Application of Three-Phase Methodology for Retrofit 4.0 in Legacy Industrial Plants

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Andrei Tchepurnoy Machado

- I am an Electrical Engineer, with a specialization in electronics from São Francisco University Brazil (USF), located in the city of ITATIBA in São Paulo State, where I graduated in 2000. My journey continued as I pursued expertise in the telecommunications sector, focusing on transmission networks. I further honed my skills through postgraduate studies in computer networks at the Federal Center of Technology Learning in Curitiba, Paraná State, Brazil (CEFET-PR), and industrial automation at SENAI São Paulo, Brazil.

- Currently, I am a Master's degree student at the State University of Campinas in São Paulo State (UNICAMP), Brazil, delving into the field of 4.0 industry solutions development. With nearly two decades of experience in the telecommunications market, I have acquired comprehensive knowledge of various technologies within the technical domain.

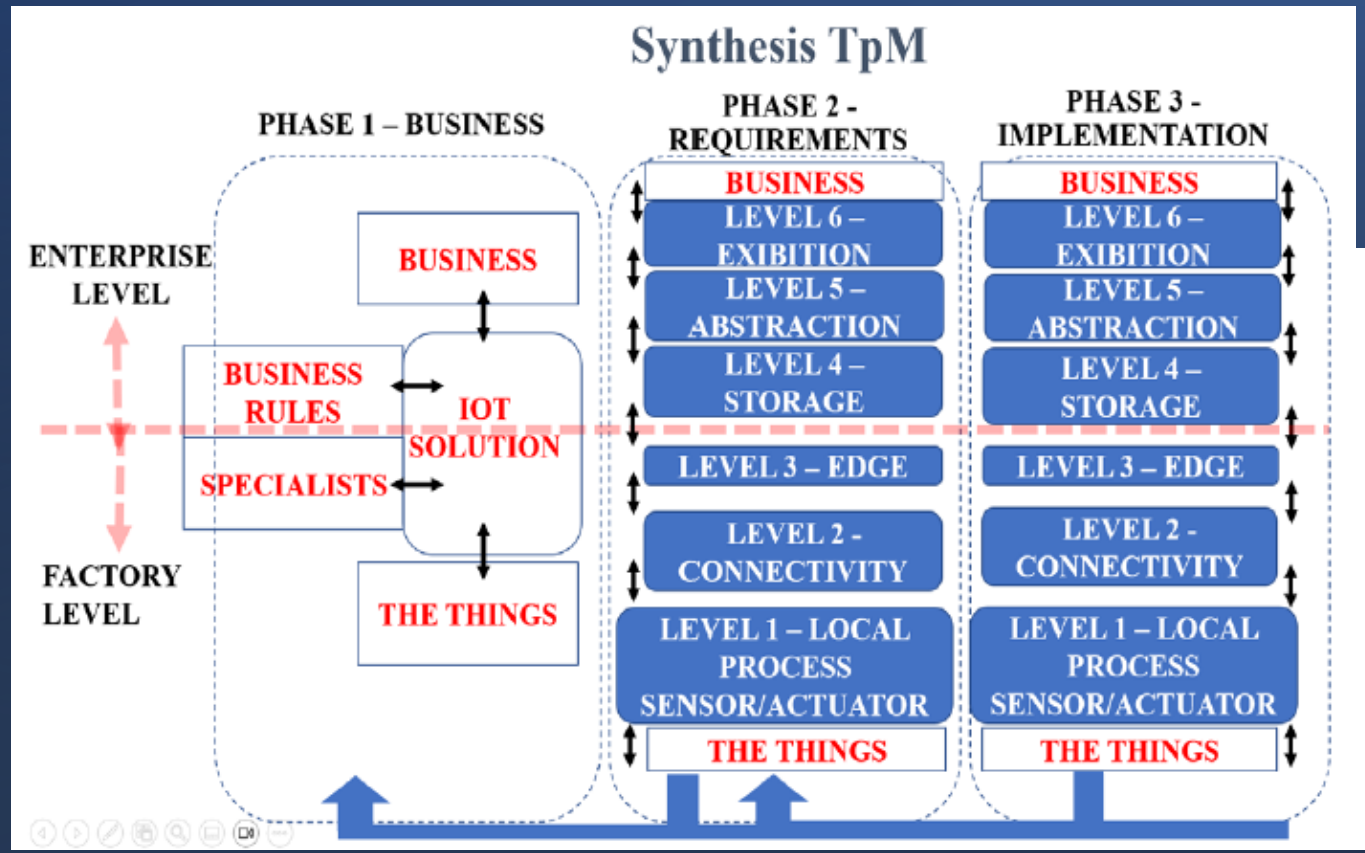
Current Project

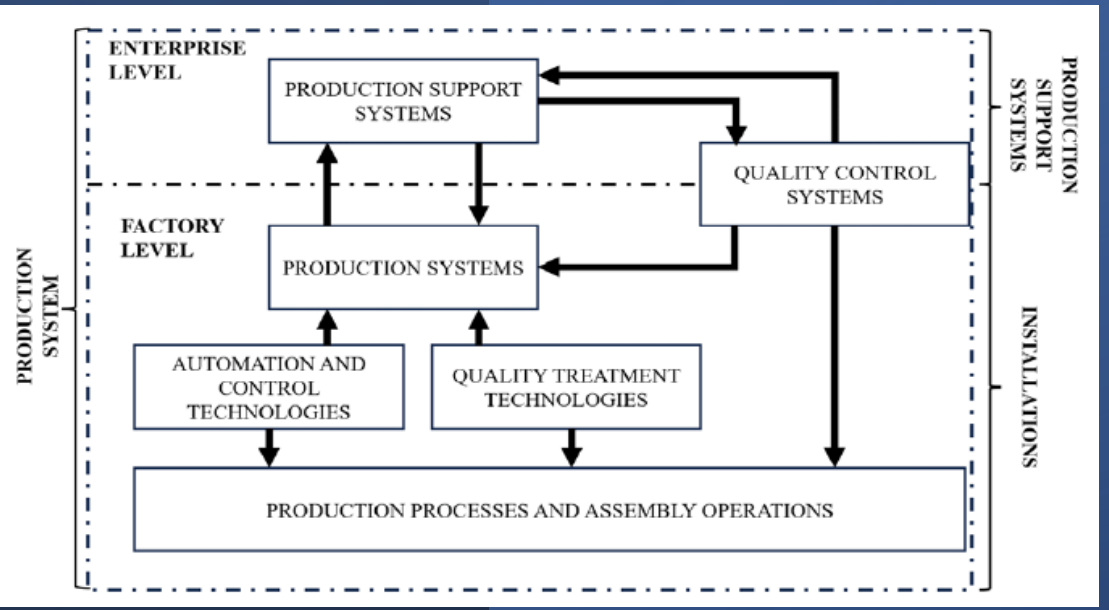
Implementing an IIoT (Industrial Internet of Things) system in a legacy production plant within a metalworking factory.

