inference Opportunities and Challenges in ATE

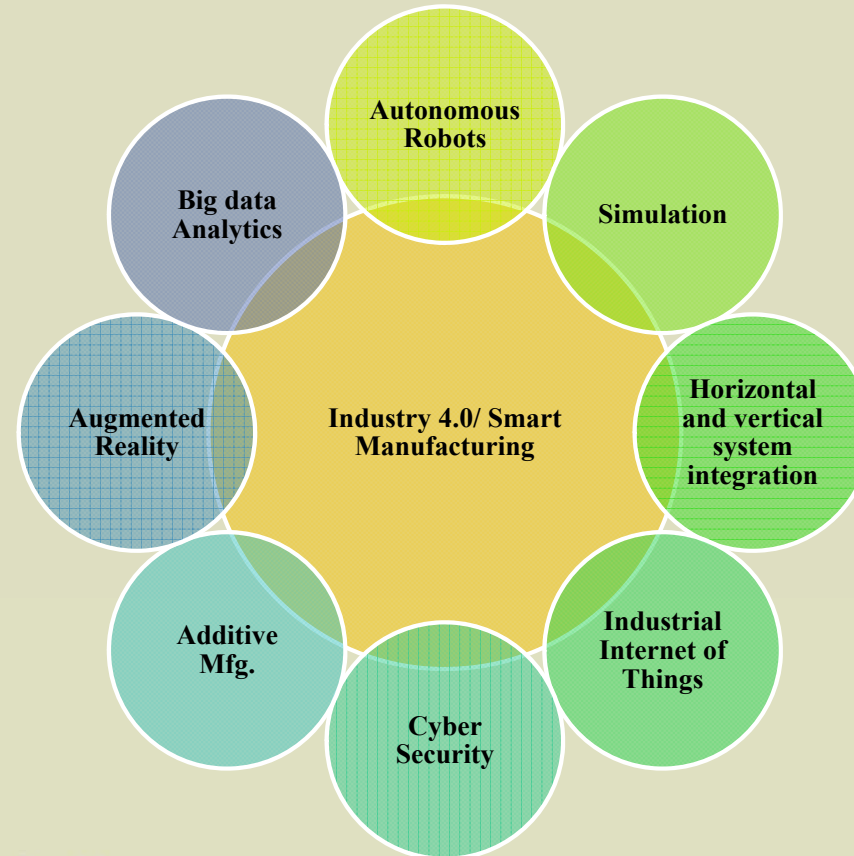
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Teradyne



