

Digital Transformation with Asset Administration Shell - Methodology Proposal

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INTRODUCTION & AIM

This work presents a case study on the digital transformation of a legacy industrial electric screwdriver within the context of Industry 4.0. The proposed approach uses the Asset Administration Shell (AAS) as a standardized digital representation to enable interoperability, monitoring, and data-driven management of industrial assets.

The work follows a structured methodology for asset digitalization, starting with asset characterization and the definition of the monitoring objective—energy consumption analysis. An AAS model is then developed using standardized submodels, alongside a custom IoT device for real-time energy acquisition. The physical asset is integrated with its digital counterpart through OPC UA communication, enabling the deployment of a type 2 AAS and real-time visualization of energy data.

The core contribution of the paper is a modular and scalable blueprint for modernizing legacy industrial equipment by combining standardized AAS modeling, IoT hardware, and industrial communication technologies aligned with Industry 4.0 principles.

METHOD

- Step 1 • **Asset Characterization & Problem Definition**
- Step 2 • **Modeling the AAS Type 1**
- Step 3 • **Asset Retrofitting**
- Step 4 • **Asset and AAS Integration**
- Step 5 • **AAS Type 2 Deployment**
- Step 6 • **Real-Time Visualization of Energy Data**

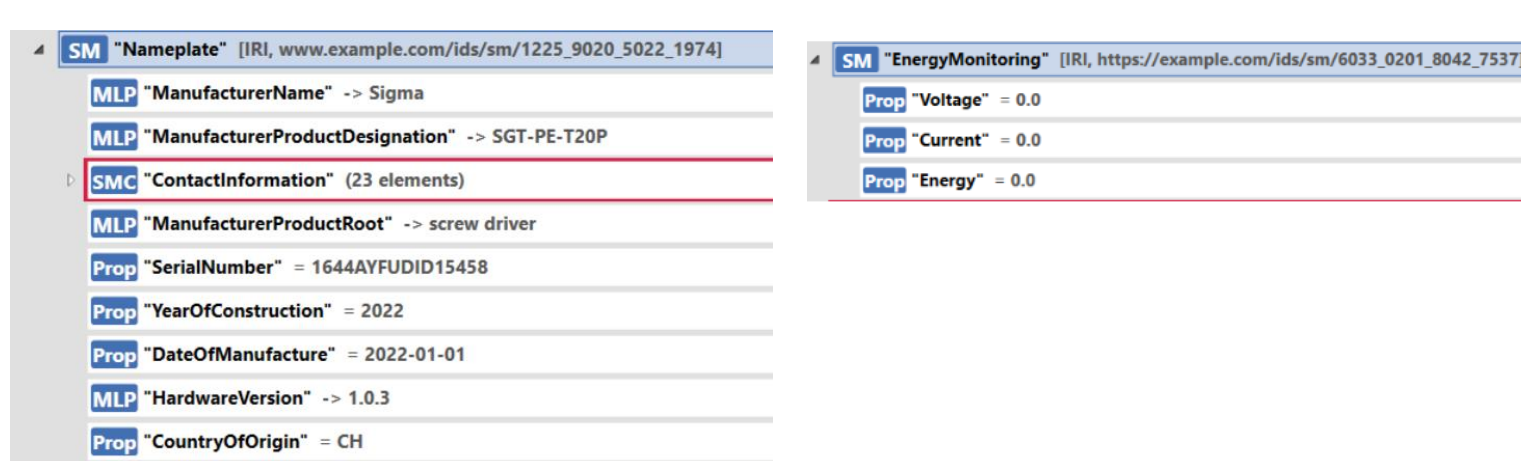
RESULTS & DISCUSSION

1



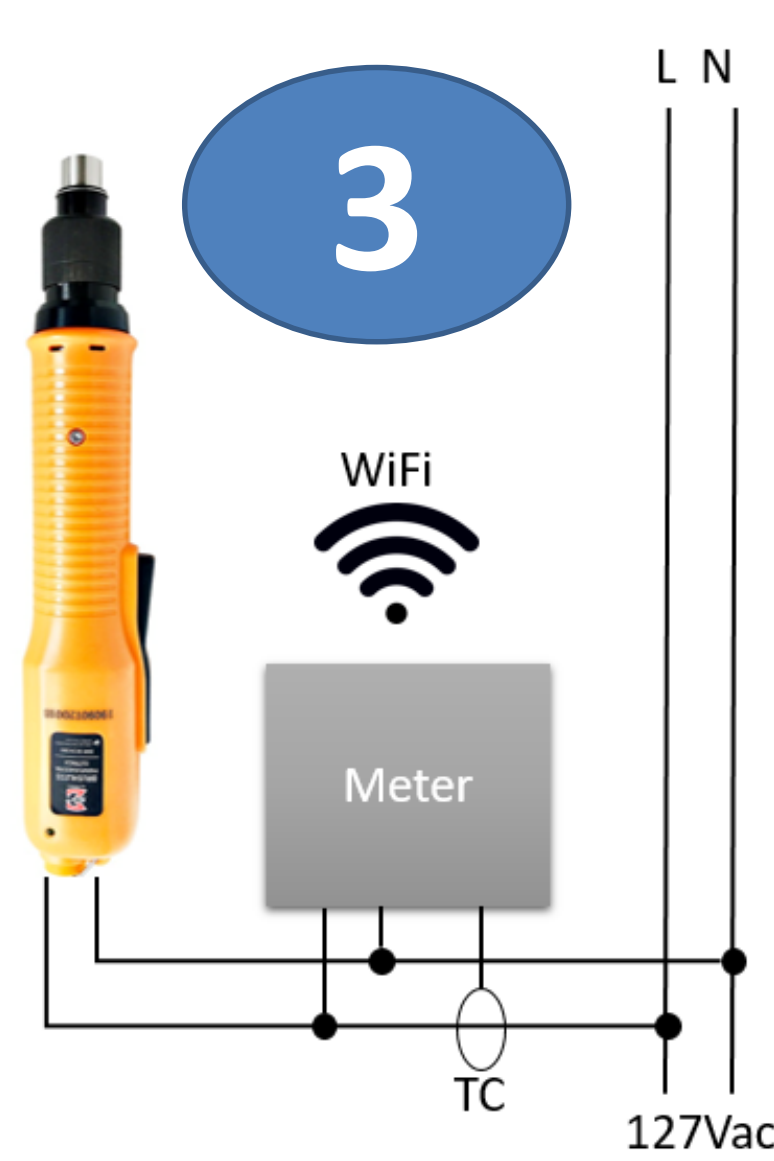
The selected asset is an industrial electric screwdriver used in automated assembly lines. Since such tools typically lack connectivity and monitoring capabilities, the main objective was to enable real-time energy consumption monitoring to support predictive maintenance and process optimization.

2



A type 1 AAS was created using the AASX Package Explorer. The model includes submodels for energy efficiency and asset identification, containing properties such as current, voltage, power, energy, serial number, and manufacturer, following IDTA standards.

3



A custom IoT device with voltage and current sensors, connected to a Wi-Fi-enabled microcontroller, was developed to collect real-time energy data. The system processes measurements and publishes them via MQTT using JSON payloads compatible with the AAS structure.

