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2023 PDF Users Conference:

AI for tomorrow's manufacturing and R&D

Santa Clara Marriott - 2700 Mission College Boulevard Santa Clara, California 95054 USA

Operationalizing and Scaling AI/ML with ModelOps

25th October 2023

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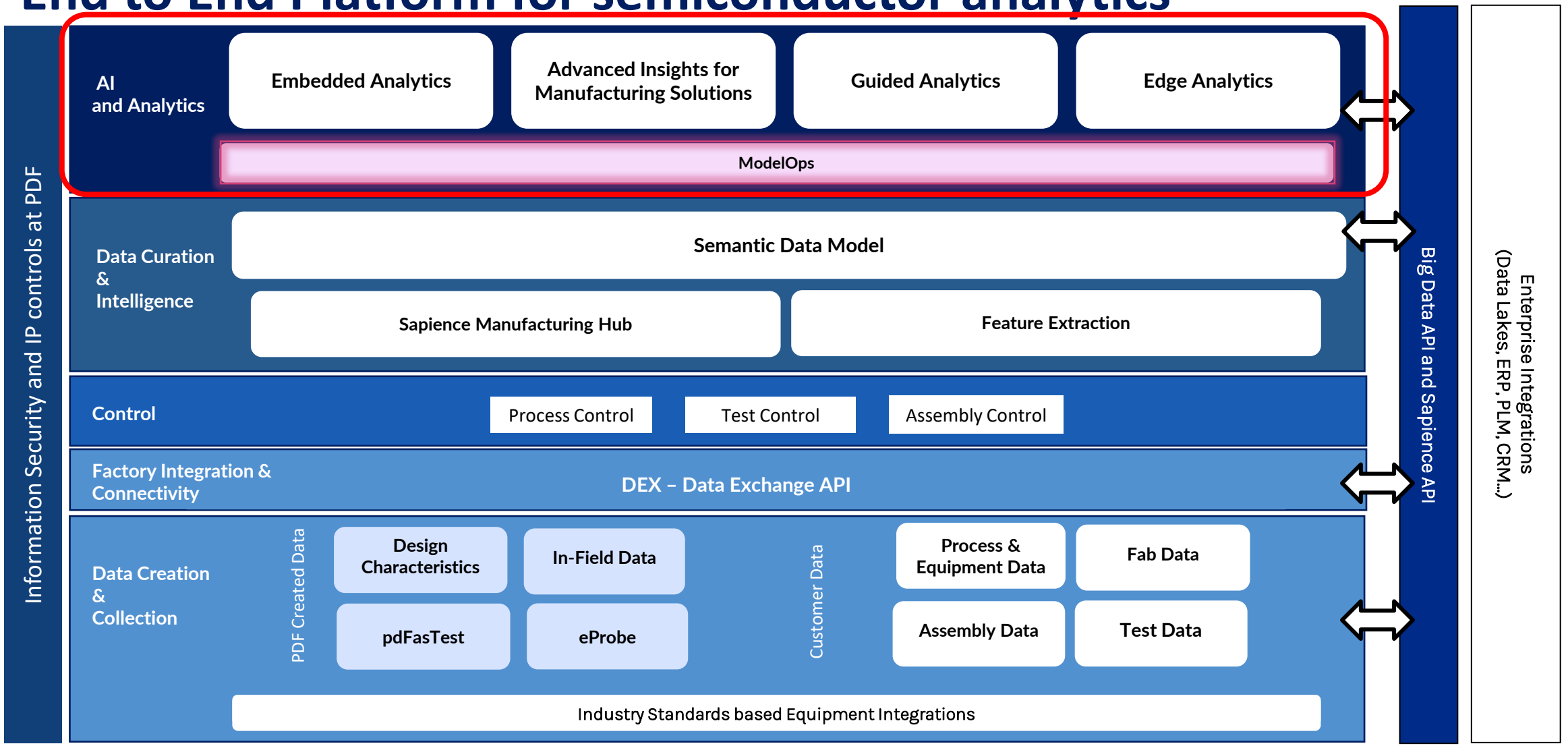
End to End Platform for semiconductor analytics



Fully integrated solution to accelerate production ramp, improve overall yield and quality for Semiconductors

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Proof of Concepts (PoC's) in AI/ML are becoming easier, and are not by themselves valuable

- Lots of people in the semi industry can do PoC's now
- *More rare* -> productionalizing the AI/ML PoC for just one chip product
- *Very rare* -> a generalized platform that can bring AI/ML to production across multiple chip products and use cases in a heavily automated way

