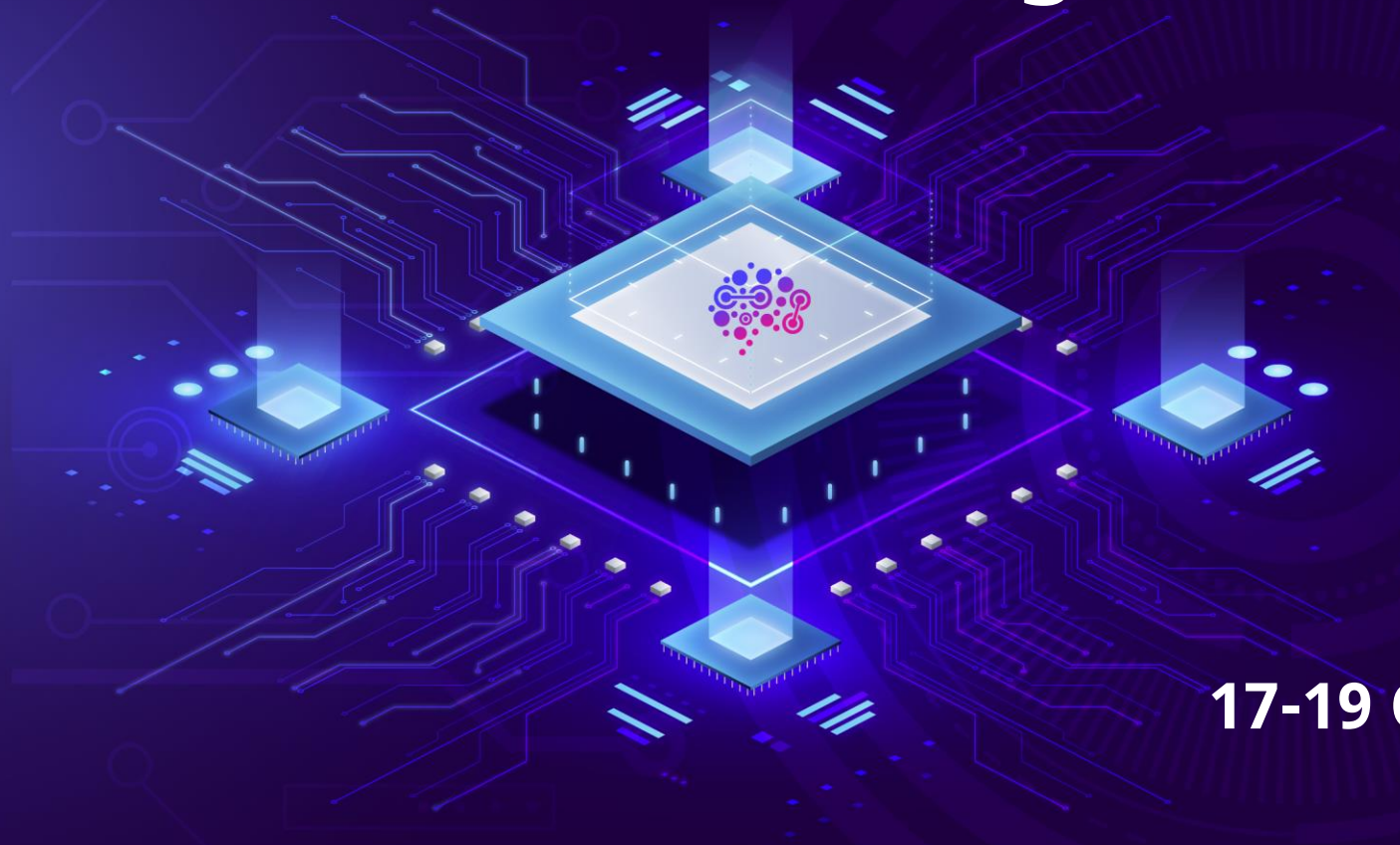
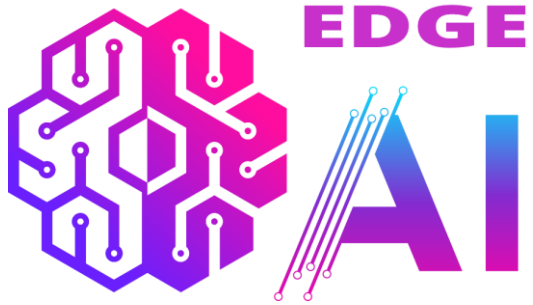
European Conference on EDGE AI Technologies and Applications - EEAI



Advancing emerging edge AI technologies and driving next generation intelligent applications.