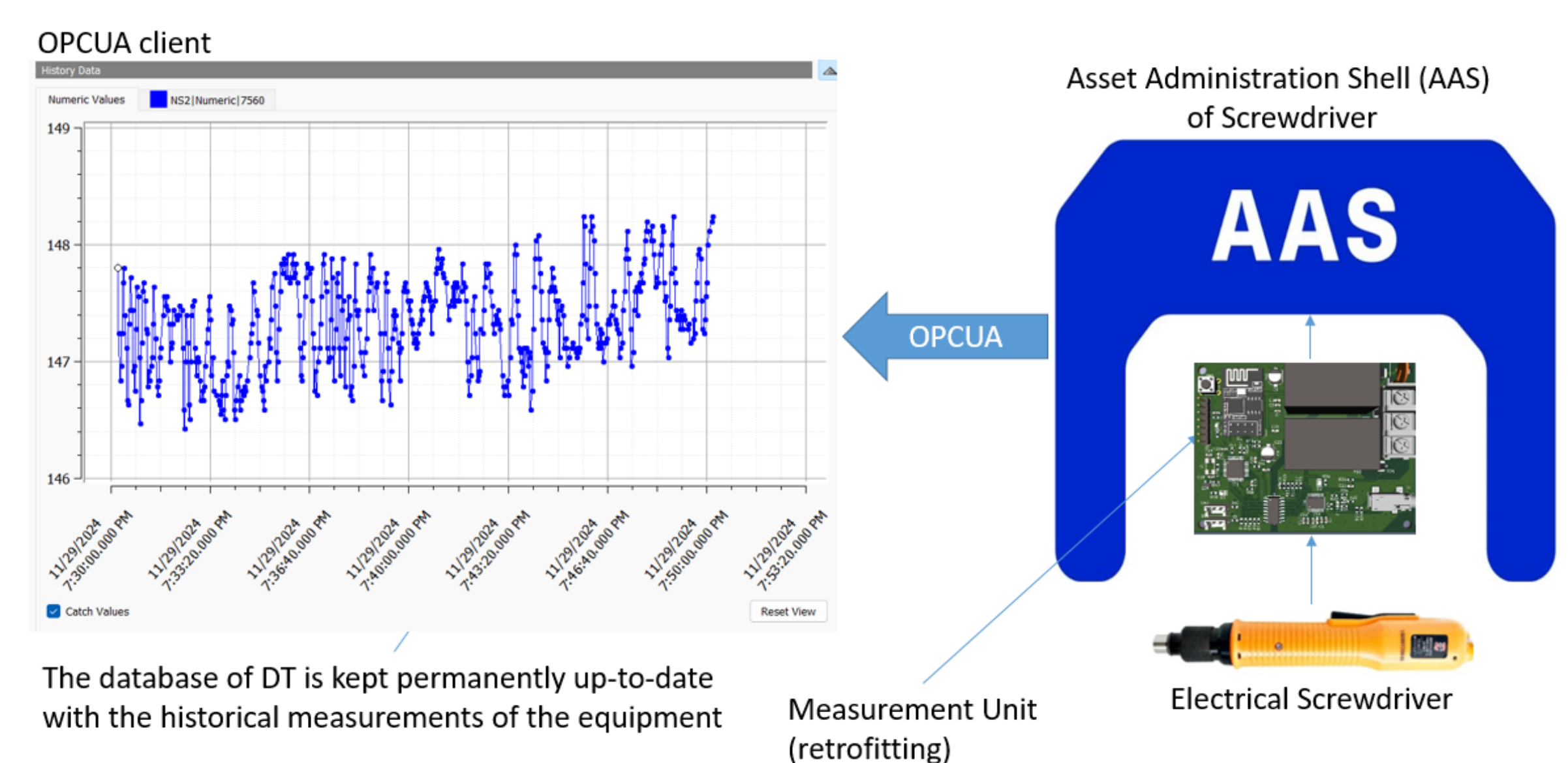
4



A Python-based middleware subscribes to MQTT topics and transfers the collected data to an OPC UA server while preserving the AAS hierarchy. This establishes synchronization between the physical asset and its digital representation.

5/6

The type 1 AAS was deployed as a type 2 AAS through an OPC UA server, enabling real-time interaction and data access while supporting the visibility and transparency levels of the Acatech maturity model.



The database of DT is kept permanently up-to-date with the historical measurements of the equipment

Measurement Unit (retrofitting)