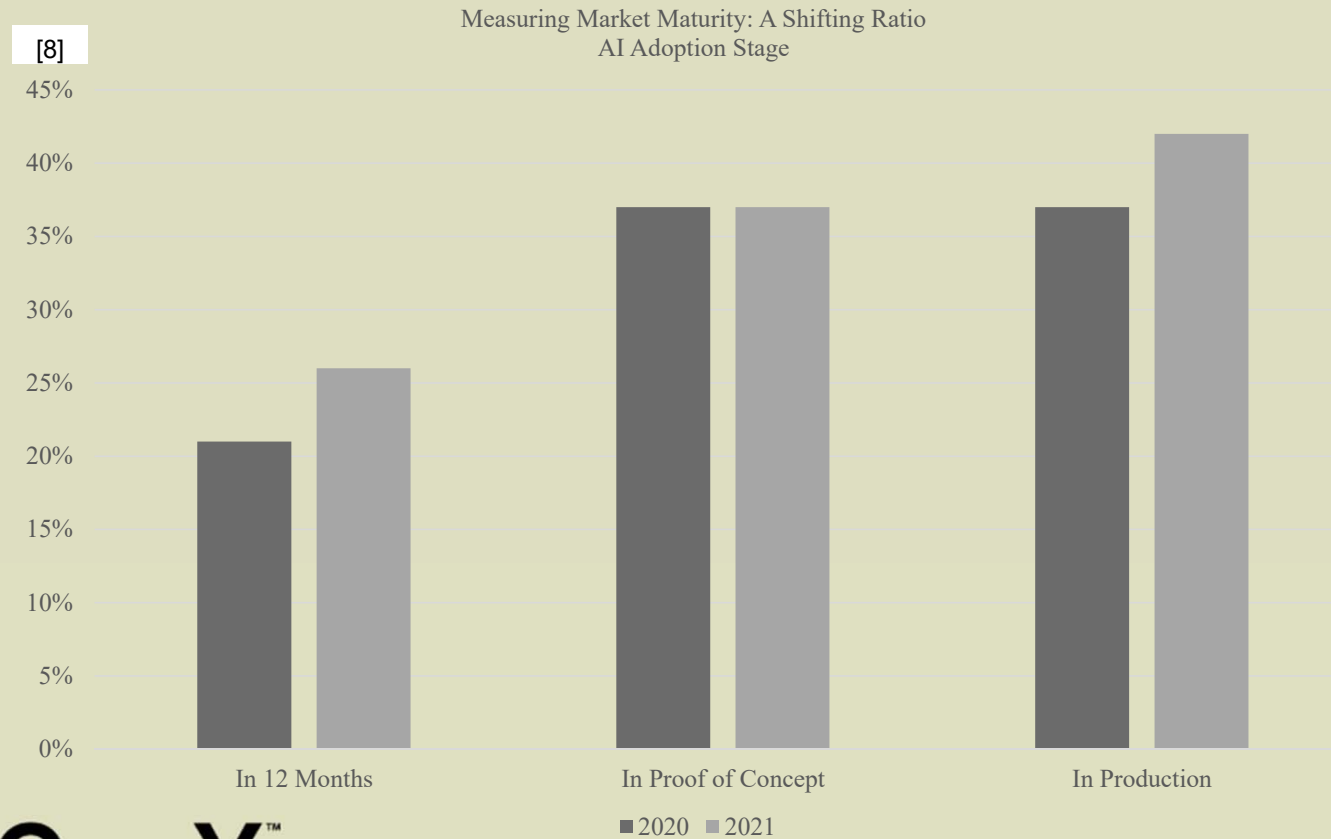
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Everything in your factory is getting smarter