LEGACY

Consolidated Methodology

4.0 INDUSTRY





THREE-PHASE METHODOLOGY WORKFLOW

PHASE 1

UNDERSTAND THE BUSINESS

LOCAL VISIT AND MEETING WITH COSTUMER

COLLECT CRITICAL INFORMATION ABOUT PERFORMANCE DATA AND BUSINESS DETAILS

BUSINESS RULES

IOT SOLUTION VIABILITY

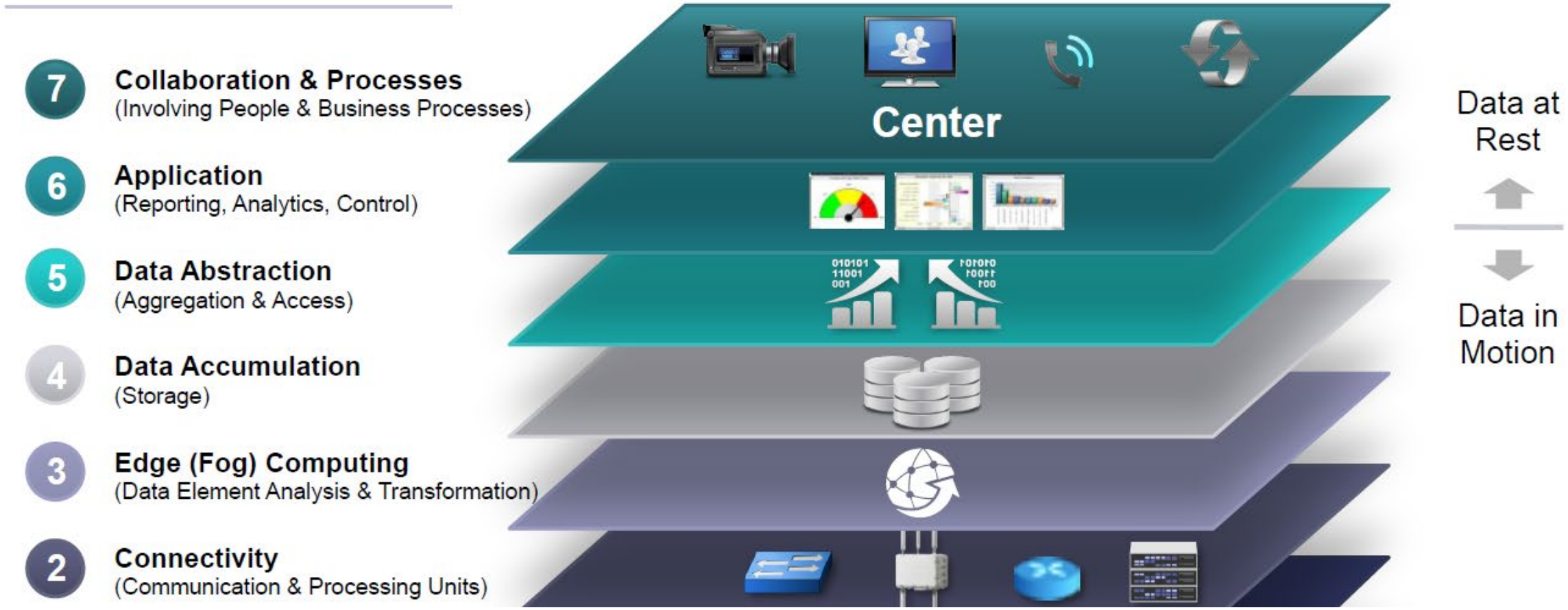
PROOF OF CONCEPT NECESSITY

PHASE 2

- Necessary Requirements