PoC's in AI are difficult to scale for semiconductor use cases

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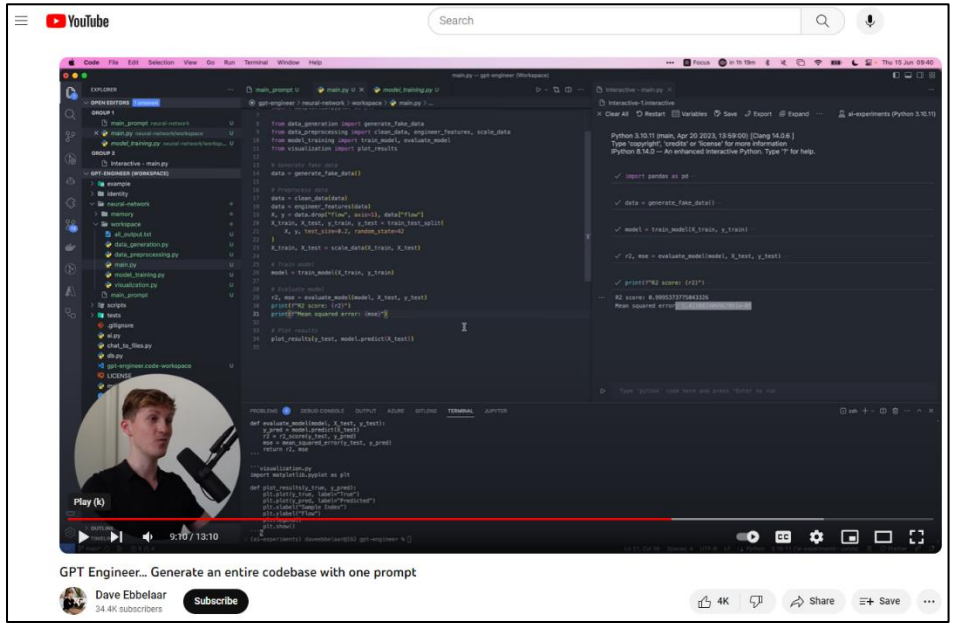
Examples of PoC's getting easier (and changing)..

- **"GTP Engineer" is a new offering, here is a nice demo/overview with a relevant use case. Interesting sections 4:00-7:00.**

Prompt: Create code to train and test a neural network using a typical machine learning pipeline. Use a fake dataset (regression), process it with the pipeline, split it into train/test and evaluate the performance by creating line plots. Use sklearn and matplotlib.



https://www.youtube.com/watch?v=gWy-pJ2ofEM

"AI won't take your job, it's somebody using AI that will take your job."

- Richard Baldwin, economist and professor at the Geneva Graduate Institute, Switzerland

… but PoC's by themselves don't generate value

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Enabling you to realize value with AI

- **Single platform for all data in Exensio**
- **Infrastructure for semiconductor-specific data**
- **The same data science platform for all semiconductor data types – this saves data scientists' time and effort**
  - Bring your own algorithm/model, predefined solutions

PDF provides a platform and solutions that brings ***better*** models to chip production ***faster***

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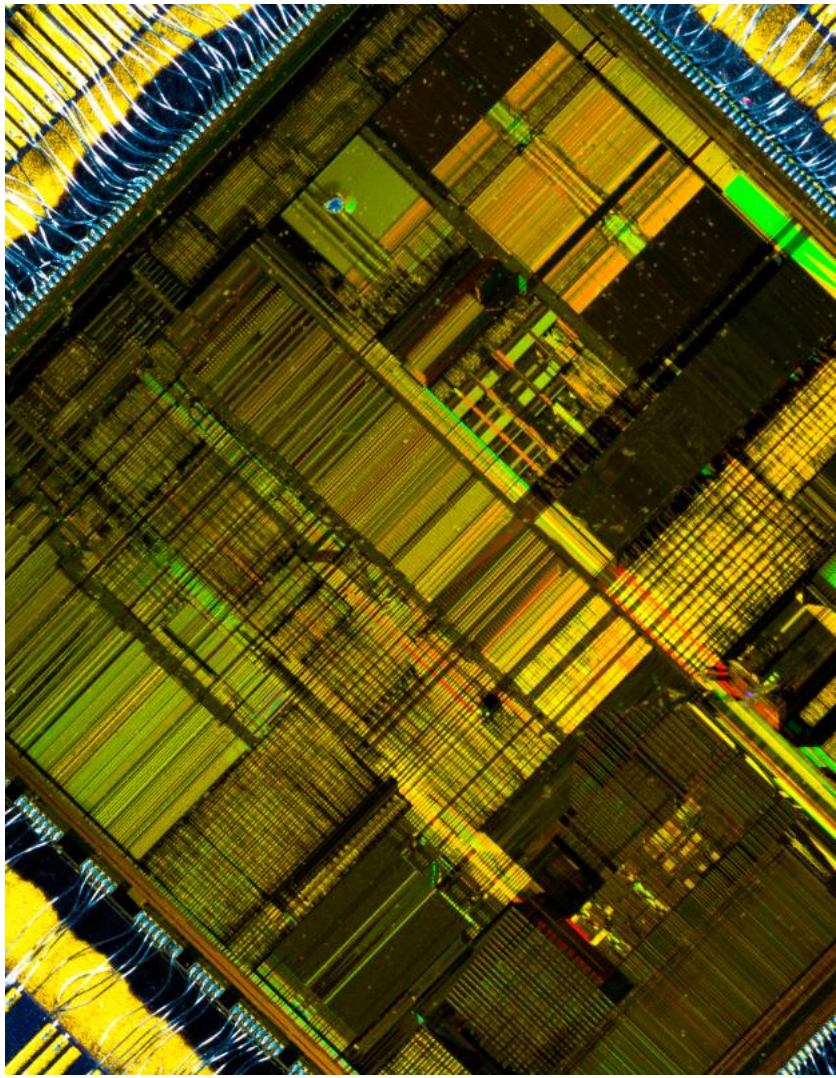
Pain Points for model training in the Semiconductor Industry

- Semiconductor data makes it difficult to apply ML pipelines designed for other industries
- Models need to be deployable to the edge
- Upstream data preprocessing and staging
- Agnostic to model development and deployment environments (e.g. AWS, Azure, GCP, etc..) and enable BYOA/BYOM