The World is Adopting Data Analytics and Artificial Intelligence

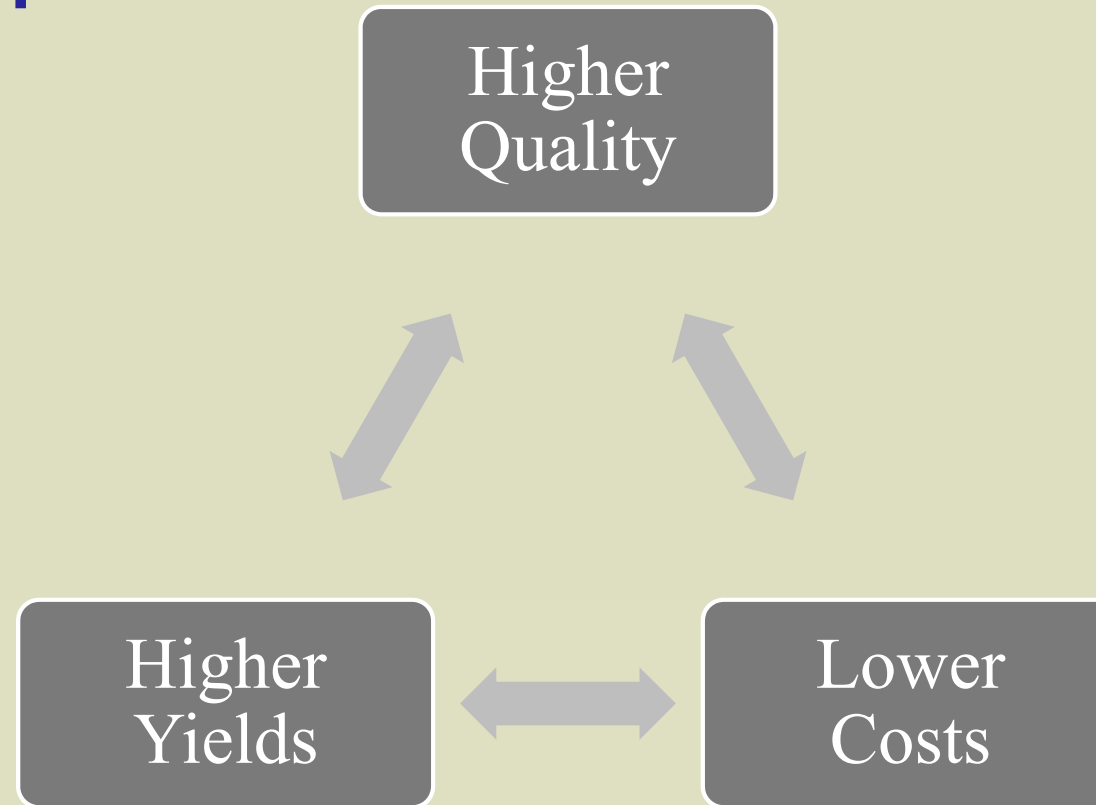


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3

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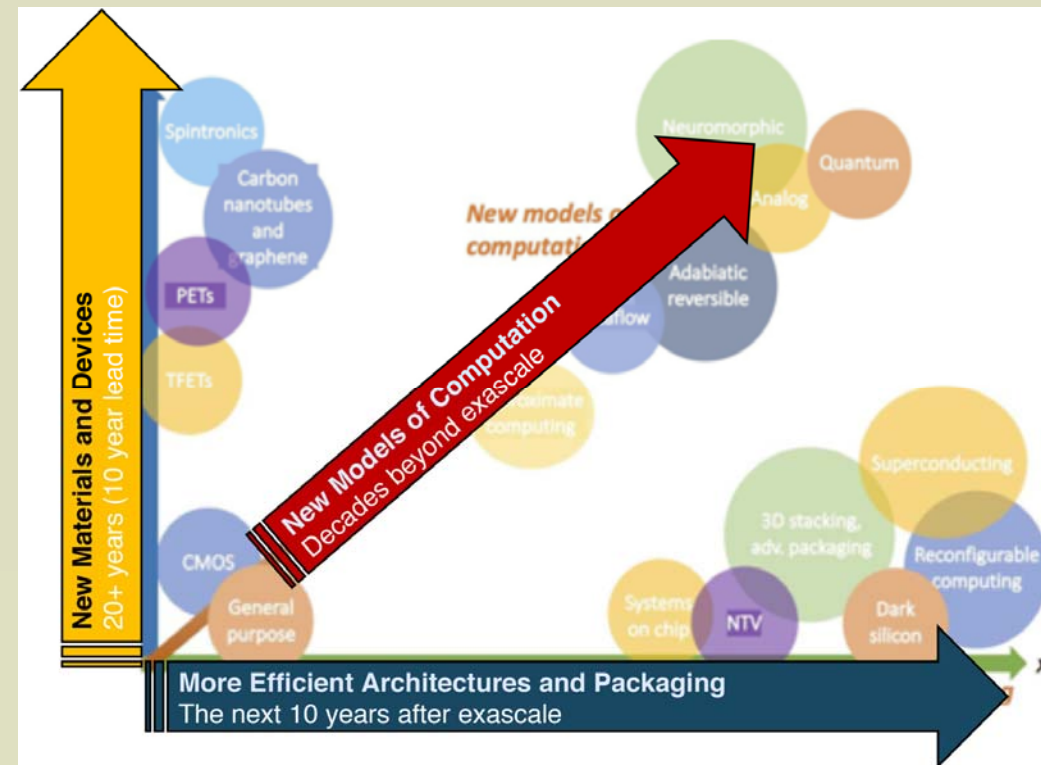
Can advanced analytics help meet industry objectives?



