ASML

Pluggable models in semiconductor metrology

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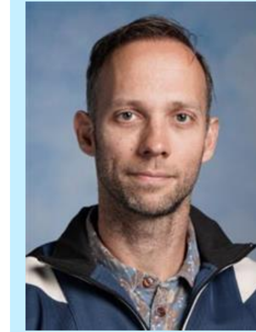
Public

Introduction

Key Message

- To keep up with the increasing challenges in semiconductor metrology we need to rethink our architecture
- Data Scientists should be enabled to quickly bring new ideas to the field
- Managing (metrology) data on a global scale is key to make this happen



Erik Crombag

- MSC Computer Science, Radboud University
- System Engineer, ASML Digital Platform
- Joined ASML in 2011

Outline

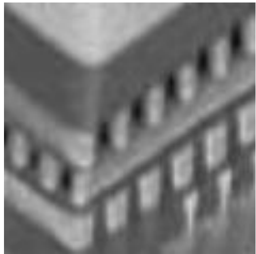
- Holistic Lithography and metrology
- Metrology challenges
- Pluggable architecture and challenges

The nm level is really fine-grained

Scale of
The Netherlands

300 km

1 nm



The nm level is really fine-grained

1 mm displacement on scale of The Netherlands: 1:300,000,000

1 nm displacement on scale of a wafer: 300 mm

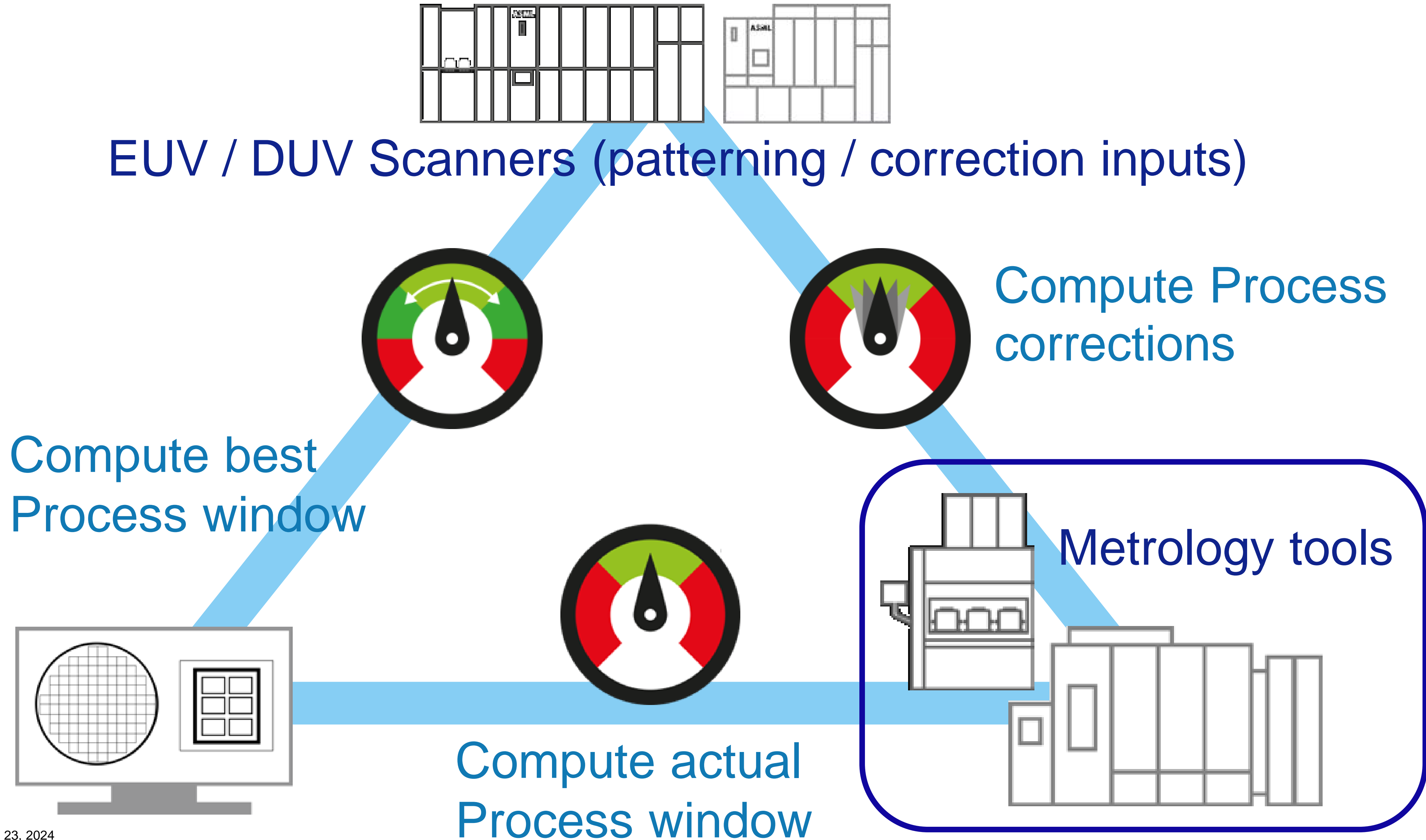
→ Now ASML is dealing with less than 0.1 nm