- IoT Solution development

PHASE 3

- IoT Solution deployment



PROPOSAL

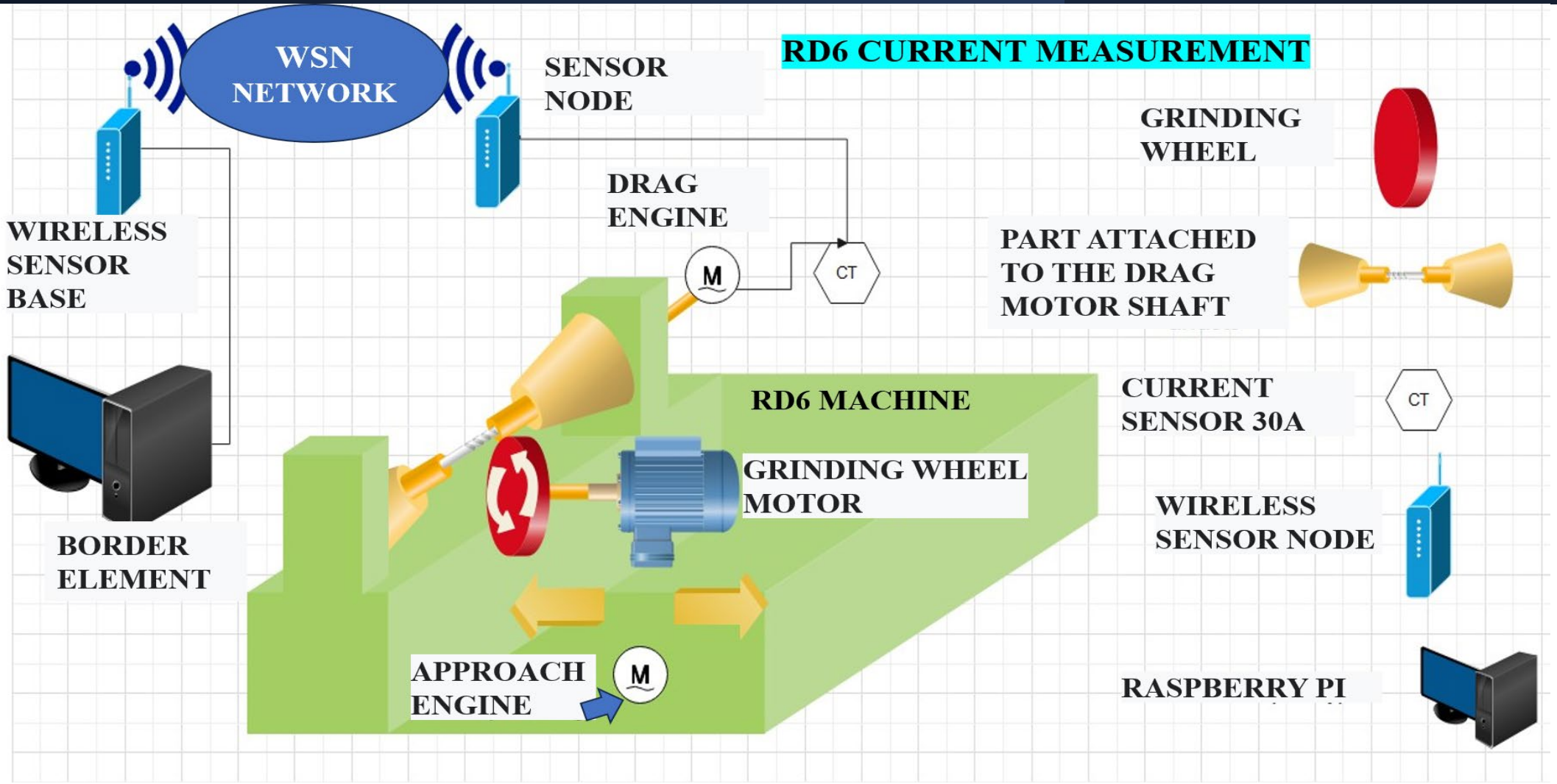
- This paper proposes a PoC for the application of the TPM to enable an IoT solution through Retrofit 4.0 in industrial environments. The proposal for Retrofit 4.0 in the industry combines the concepts of the production system, the IoT reference model , and the TpM.