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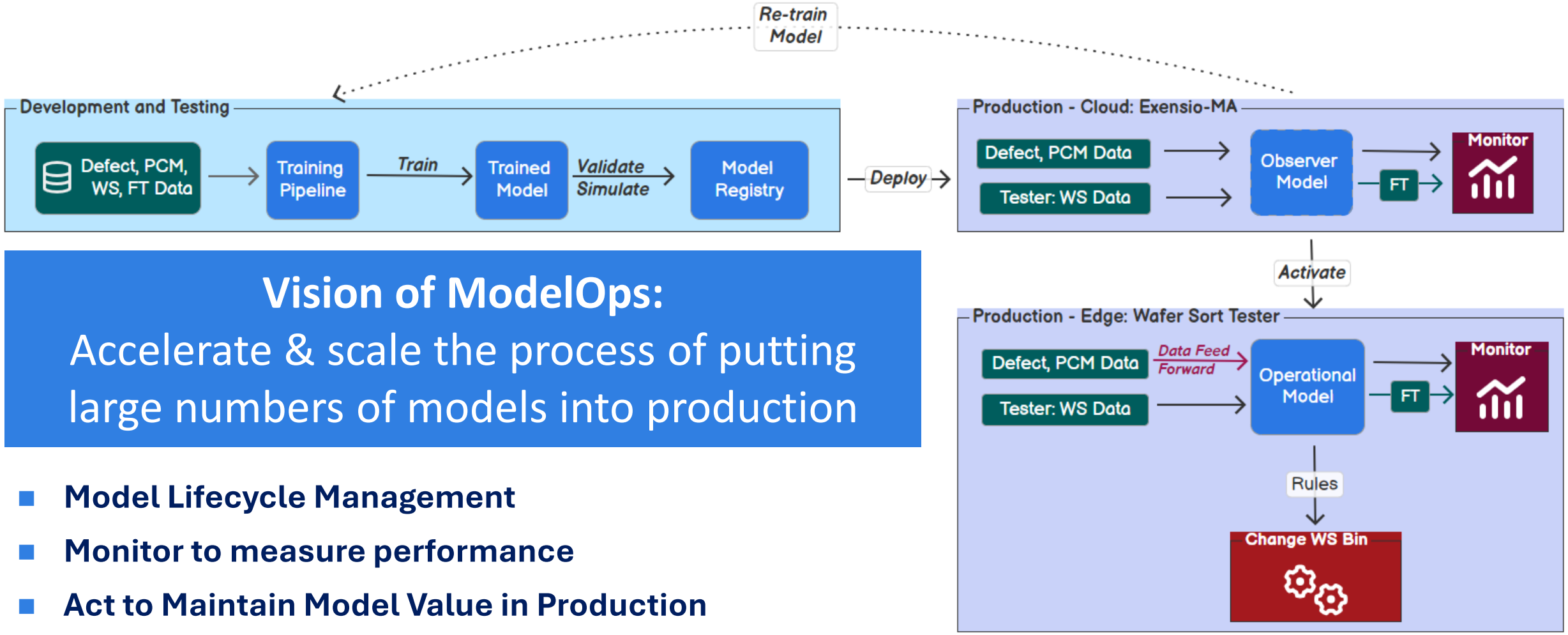
System Capabilities: Create, manage & control models across their lifecycles

Example: Predict Post-Burn-in Test results at Wafer Sort from Defect, PCM & Wafer Sort data



Vision of ModelOps:
Accelerate & scale the process of putting large numbers of models into production

- **Model Lifecycle Management**
- **Monitor to measure performance**
- **Act to Maintain Model Value in Production**

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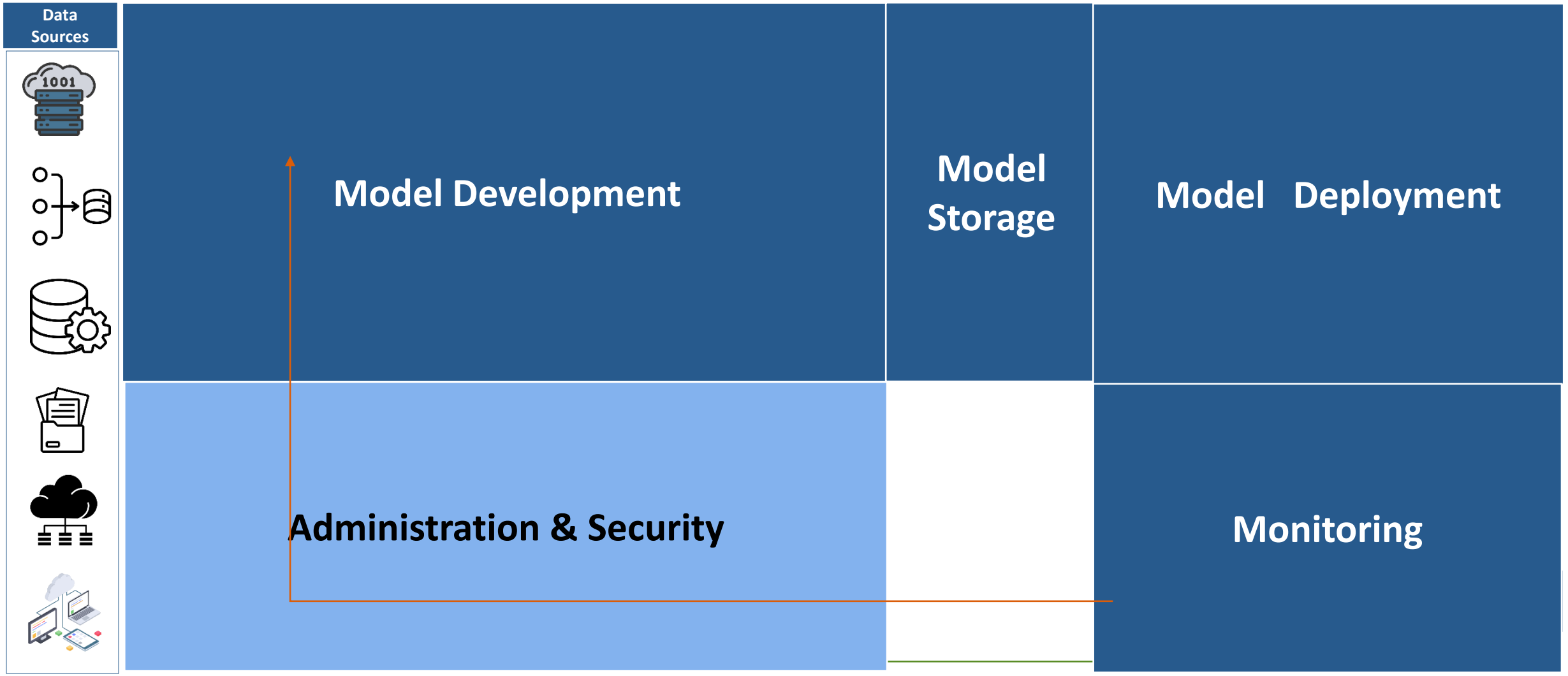
ModelOps Lifecycle with PDF capabilities & Extension Points