300 km

↔ 1 mm

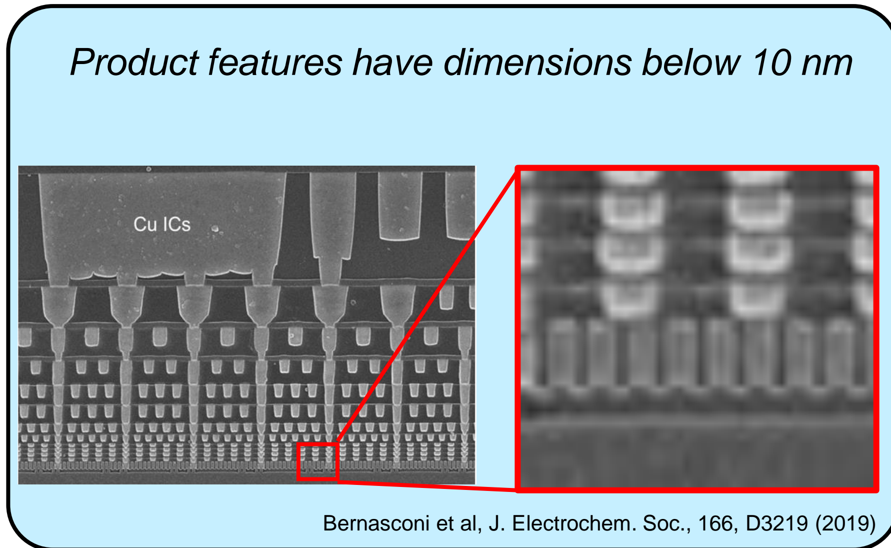
▸◂ 1 nm

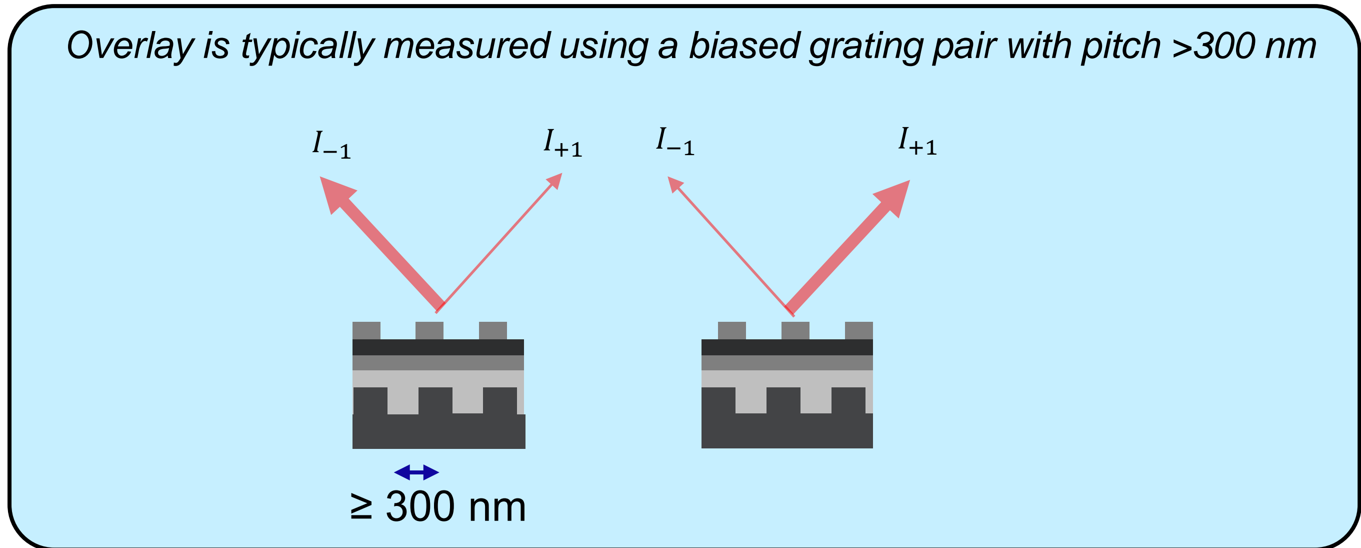
Holistic Lithography is our world



Optical overlay metrology: fast and precise

Semiconductor industry workhorses use visible light for overlay metrology





- Commonly used optical overlay metrology tools operate based on measuring properties of higher order diffraction on diffraction gratings using visible light
- In order to do so, dedicated test structures are used
- Typically multiple target-types with different designs are present

Increasing metrology challenges requires us to rethink our architecture

Conclusions

33/33 SAMSUNG

☐ Time to find new innovative MI solutions

- ➢ Due to the novel 3D integration schemes, we continue to develop the new semiconductor devices.
- ➢ Too many challenges to overcome
  - ① Increased R&D period & cost
  - ② Too many things(CDs, Defects, Material Properties) to measure with limited TPT.
  - ③ Continuously reduced MI signal sensitivity for coming new devices

※ Throughput

05

- ➢ Need different MI strategies between R&D and HVM
- ➢ Maximizing performance of various MI technology should be speed up and industry needs the new break-through technology