PROOF OF CONCEPT PoC

IN PHASE 1 BUSINESS THERE ARE 2 MOTIVATIONS:

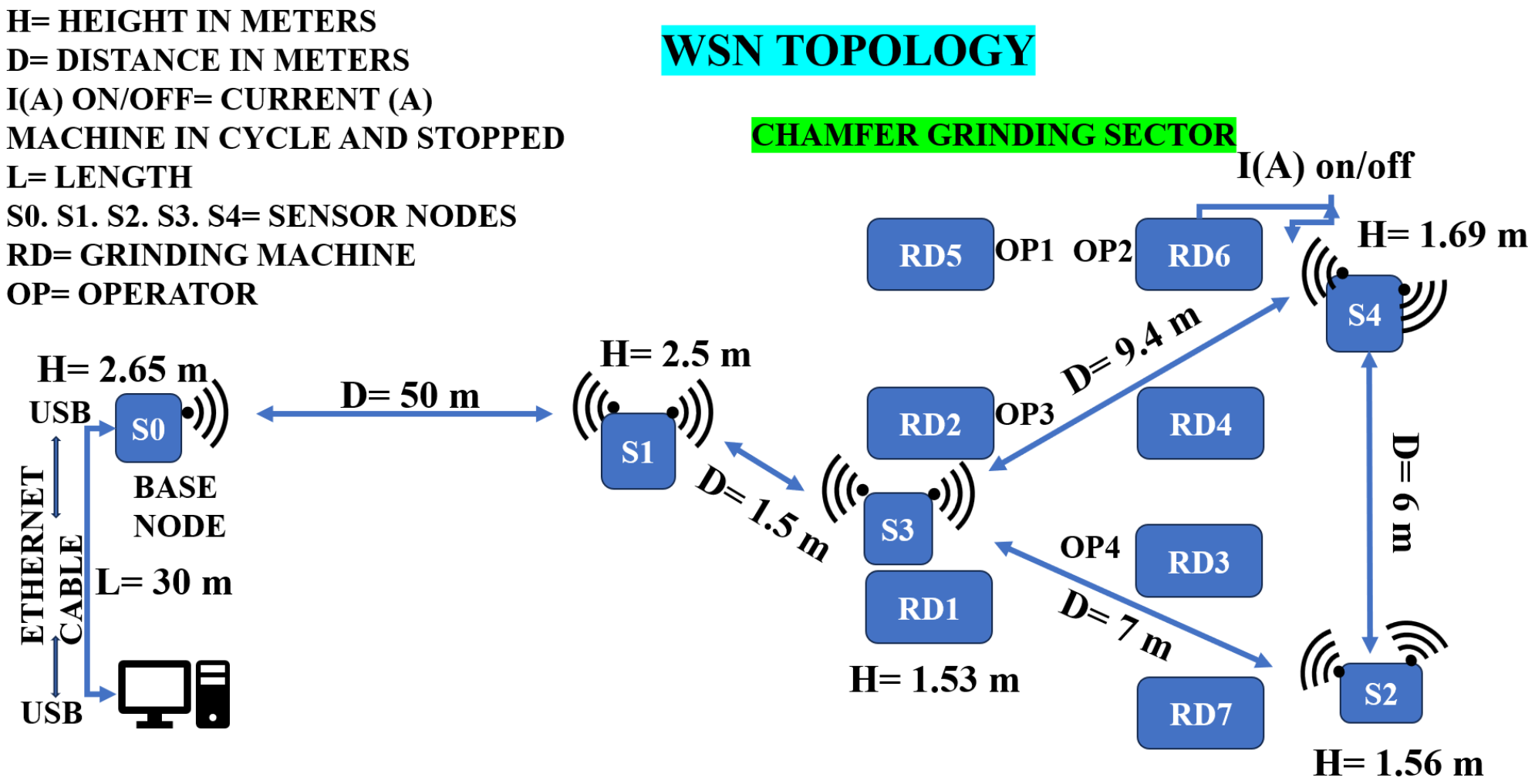
- **MOTIVATION 1 – MONITORING MACHINE CYCLES**
- To monitor the current values of an AC motor in a machine, focusing on KPIs such as "machine in cycle" and "machine stopped."
- **MOTIVATION 2 – RSSI MEASUREMENT TO DETECT OPERATOR'S MOVEMENT IN THE AREA.**
- To implement a wireless sensor network to measure operator's movement through radio signal variations within the sector during different shifts.