PDF ModelOps capabilities

Extension Points to Bring-your-own Algo / Model / Inference Engine

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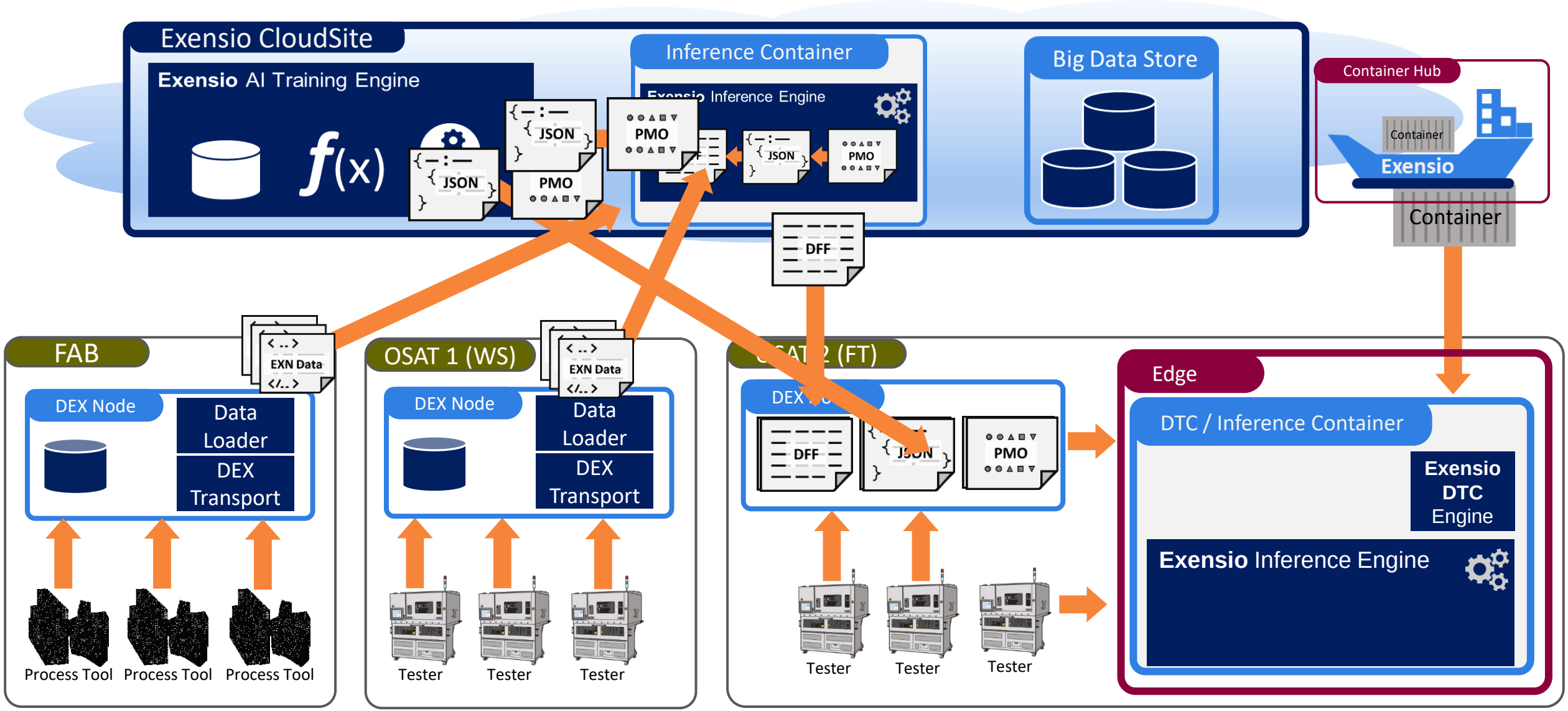
Exensio ML: Test Example



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ModelOps Platform Capabilities