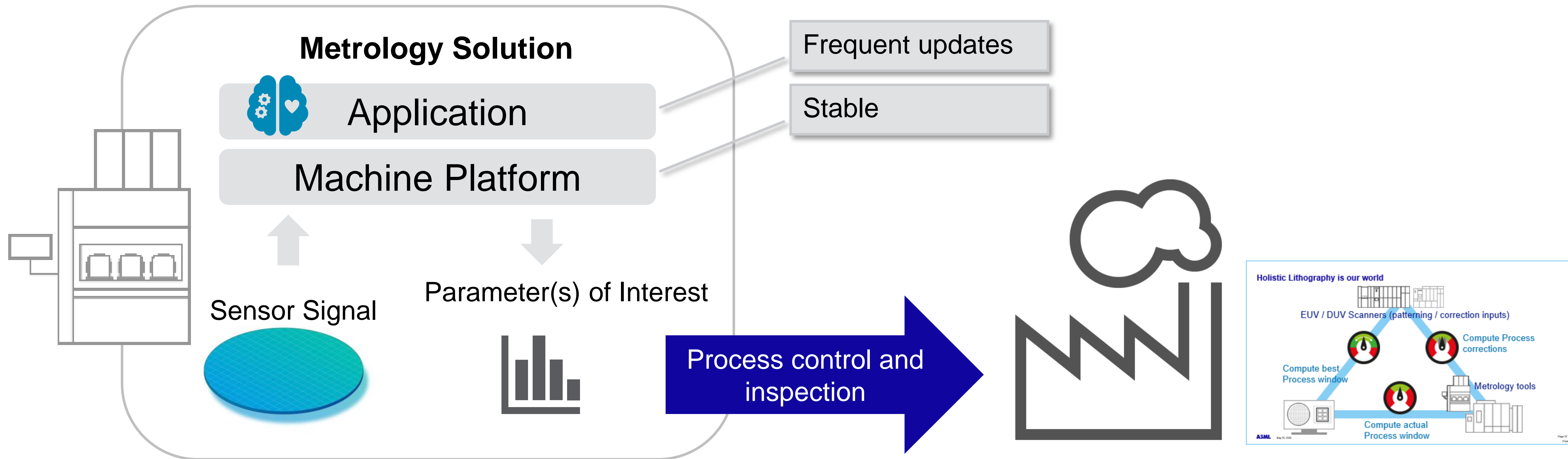
Increasing complexity

Increasing costs

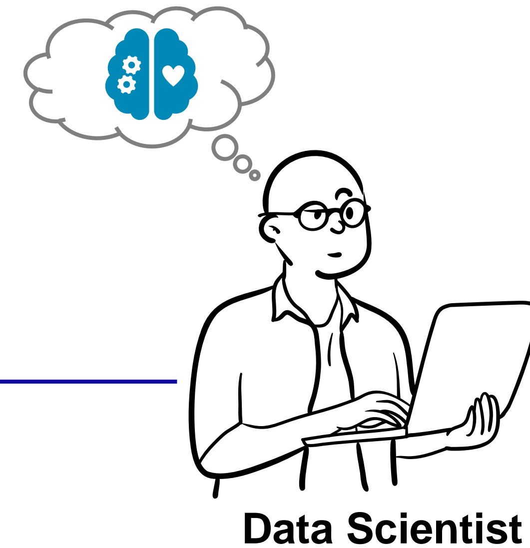
Increasing diversity

Source: The challenges of in-fab metrology: the needs for innovative solutions, ChungSam Jun, SPIE Advanced Lithography 2021

The current architecture is monolithic; application and machine platform are tightly coupled