17-19 October 2023, Athens, Greece

European Conference on EDGE AI Technologies and Applications - EEAI



Smart Semiconductor Manufacturing Assistant (SSMA) – An Efficient Quality Management Supporting Tool

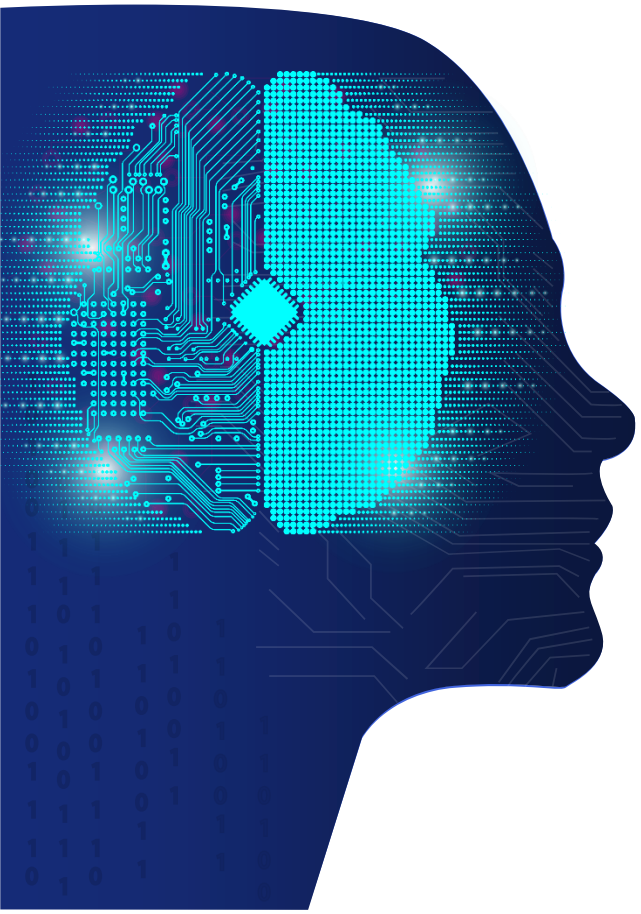
Houssam Razouk, Silke Braun, Infineon Technologies Austria, Austria

Astrid Khokhar, Erwin Stadler, Philip Glinzner, SoftwareCube, Austria

Jie He, TU Wien, Austria

17-19 October 2023 Athens, Greece

Outline



- Motivation
- Concept
- State-of-the-art
- Research Goal
- Methodology
- Design and Implementation
- Conclusion

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Motivation

- Smart Semiconductor Manufacturing Assistant (SSMA) as Quality Management Supporting tool including the holistic lot check

Support Efficient and Effective Quality Management

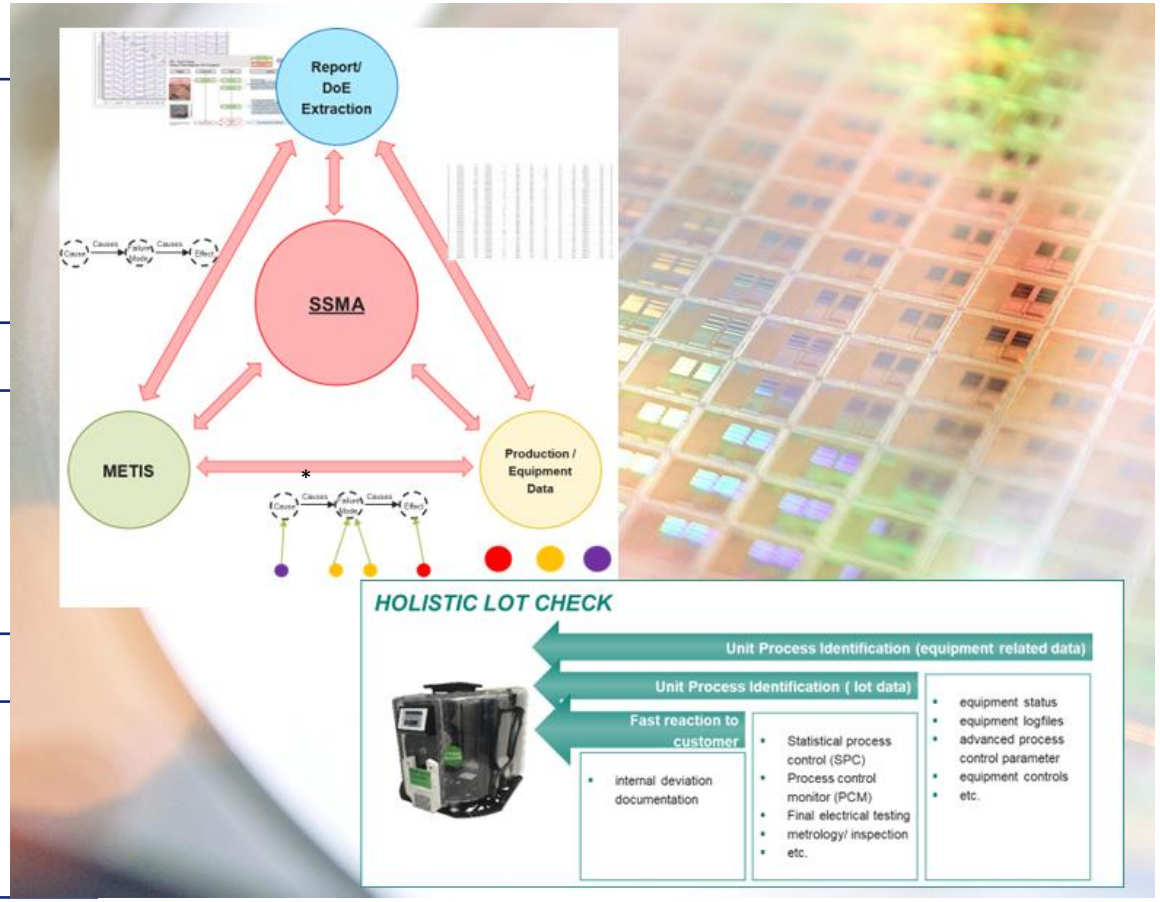
- quickly identify, predict, classify potential failure, failure risks, failure causes
- support domain experts in making fast and informed decision