MOTIVATION 1 – MONITORING MACHINE CYCLES

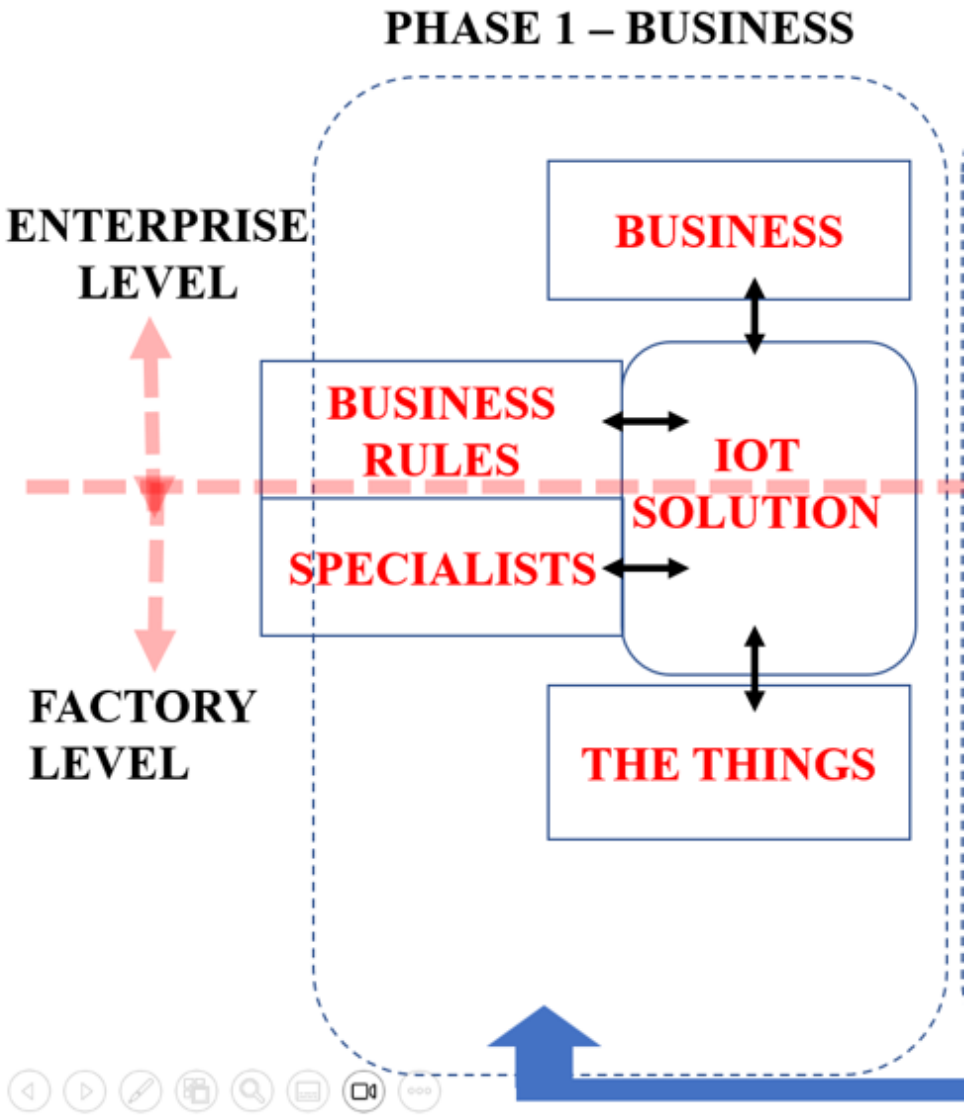



GRINDING
CARRIED OUT

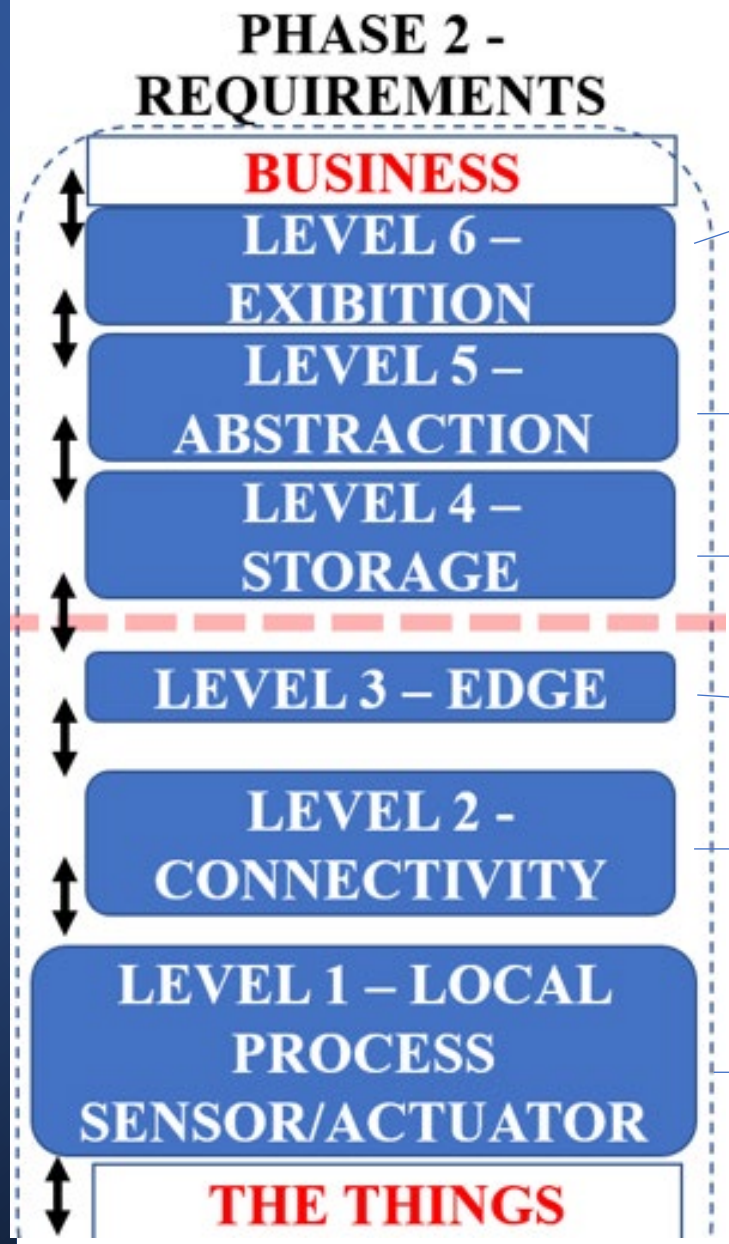
Motivation 2 – Rssi measurement to detect Operator's movement In The Area.