A pluggable application architecture allows for independent evolution



Application

Metrology Solution

Application

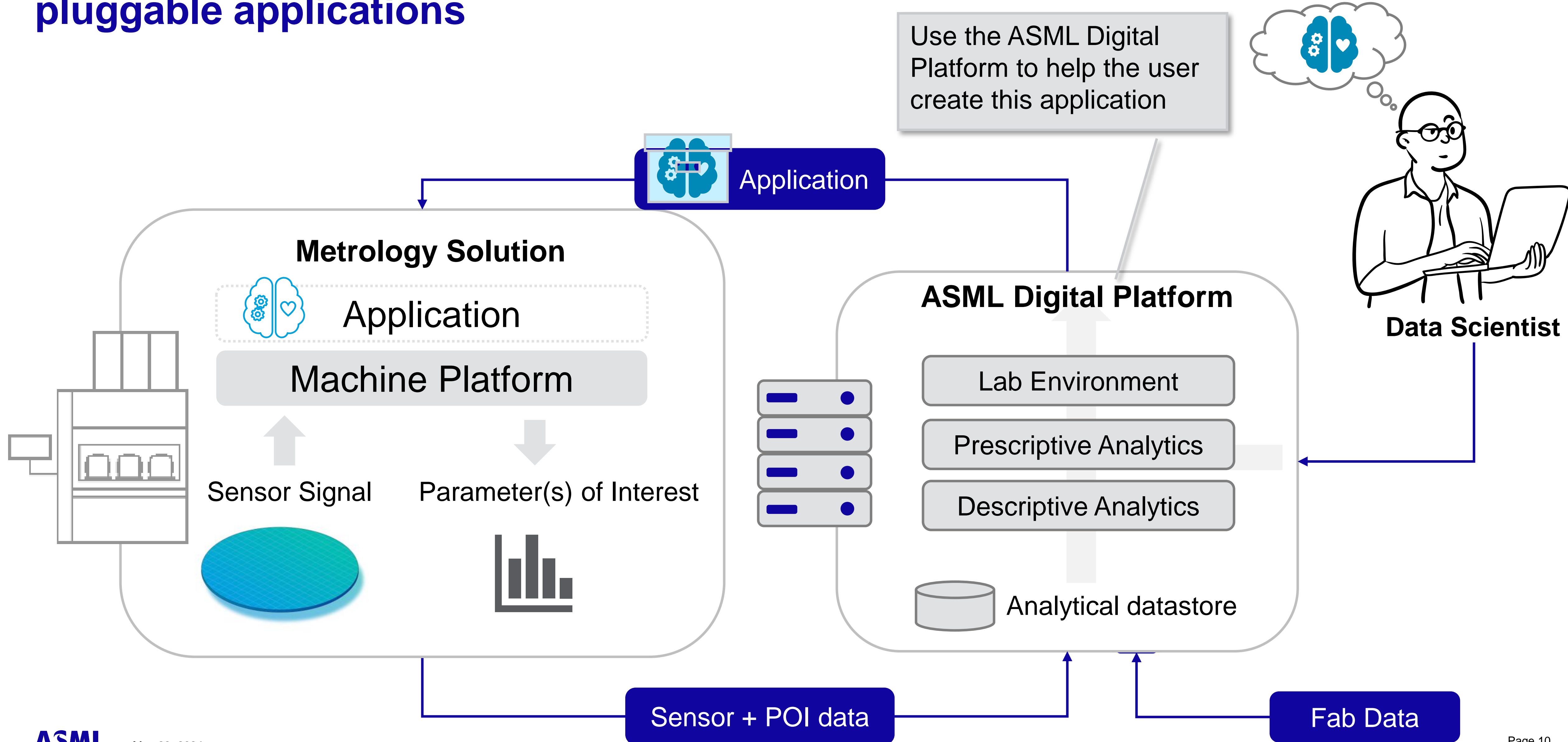
Machine Platform

Sensor Signal

Parameter(s) of Interest

Remove the fixed application. Replace it with a flexible deployment (container) instead.

The ASML Digital Platform will support data scientists in creating these pluggable applications



Meeting today's challenges with this new architecture

Increasing metrology challenges requires us to rethink our architecture

Conclusions — SAMSUNG

- Time to find new innovative MI solutions
  - Due to the novel 3D integration schemes, we continue to develop the new semiconductor devices. ← Increasing complexity
  - Too many challenges to overcome
    1. Increased R&D period & cost ← Increasing costs