Connect Domain Knowledge and data

- human domain knowledge are available in FMEA, 8D reports, failure tree/ fishbone diagram or DoE
- Data collected during production

Identify AI based causal links based on

- production and equipment relevant data
- DoE data



* METIS = Knowledge Representation (KR)

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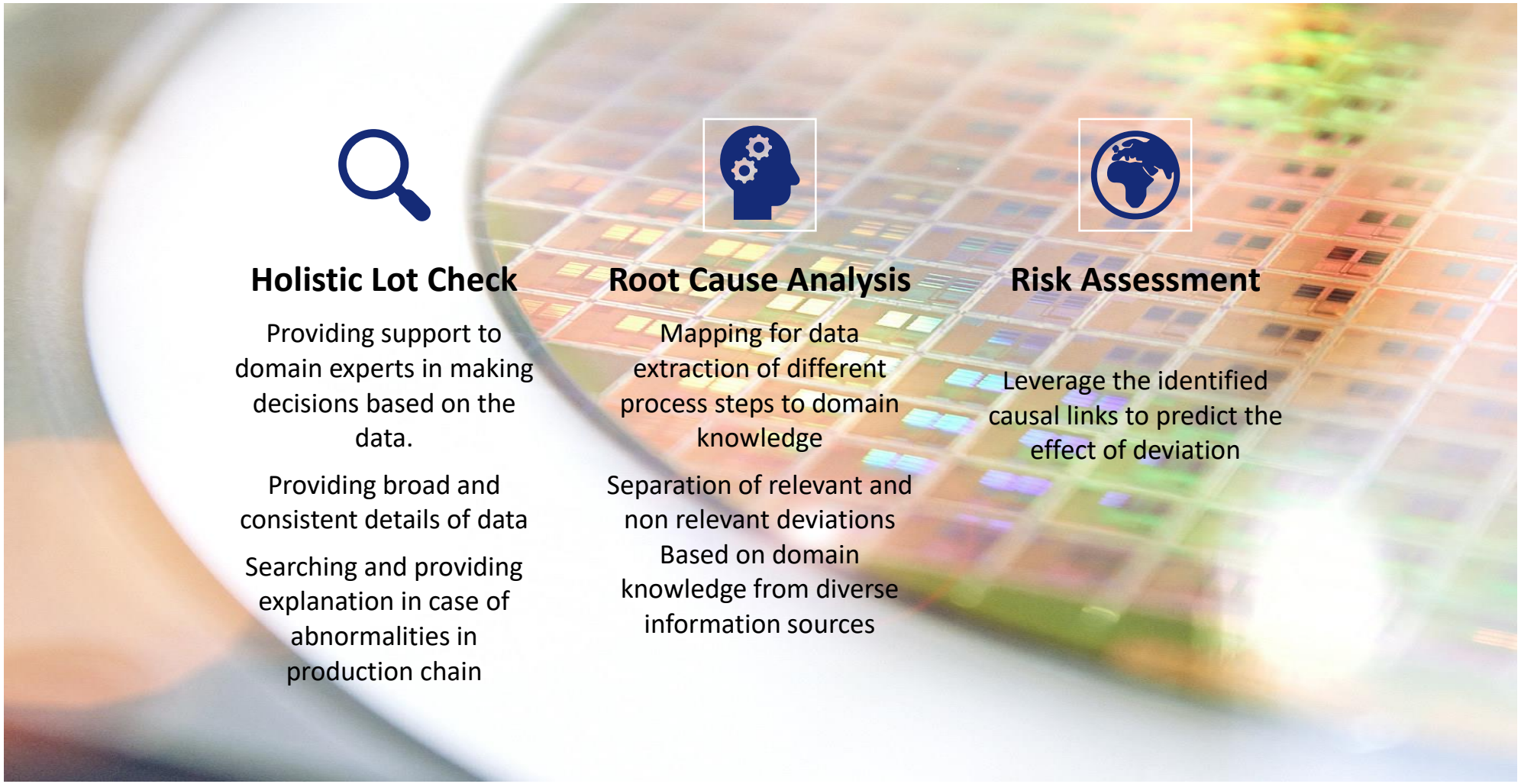
Concept

Creating digital tacit knowledge out of implicit and explicit expert knowledge



Holistic Lot Check

Providing support to domain experts in making decisions based on the data.