Build

- Dynamically scaled compute
- Leverages any Exensio data
- Modularized pipeline
- Configurable data types / products
- Models saved for deployment
- BYOA - python
  - Most technologies supported
- Integrates with 3rd party platforms

Deploy

- Model routing
- Automated upstream data processing
- Production Monitoring
- Performance skew handling:
  - Re-train/replace models
- Model validation
- Automated safety nets
- BYOM

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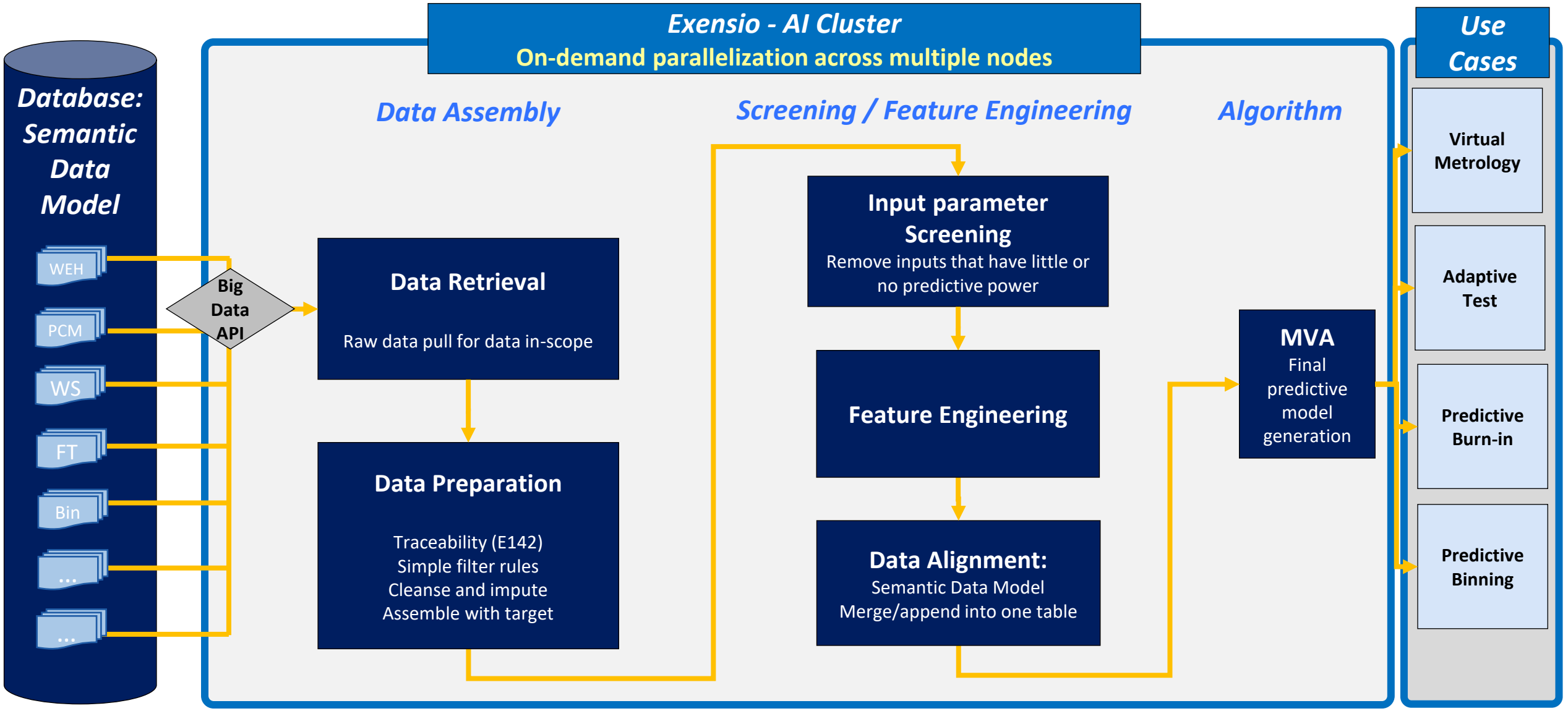
Dynamically-Scalable Training Pipeline