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Increasing complexity is an industry wide challenge

1. Advanced Materials
2. New Devices
3. More Efficient Architectures
4. Packaging Improvements
5. New Computation Models







Scale is not new, but different methods are needed for different times

[1]

The Different Ages of Scaling

(Different methods for different times)

- Geometrical Scaling (1975-2002)**
 - Reduction of horizontal and vertical physical dimensions in conjunction with improved performance of planar transistors
- Equivalent Scaling (2003~2024)**
 - Reduction of only horizontal dimensions in conjunction with introduction of new materials and new physical effects. New vertical structures replace the planar transistor
- 3D Power Scaling (2025~2040)**
 - Transition to complete vertical device structures. Heterogeneous integration in conjunction with reduced power consumption become the technology drivers

Scale is not new, but different methods are needed for different times

[1]

Improvement Paths Application Area	<i>Improvement Paths</i>				
	Algorithmic improvement	Memory bandwidth	Memory latency	Network bandwidth	Fixed-function acceleration
Big Data Analytics		X	X	X	X
Artificial Intelligence	X	X			X
Discrete Event Simulation		X	X		
Physical System Simulation	X	X	X	X	
Optimization	X	X	X		X
Graphics/VR/AR	X	X			X
Cryptographic codec		X			X



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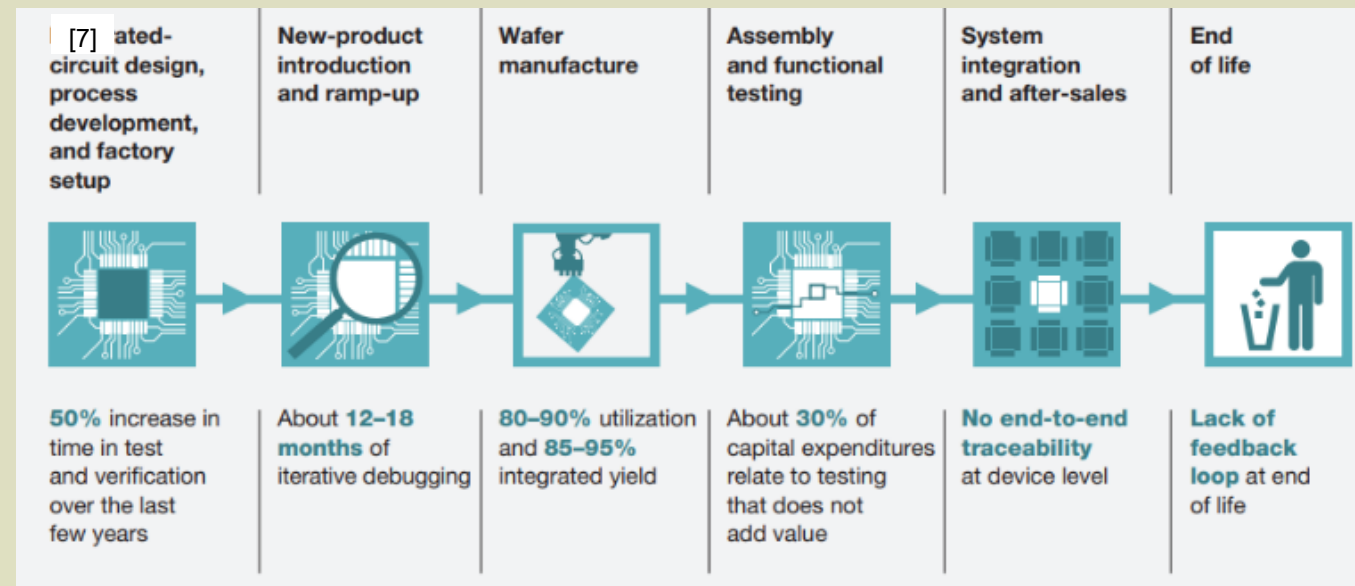
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Current value chain is improving, but continuous improvement is required

Manual intervention with some degree of automation

Improving processes by creating analytical tools

- Replace guesswork and human intuition
- Fact-based knowledge
- Pattern recognition



[7] Burkacky, O., Patel, M., Sergeant, N., & Thomas, C. (2017). Reimagining fabs: Advanced analytics in semiconductor manufacturing.