Providing broad and consistent details of data

Searching and providing explanation in case of abnormalities in production chain

Root Cause Analysis

Mapping for data extraction of different process steps to domain knowledge

Separation of relevant and non relevant deviations Based on domain knowledge from diverse information sources

Risk Assessment

Leverage the identified causal links to predict the effect of deviation

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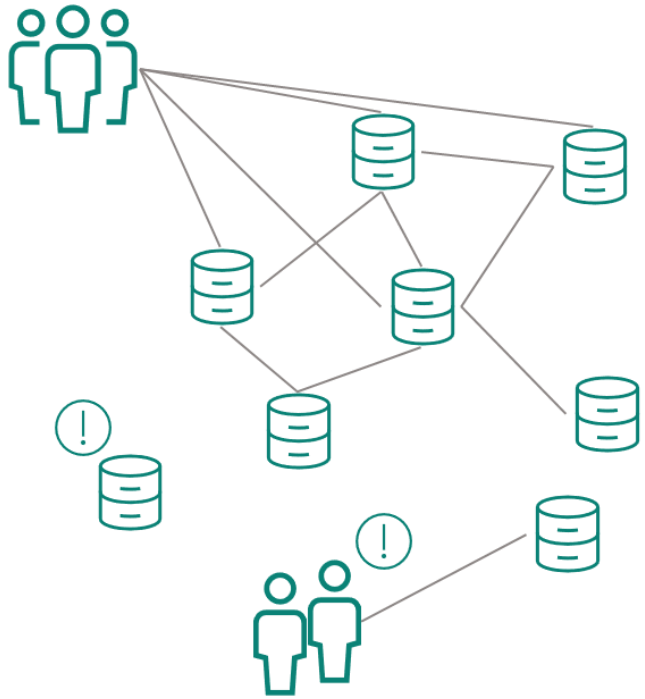
State-of-the-art

- **Prototype "FMEA Assistant"** as supporting tool for Quality Management in Semiconductor Manufacturing; Developed in EU funded Project **AI4DI**
  - Usage of **existing information** from the manufacturing process like **semi-structured documents**
  - Information extraction **from libraries** and **represented as a knowledge graph**
  - Generation of **causal chains root cause(s) / effect(s)**

- **Production/ Equipment data, textual/ graphical data evaluation**
  - based on **experience of groups of experts**
  - available in **several systems**
  - Data is aggregated and analysed **manually based on the case**



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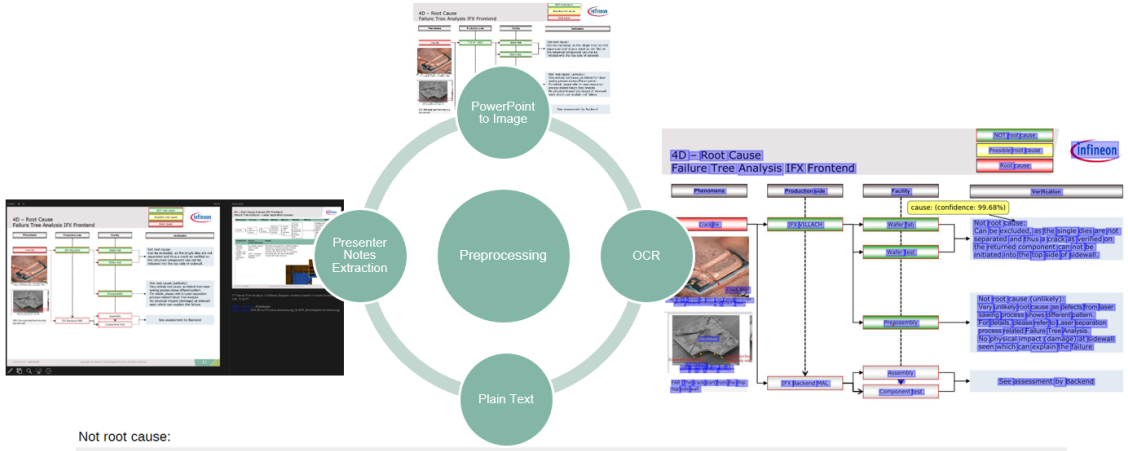
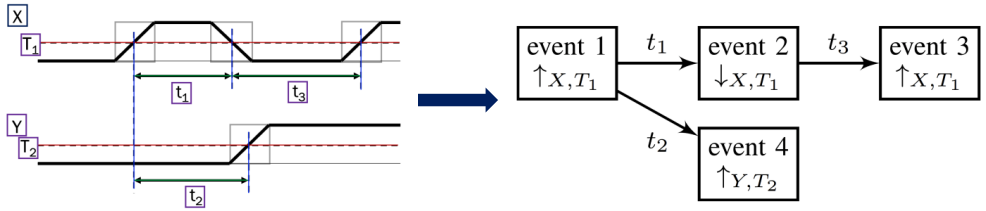
Research Goal