    2. Too many things(CDs, Defects, Material Properties) to measure with limited TPT.
    3. Continuously reduced MI signal sensitivity for coming new devices
  - Need different MI strategies between R&D and HVM ← Increasing diversity
  - Maximizing performance of various MI technology should be speed up and industry needs the new break-through technology

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Increasing Complexity

- Aggregated data from multiple sources and/or time-series
- Complex data visualization and transformation
- Enables non-linear models

Increasing Costs

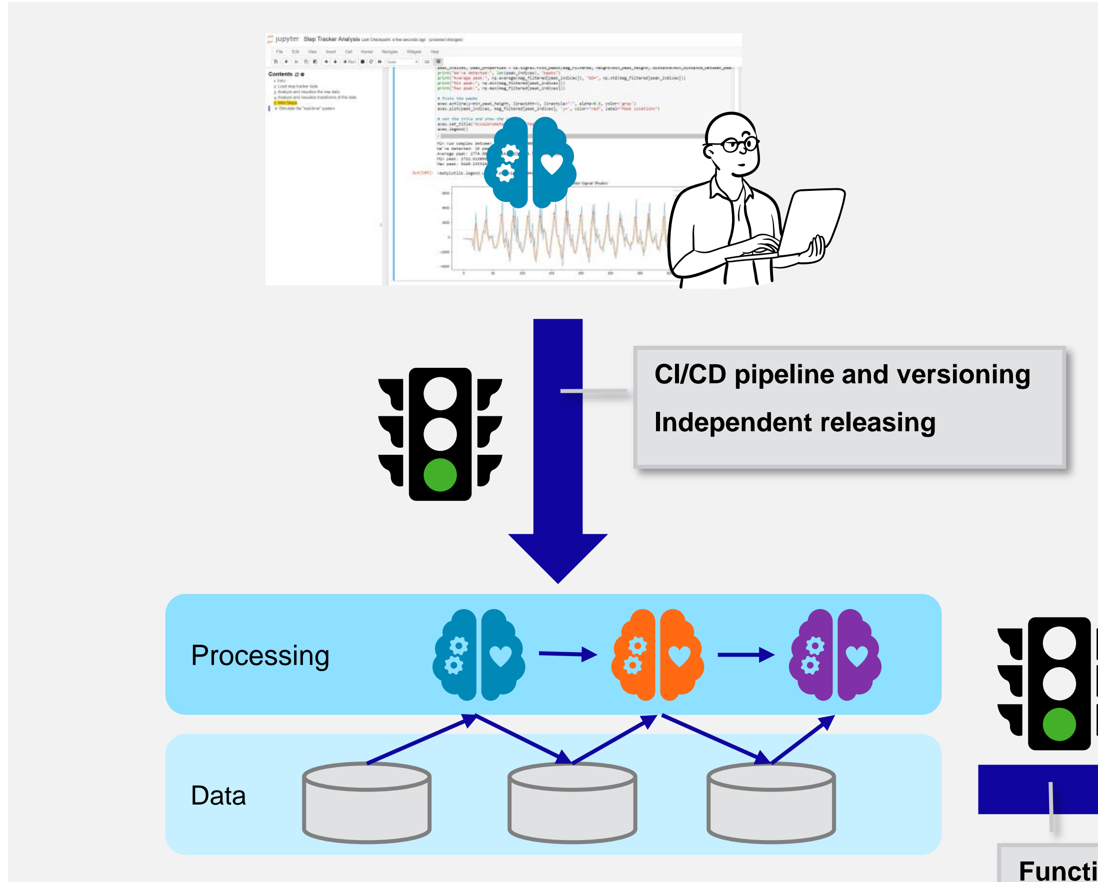
- Separate evolution of volatile application and stable machine platform enables locality of change
- Quick data gathering for new application features
- Prototyping on demand
- Reduced testing complexity