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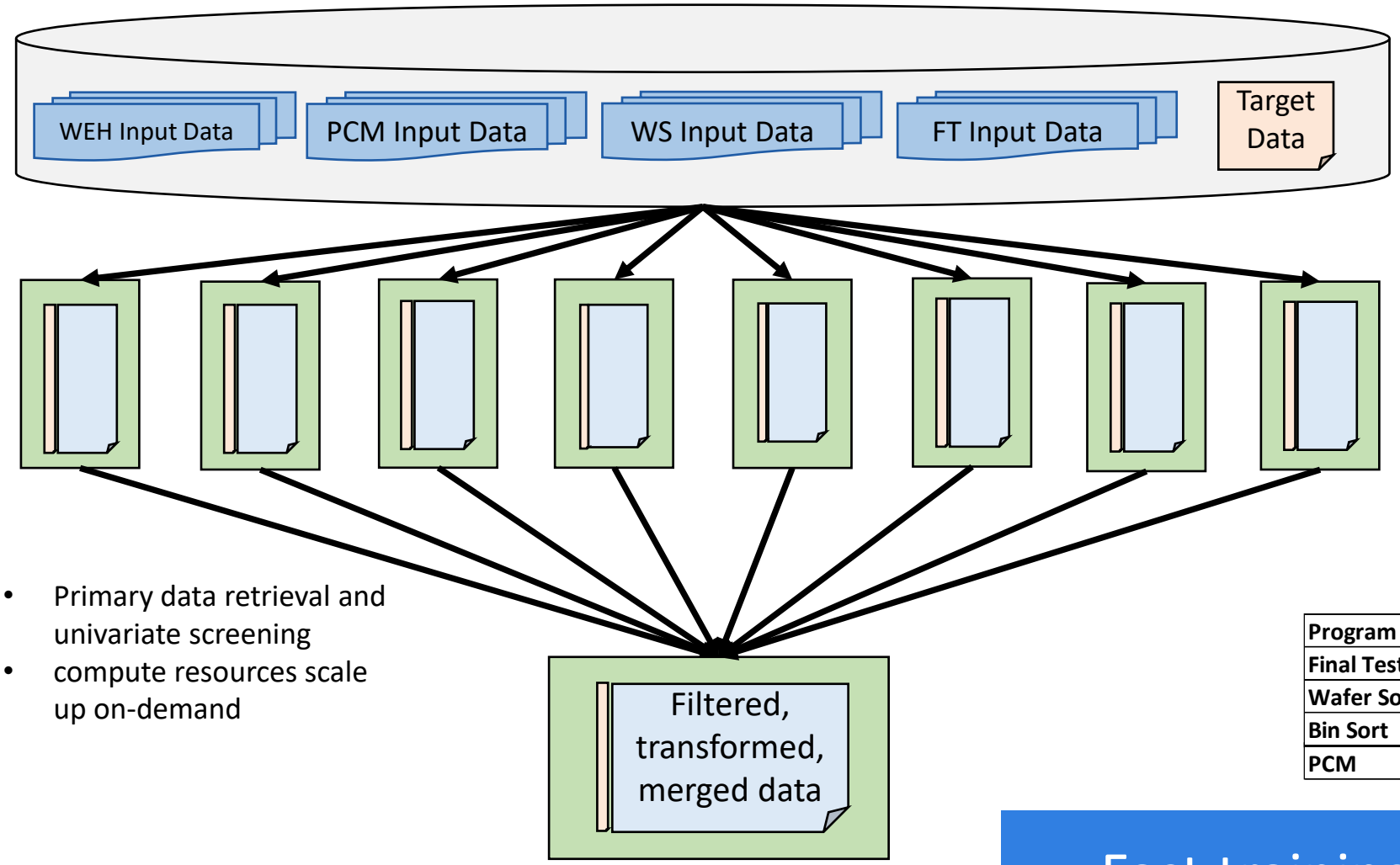
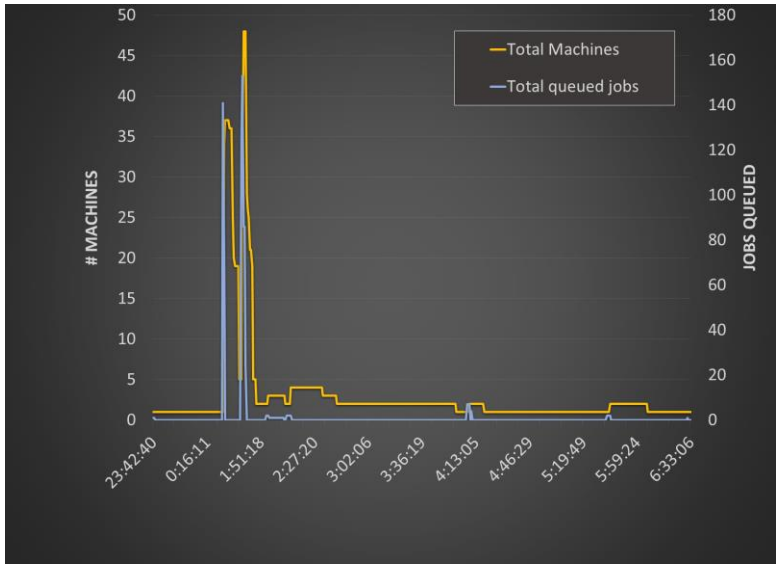
Dynamically-Scalable Training Pipeline





- Primary data retrieval and univariate screening
- compute resources scale up on-demand

Program Class	Program	Columns	Rows
Final Test	1	2,039	11,168,651
Wafer Sort	1	2,039	12,134,526
Bin Sort	1	(Thin)10	12,136,960
PCM	1	312	671,832