- Information extraction from industrial Documents:
  - Information extraction from presentation slides documents
  - Information extraction from engineering diagrams (TDMagic1)
- Mapping textual deviation description to the set of parameters the measure it.
- Knowledge aware and data aware methods for risk assessment
- Effective and efficient deployment of different system components





[1] Jie He, Dejan Ničković, Ezio Bartocci, Radu Grosu. TD-Magic: From Pictures of Timing Diagrams To Formal Specifications, DAC 2023

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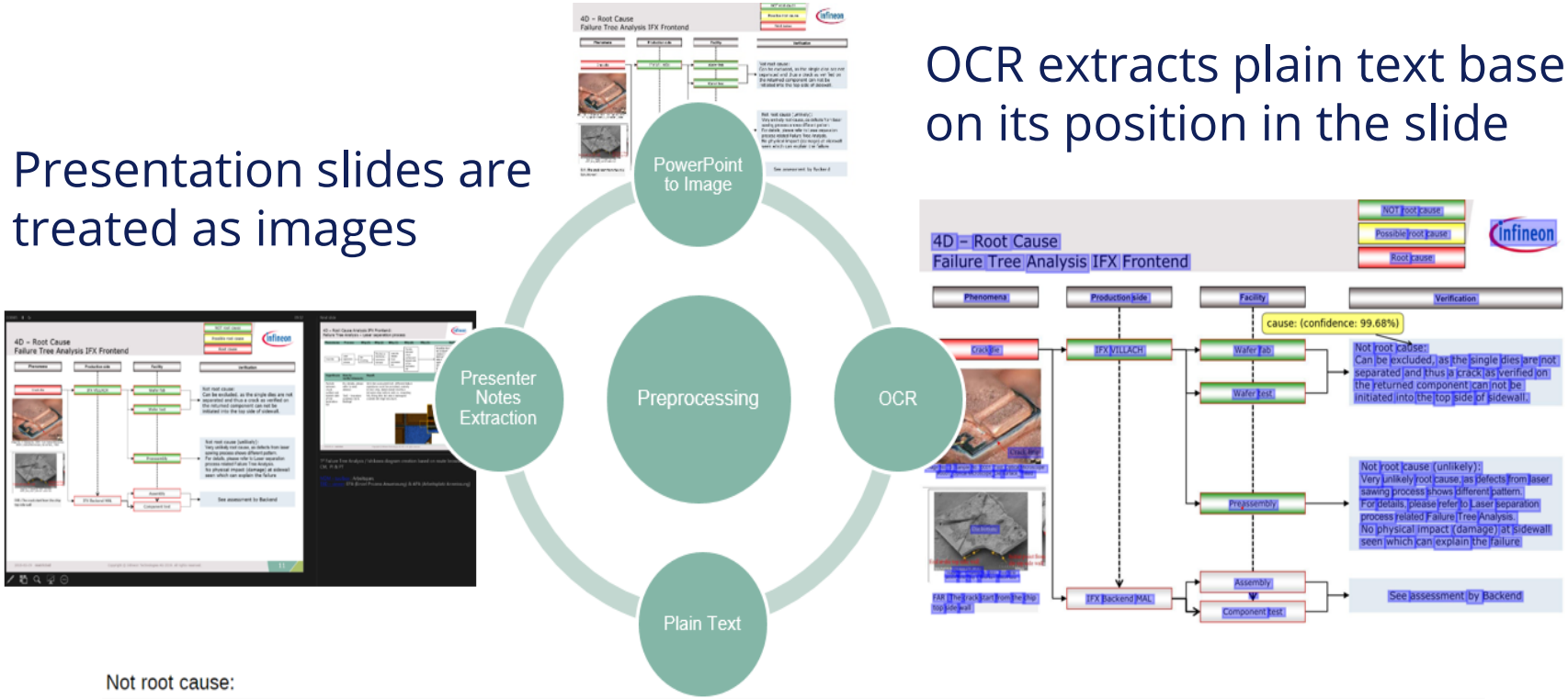
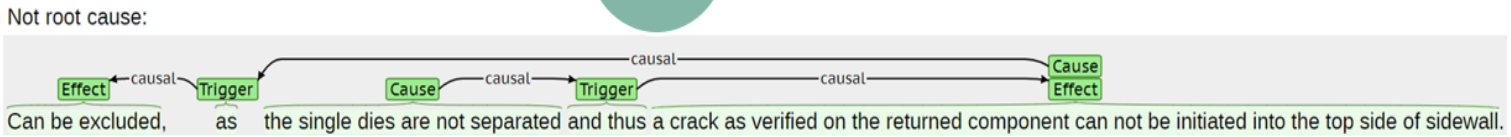
Methodology