REST OF THE PHASE 1



PHASE 2 REQUIREMENTS



Level 6 Exibition

Methods were established to quantify and display data for the enterprise level.

Level 5 Abstraction

Measurements intervals.

Level 4 Storage

Data files stored

Level 3 Edge Element

Edge component.

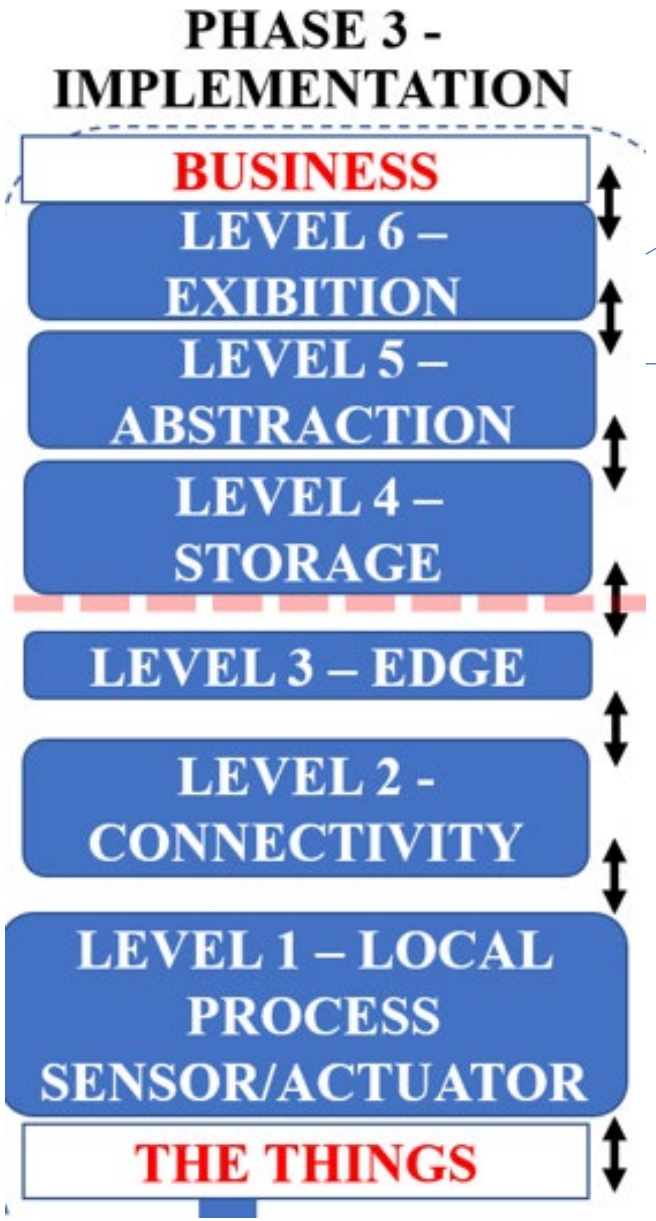
Level 2 Connectivity

Collected data transmission (packets WSN).

Level 1 Local Node / Sensing

The key parameters ON OFF machine cycle and RSSI variations.

PHASE 3 IMPLEMENTATION



Level 6 Exibition

Illustrates the collected data with graphics and statistics analysis.

Level 5 Abstraction

Edge element process and convert data.

Level 4 Storage

Raspberry Pi, the data is stored.

Level 3 Edge

Raspberry Pi

Level 2 Connectivity

Radio sensor devices.

Level 1 Local Node

R6 machine current sensor node.