Fast training and resource efficient

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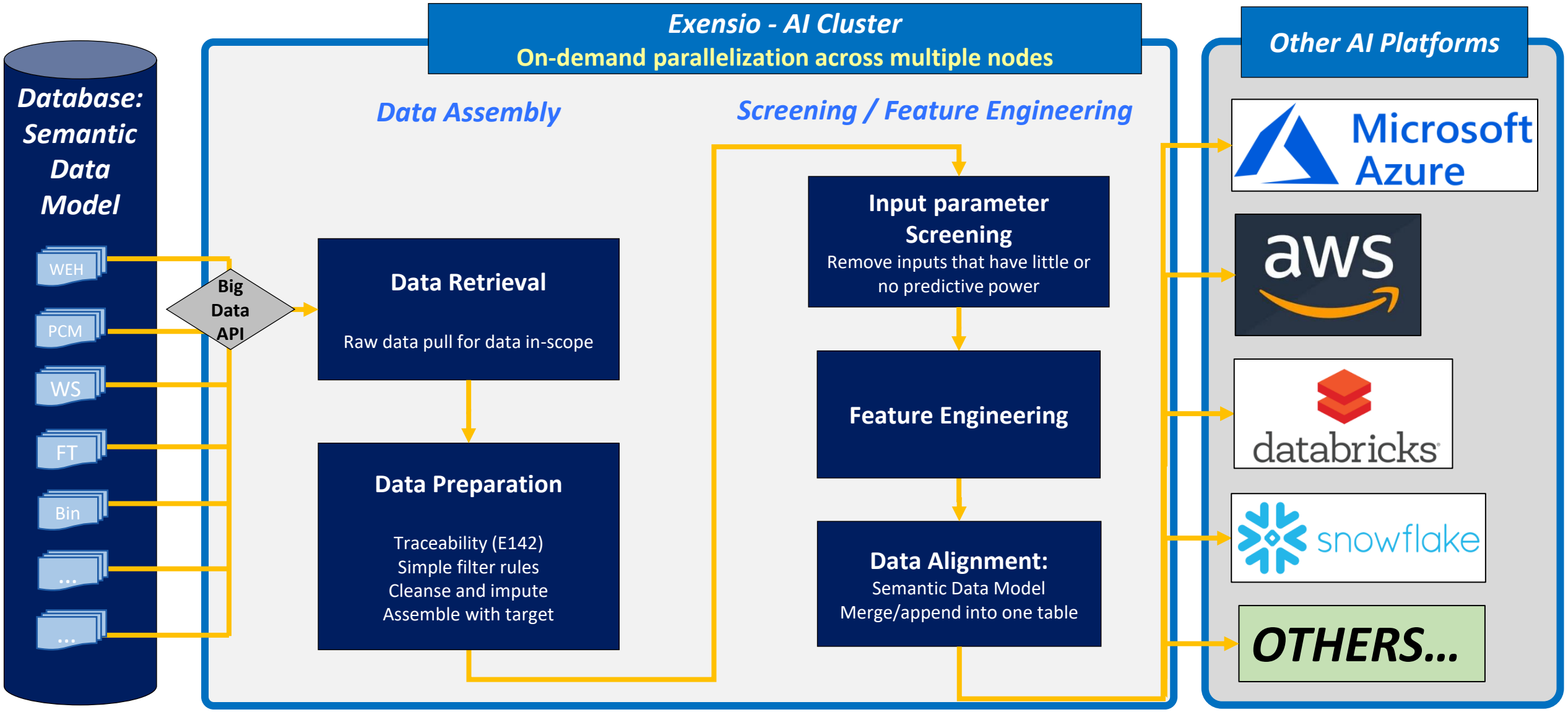
Designed to easily integrate with other platforms



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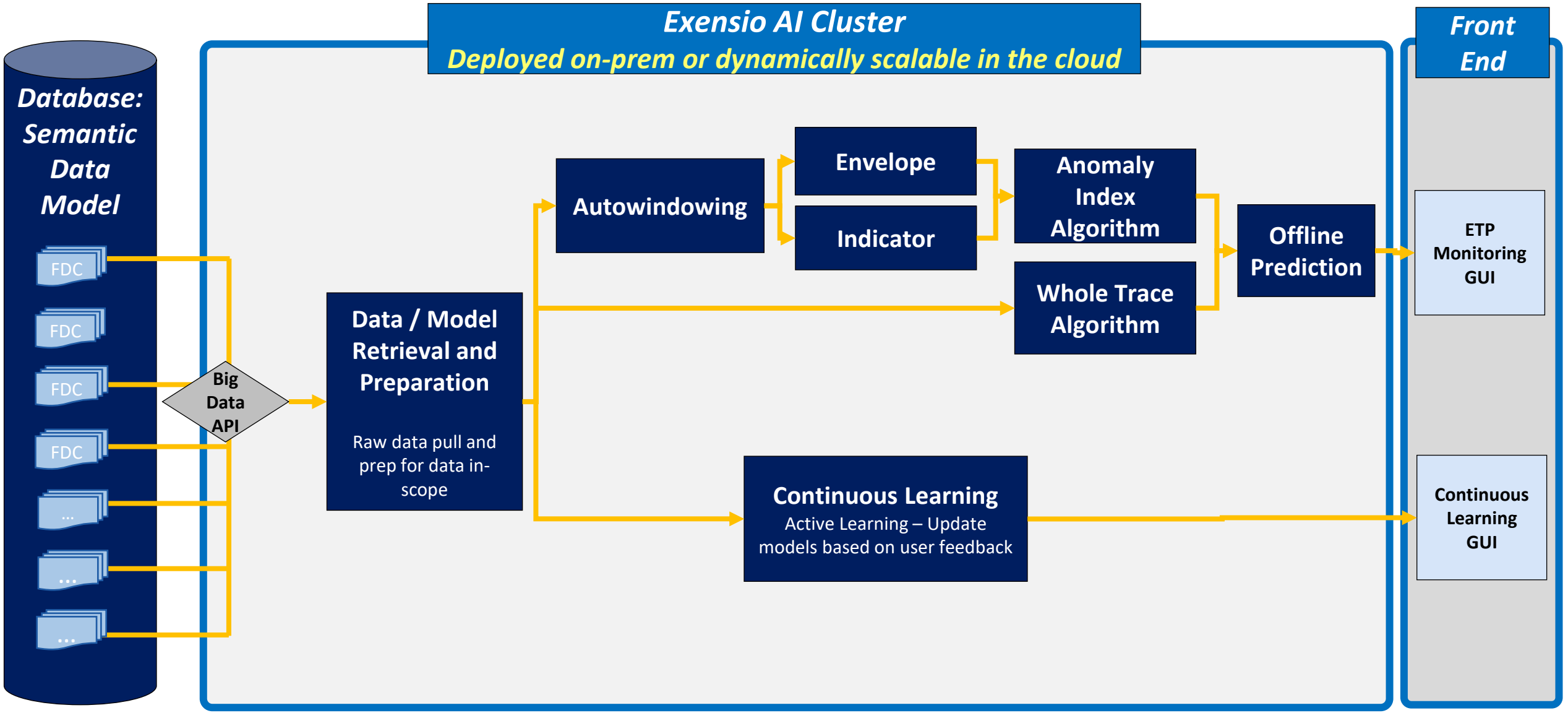
Training Pipeline for Equipment Trouble Protection (ETP)