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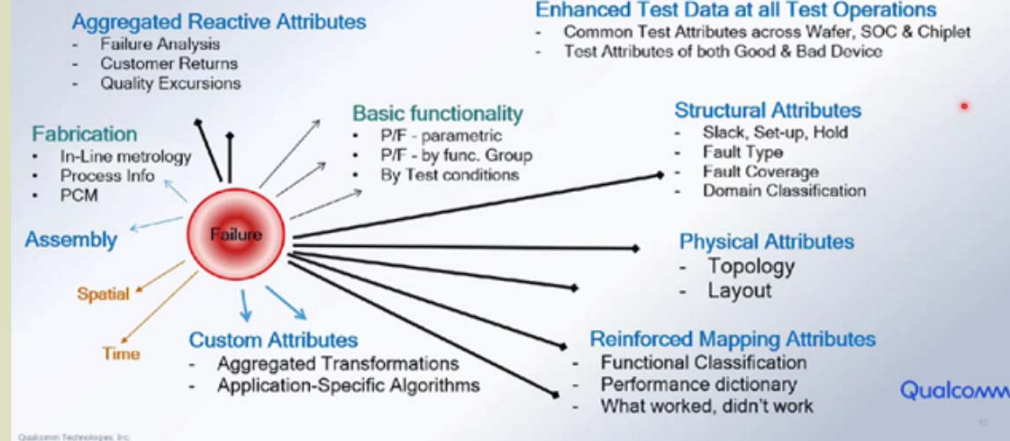
Existing and near-term solutions are a combination of automation, expert systems and advanced analytics

1. Expedite Test program bring-up
2. Shorten debug cycles
3. Accurately associate root cause failures with design, process or equipment issues
4. Minimize test time impact

Capture Variances with Higher Dimension Datasets

Collaboration across all disciplines → Strong Failure Signatures

[3]



[3] (2021) MEPTEC: Road to Chiplets: Data & Test

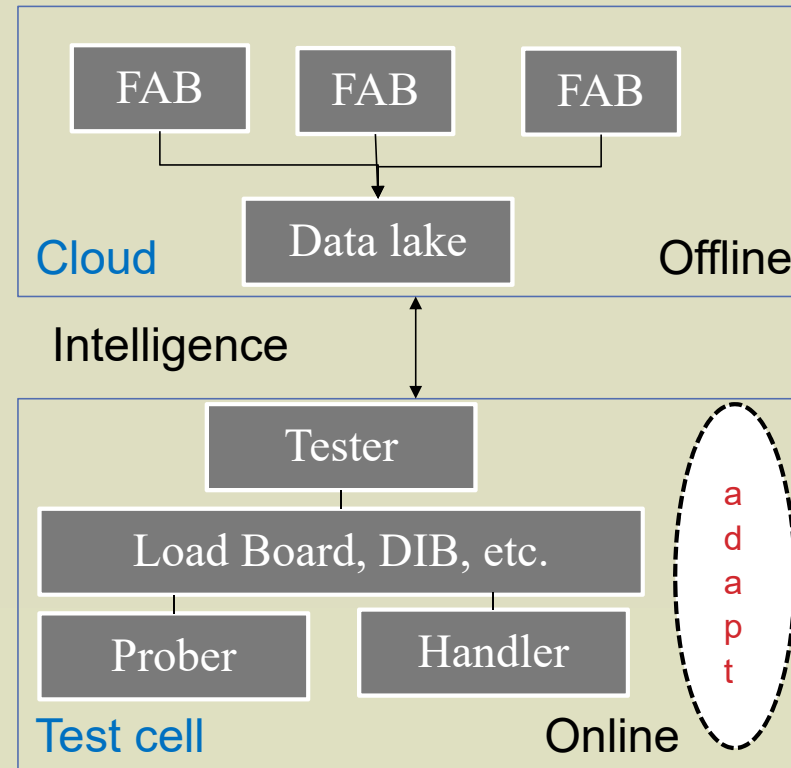


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Today's Solution and Challenges