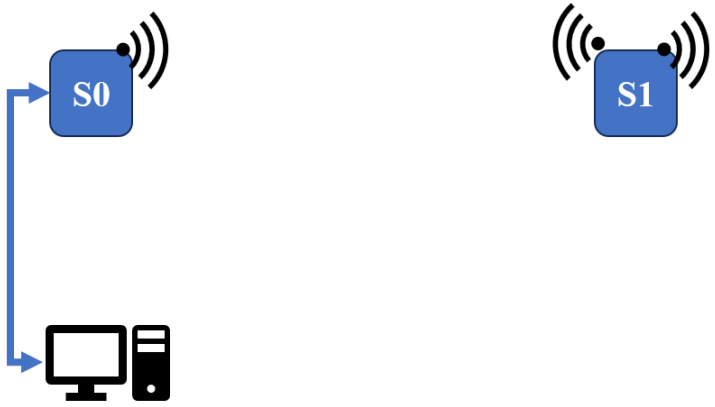
TOPOLOGY WSN AND HOPS ROUTES

ROUTE 1- S0 > S1 > S2 > S3 > S4

ROUTE 2- S0 > S2 > S4 > S1 > S3

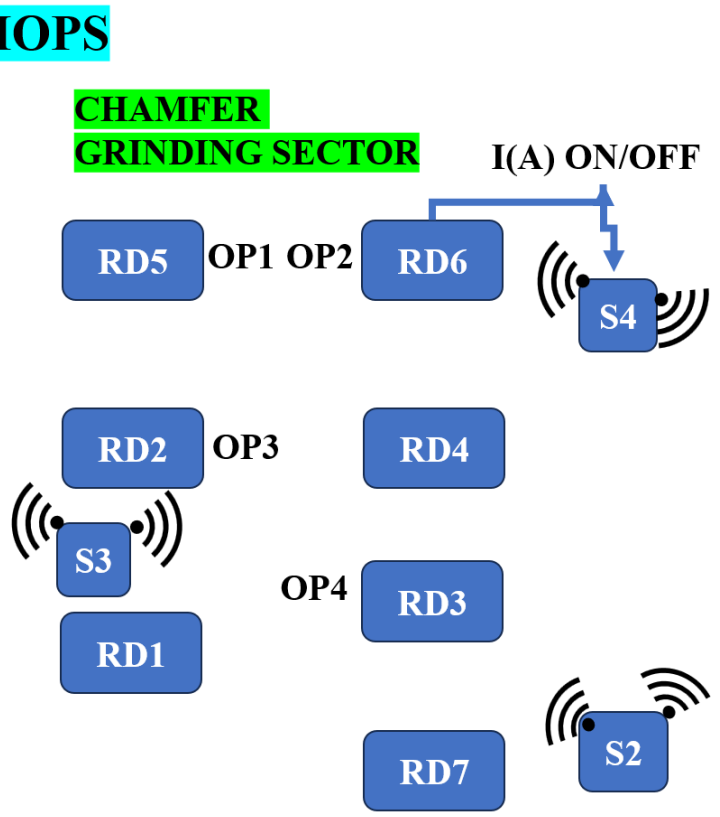