Increasing Diversity

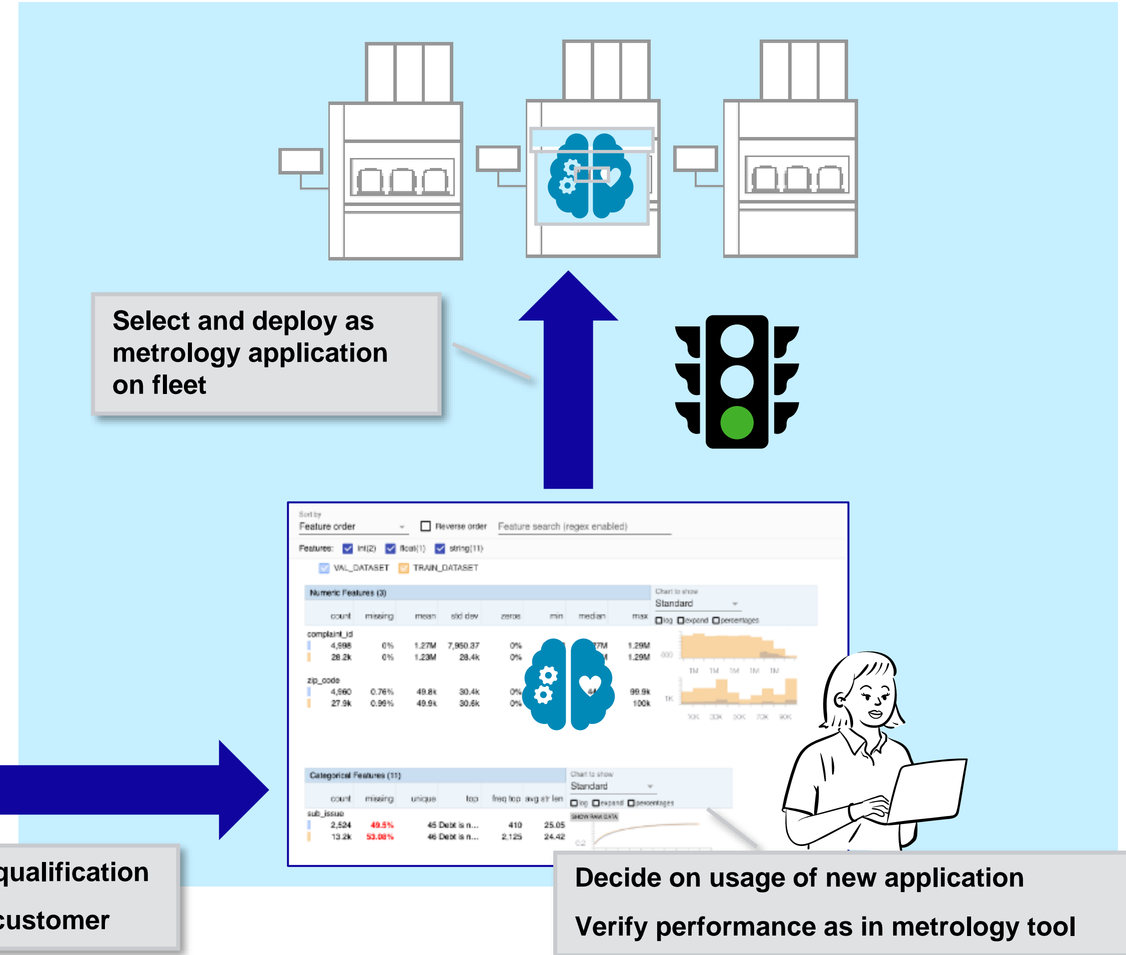
- Flexible configuration management
- User configurable analytics