Today's Solution and Challenges

	SOLUTIONS	CHALLENGES
Offline	<ul style="list-style-type: none"> • Data collected from multiple OSATs is analyzed to identify systematic issues • Recommendations to test teams of potential causes of variance 	<ul style="list-style-type: none"> • A knowledge network to augment analytics and provide optimal, robust & usable recommendations • Security and latency deploying intelligence to the test cell
Online	<ul style="list-style-type: none"> • Secure inference compute connected to tester, e.g., Edge inference • Low latency and does not add to floor space • Integrates with ATE OS / test program to minimize test time overhead 	<ul style="list-style-type: none"> • Capture data variance from test cell equipment • Update intelligence in real time • Scalability at OSATs

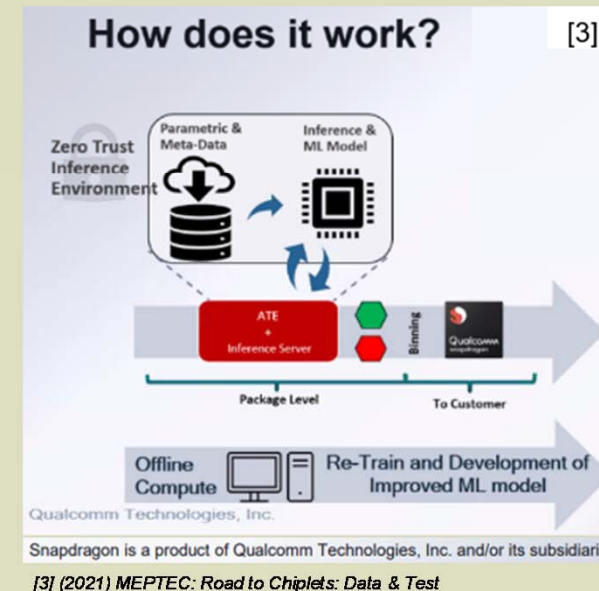
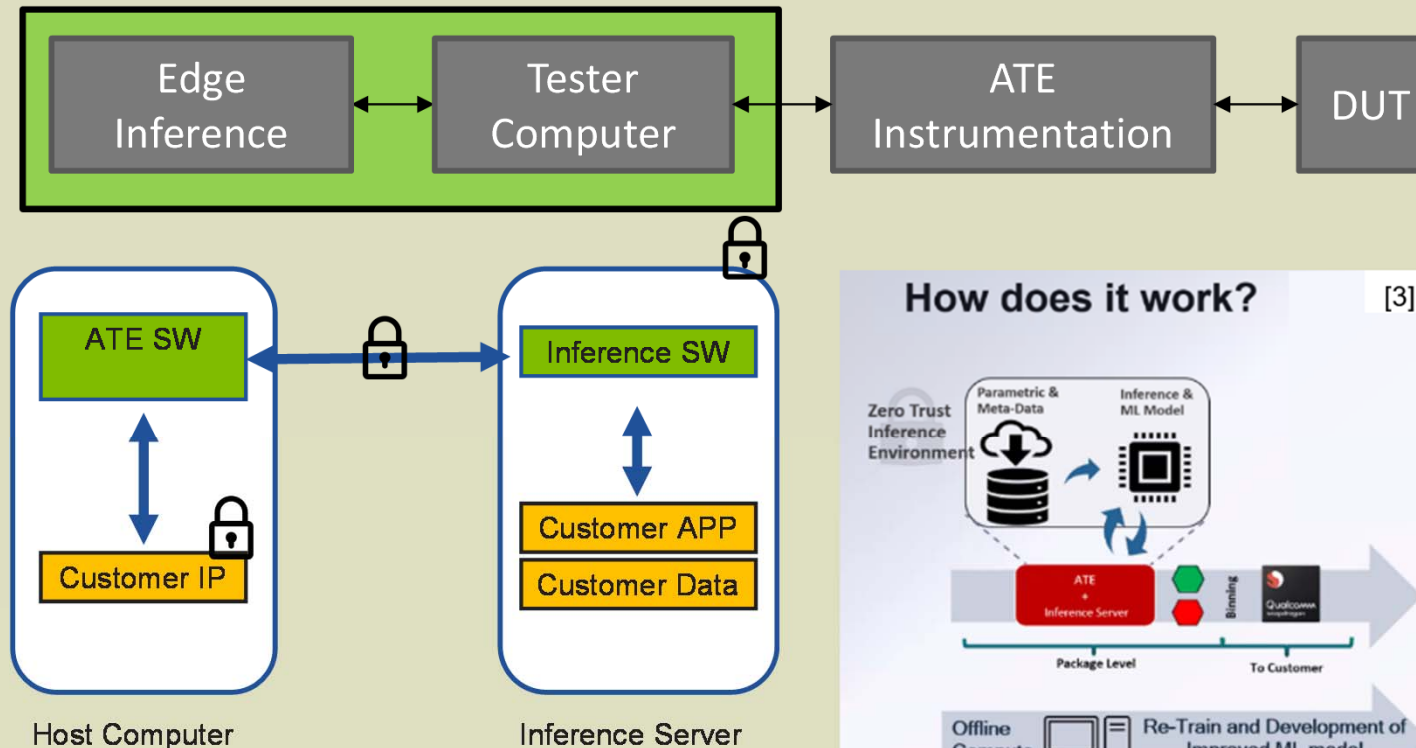