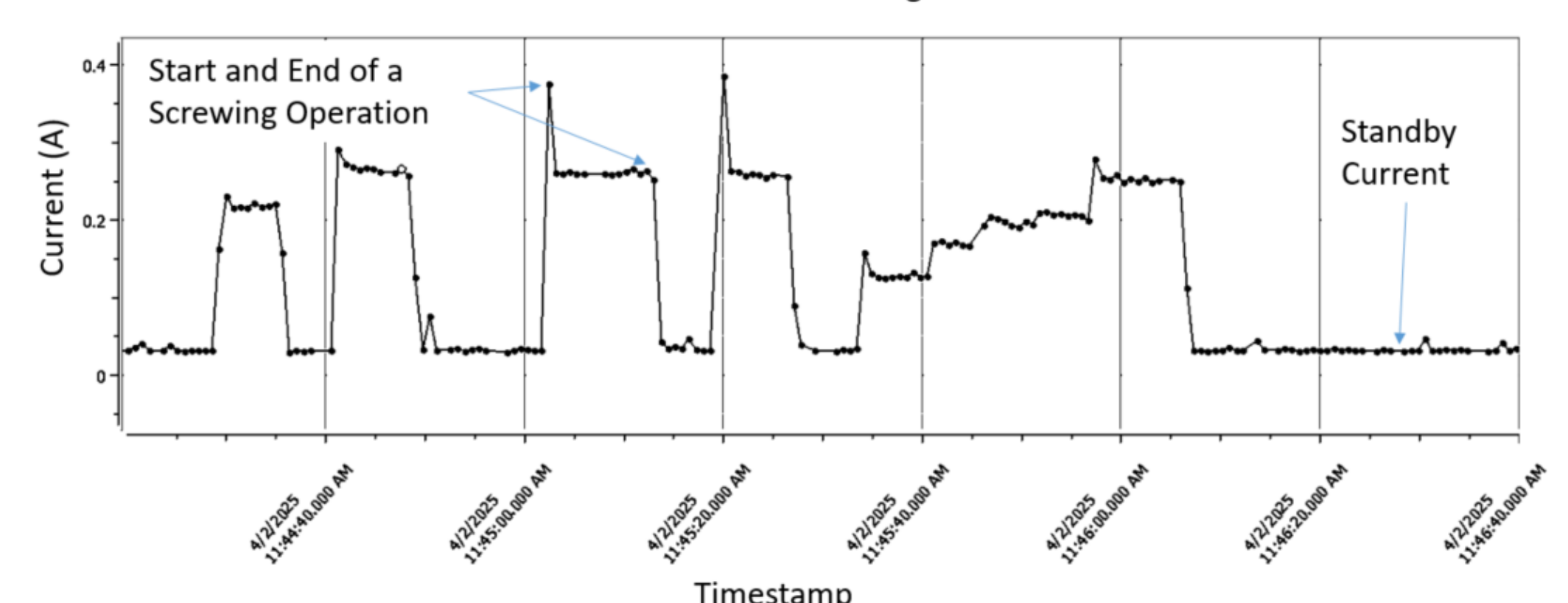
Asset Administration Shell (AAS) of Screwdriver

AAS

Electrical Screwdriver

The UAExpert client was used to visualize live energy data, including current, voltage, power, and energy consumption, supporting process monitoring and performance analysis.

Screwdriver Historical Data Through AAS



CONCLUSIONS

The case study focused on an industrial electric screwdriver due to its widespread use in assembly lines and its potential for energy optimization. The solution included the creation of a type 1 AAS, the development of a custom IoT device, and integration with a type 2 AAS deployed through an OPC UA server. This architecture enabled real-time monitoring, visualization, and data-driven analysis of energy consumption.

The adoption of open communication protocols such as MQTT and OPC UA, combined with standardized AAS modeling, demonstrated the feasibility of implementing interoperable and cost-effective digital twins for industrial retrofitting applications.

FUTURE WORK/ REFERENCES/ACKNOWLEDGMENT

Future work will focus on evolving the system toward type 3 (active) AAS implementations with embedded intelligence capable of autonomous edge-level decision making. This advancement aims to enable the digital twin to perform local inference, detect anomalies, and execute corrective actions without human intervention.

Acatech – National Academy of Science and Engineering, "Industry 4.0 Maturity Index – Managing the Digital Transformation of Companies – Update 2020," Herbert Utz Verlag, 2020. [Online]. Available: <https://en.acatech.de/publication/industrie-4-0-maturity-index-update-2020/>

Industrial Digital Twin Association (IDTA), "Structure of the Administration Shell," 2016. [Online]. Available: <https://industrialdigitaltwin.org/wp-content/uploads/2021/09/01structure-of-the-administration-shell-en-2016.pdf>