A new operational model is required to release pluggable applications to our customers

ASML Premises



Customer Premises



Functional qualification
Release to customer

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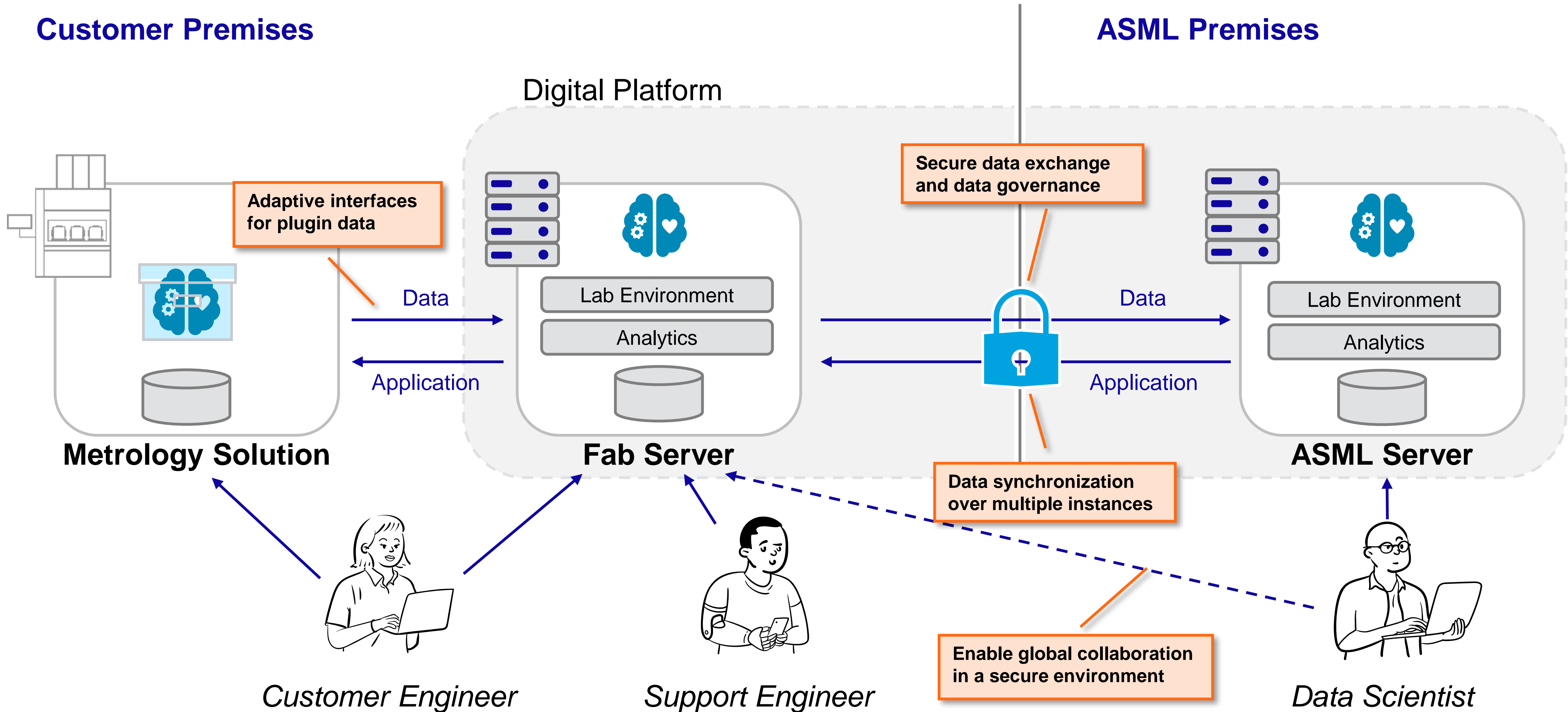
Data management challenges of deploying this architecture in a global context



Conclusion

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Key challenges to overcome

- Facilitate secure global cooperation between different roles and locations
- Set up an operational model to enable the pluggable architecture
- Verify the quality of our plugins, such that they don’t break the machine and/or the wafers
- How to distribute metrology data over the different instances of the platform?
- How to design adaptable interfaces between the metrology tool and the Digital Platform?
- Secure data exchange between customer and ASML premises meeting data sharing agreements

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Holistic Lithography is our world