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11

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Inference server provides secure parallel compute



Inference server provides secure parallel compute

1. On-the-fly machine learning scoring/decision making
2. Zero Trust Environment
3. Minimum Latencies
4. Easy model integration with test programs and ATE Control



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13

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Test Cell Edge Inference Compute Requirements

BENEFITS

1. Secure communication to ATE OS
2. Low latency
3. Does not consume floor space



Test Cell Edge Inference Compute Requirements

Challenges

1. Inference limited test time
2. Adds to test cell infrastructure capital cost
3. Combines knowledge and data analytics for inference

Table AB-4 AI/ML Deployment Platforms and Constraints

Deployment Platforms	High Performance (Cloud)	Real Time Inference (IoT Edge)	Resource-constrained Inference (IoT Edge MCU/IOT)
Training System	Cloud	Cloud	Cloud
Inference System	Cloud	IoT Edge Computer	IoT Edge Microcontroller
Training Speed	High	High	High
Inference Throughput (pages/second)	High	Medium	Low
Inference Latency (milliseconds)	High	Low	Low
Compute	High	Medium	Low
Cost	High	Medium	Low
Power	High	Medium	Low

IEEE: 2021 International Roadmap for Devices and Systems



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Conclusion

Advanced analytics coupled with automation and knowledge systems can facilitate in addressing the upcoming challenges

- Advanced analytics are needed
- Security, infrastructure and latency will be balanced between offline and online analytics
- Data
 - Collaboration, and sharing data and intelligence between design and test cell equipment vendors is necessary
 - Data variances will be used to build algorithms for inference



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16

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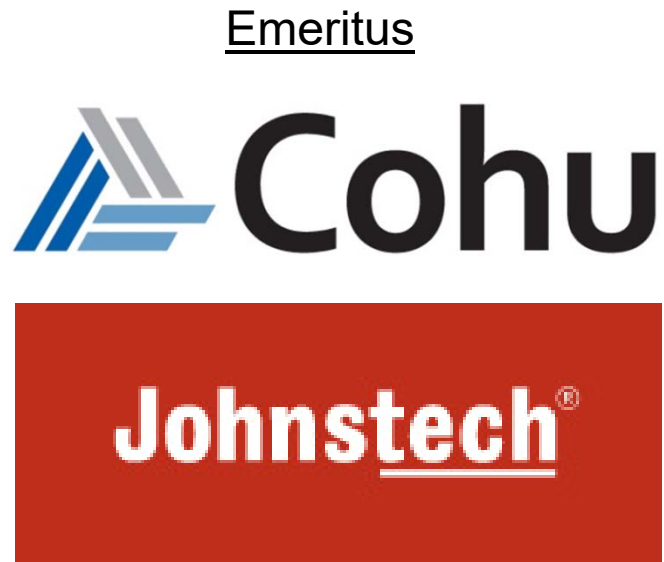
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