Information extraction from presentation slides documents:

Presentation slides are treated as images



OCR extracts plain text based on its position in the slide



Sequences tagging based method for causal information extraction

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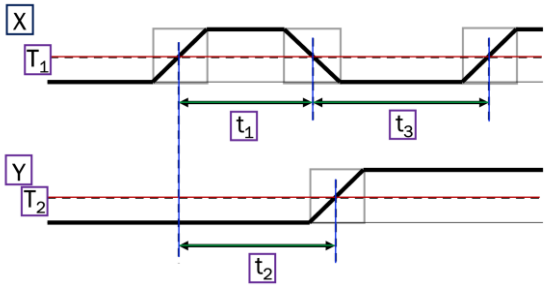
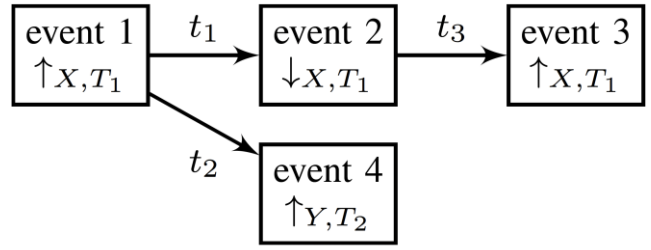
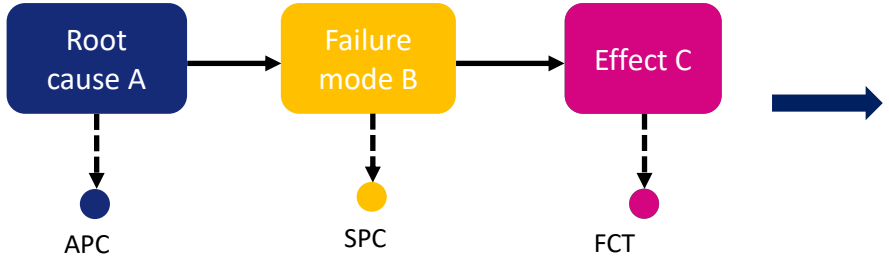
Methodology

- Information extraction from industrial Documents (TDMagic1)
  - Reuse and extend techniques from EdgeAI funded paper: TDMagic[1]





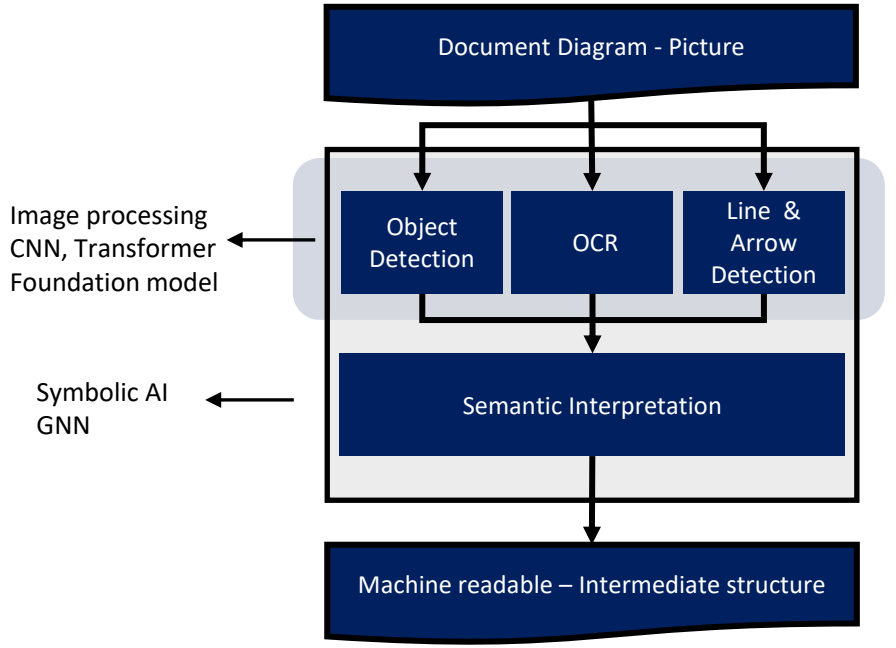


Causal links:

```
Link 1 =
Root cause A -> Failure mode B
Link 2 =
Failure mode B -> Effect C
```

Sources:

```
Root cause A: APC
Failure mode B: SPC
Effect C: FCT
```



- Knowledge aware and data aware methods for risk assessment
  - Traditional regression, e.g., spline on DoE data
  - Deep-learning based regression, e.g., recurrent neural networks, transformer on DoE data

[1] Jie He, Dejan Ničković, Ezio Bartocci, Radu Grosu. TD-Magic: From Pictures of Timing Diagrams To Formal Specifications, DAC 2023