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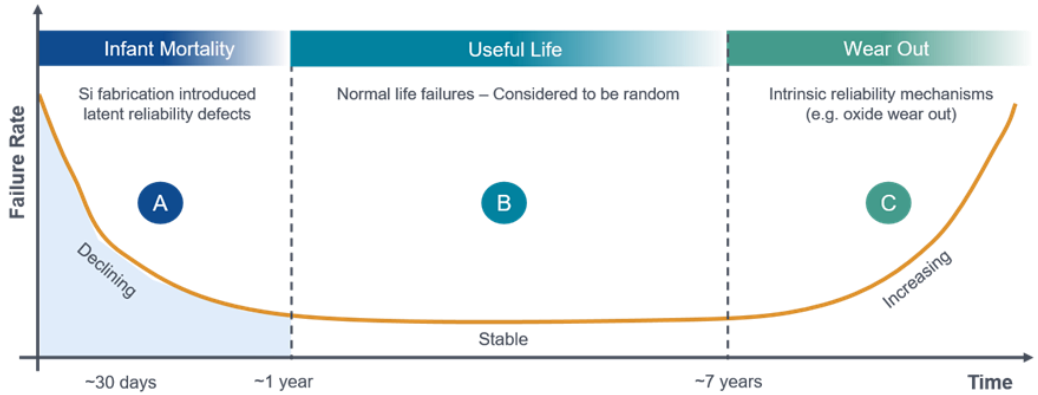
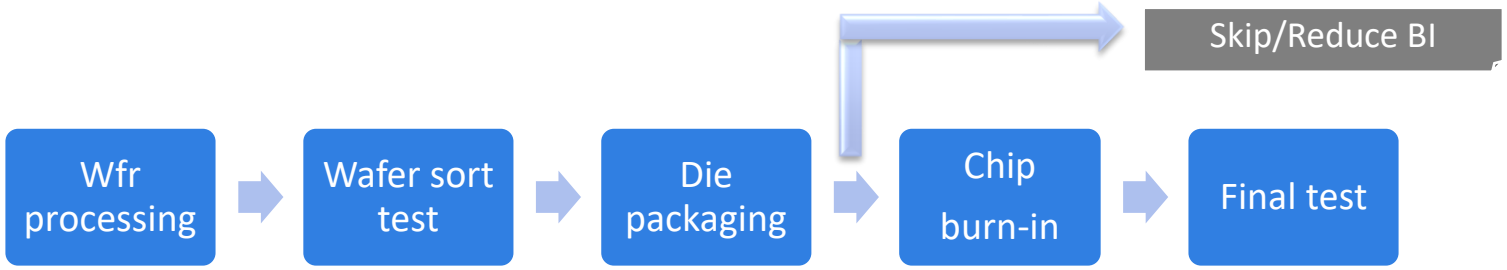
Exensio AIM Predictive Burn-In

- **Product burn-in**
  - High temperature/voltage stress test to screen out weak die (section A of the figure)
  - Done on packaged dies (wafer level burn-in is rare)



https://semiengineering.com/the-importance-of-product-burn-in-test/



- **AIM Predictive Burn-In**
  - ML solution to build models to predict burn-in fails
  - **Save package and burn-in test costs**

Chip Cost	$45	
Die Size	107.7	mm^2
Tech Node	**5nm**	
Wafer Cost ASP (USD)* 2021 ASP	$17,000.00	
Gross Die Per Wafer	553	
Net Die Per Wafer (Assume 95% Yield)	530	
Die Cost	$32.08	71%
Assembly / Package Test Cost	$12.92	29%

Illustrative die assembly and package test cost

https://semiengineering.com/using-machine-learning-to-increase-yield-and-lower-packaging-costs/

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Solution Example for Exensio Test : Predictive Burn-in

- **Use Case Results (escapes < 2 dppm):**

BI Failure Bin A Prediction	BI Failure Bin B Prediction	Combined Prediction	Die Population	ACTION
PASS	PASS	BOTH_PASS	< 35%	Completely Skip BI
FAIL	PASS	FAIL_BIN_A_ONLY	< 25%	Partial BI Test
PASS	FAIL	FAIL_BIN_B_ONLY	< 20%	Partial BI Test
FAIL	FAIL	BOTH_FAIL	< 30%	Complete BI

Burn-in cost savings realized from a combination of completely skipping burn-in and reduced testing at burn-in

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In summary…

- **Single platform for all data in Exensio**
- **Infrastructure for semiconductor-specific data**
- **The same data science platform for all semiconductor data types – this saves data scientists' time and effort**

With PDF ModelOps, you can bring
the value of AI to chip production *faster*

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Thank You

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