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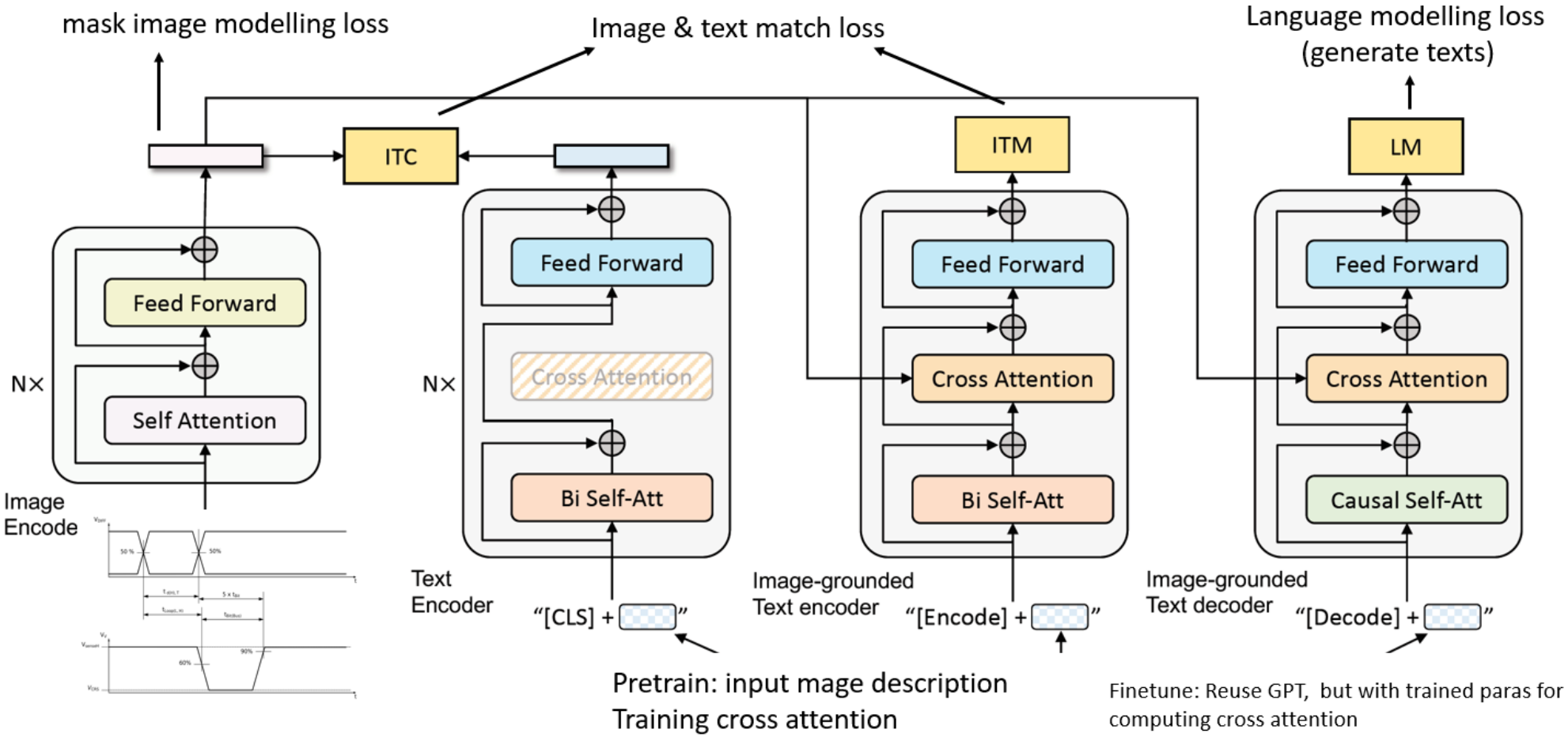
Methodology

Information extraction from industrial documents:

- End-to-end learning framework with reinforcement learning with human feedback [2]



[2] Ouyang, L., Wu, J., Jiang, X., Almeida, D., Wainwright, C., Mishkin, P., ... & Lowe, R. (2022). Training language models to follow instructions with human feedback

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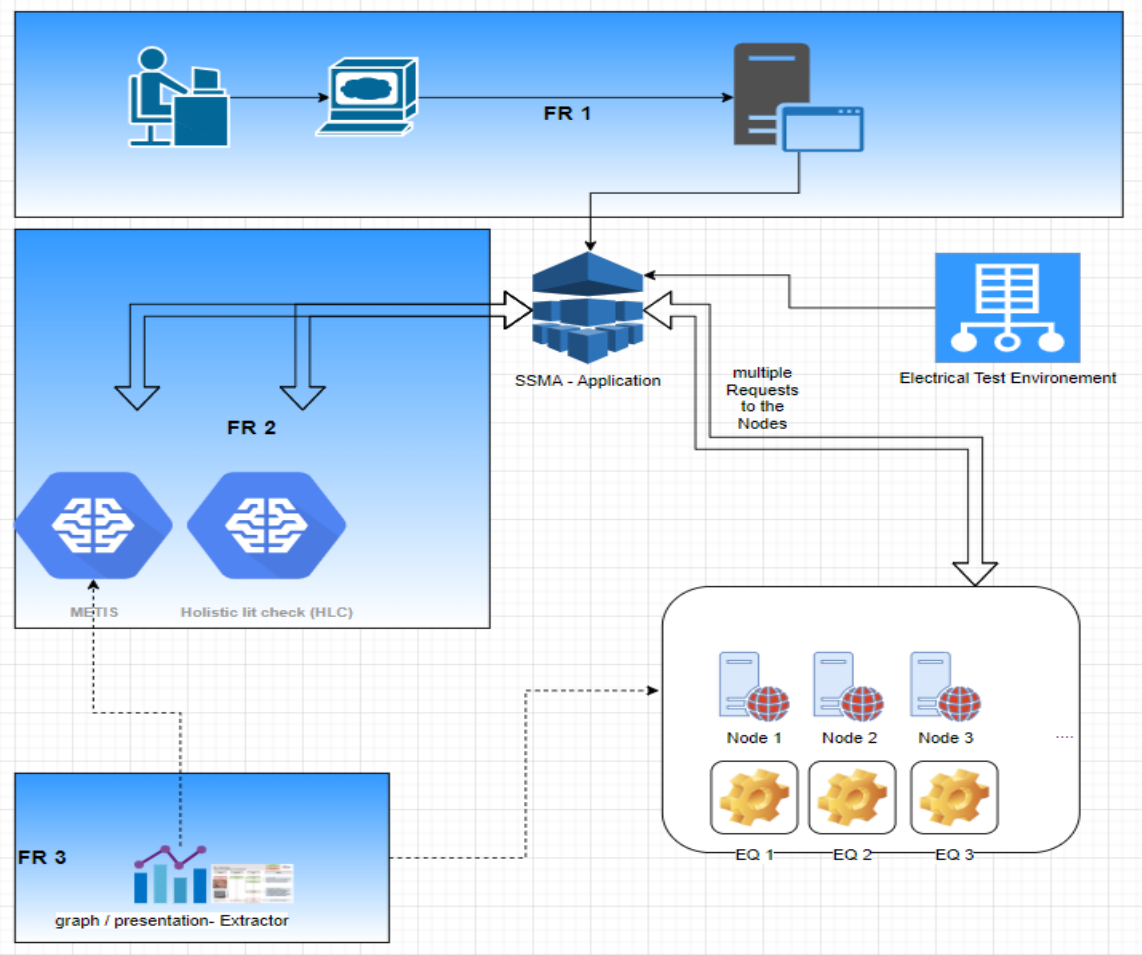
Design and Implementation

Linking Corporate Knowledge with Manufacturing Data at the Edge



- IT architecture/infrastructure to collect different types of data from valuable sources
- Prepare, label, improve, filter data **during processing in production line**
- Provide monitoring software for data sources and EdgeAI infrastructure
- Continuous Integration and Continuous Delivery using OpenShift and Docker
- Tooling for system verification for EdgeAI applications

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Conclusion

Development of new concept for industrial **knowledge management system (SSMA)**

- Combine the domain knowledge from different data sources with the data collected during the prediction
  - Root cause analysis and risk assessment
    - Fast and reliable usage of data / knowledge for decision making
  - Knowledge Accessibility
    - Increased knowledge accessibility and availability for wider audience
  - Improved Cost- efficiency and time to solution
    - by mitigating identified potential risks
    - decreasing the ramp-up time for new production lines

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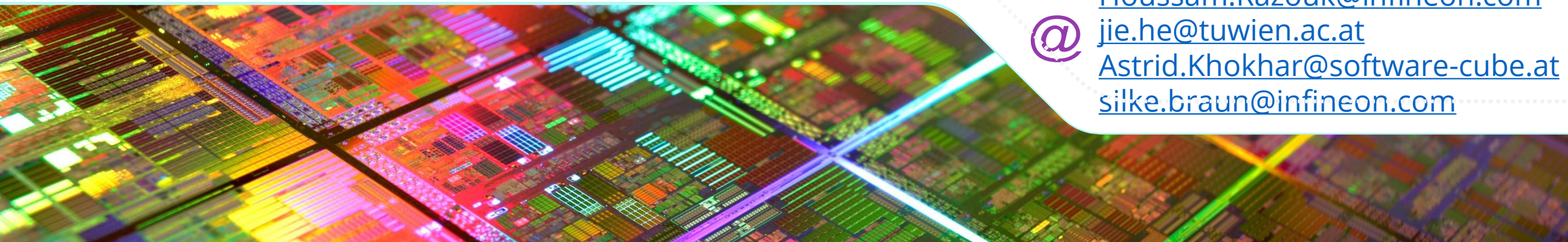
EDGE AI

Thank You

For your attention



@ Houssam.Razouk@infineon.com
jie.he@tuwien.ac.at
Astrid.Khokhar@software-cube.at
silke.braun@infineon.com