ROUTE 3- S0 > S3 > S1 > S4 > S2

ROUTE 4- S0 > S4 > S2 > S1 > S3

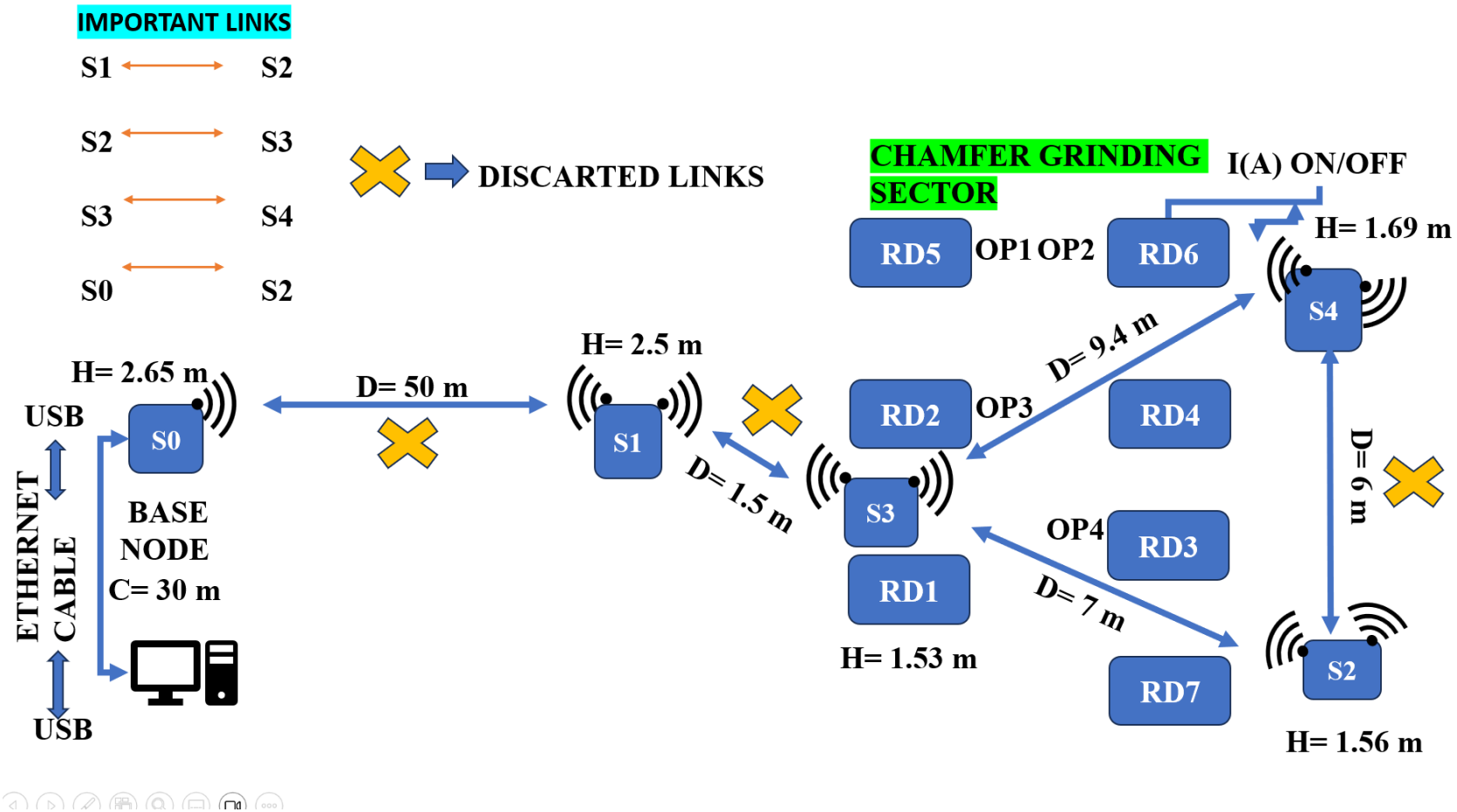


HOPS

CHAMFER GRINDING SECTOR

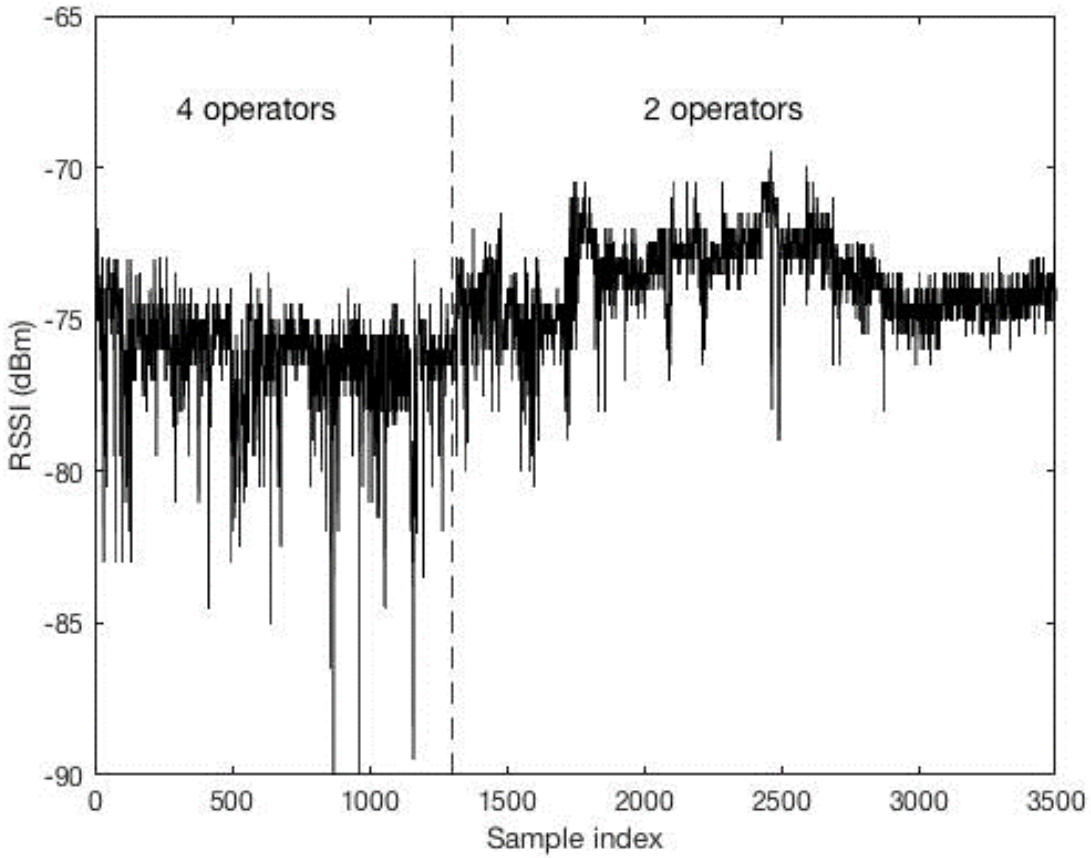


RESULT ANALYSIS

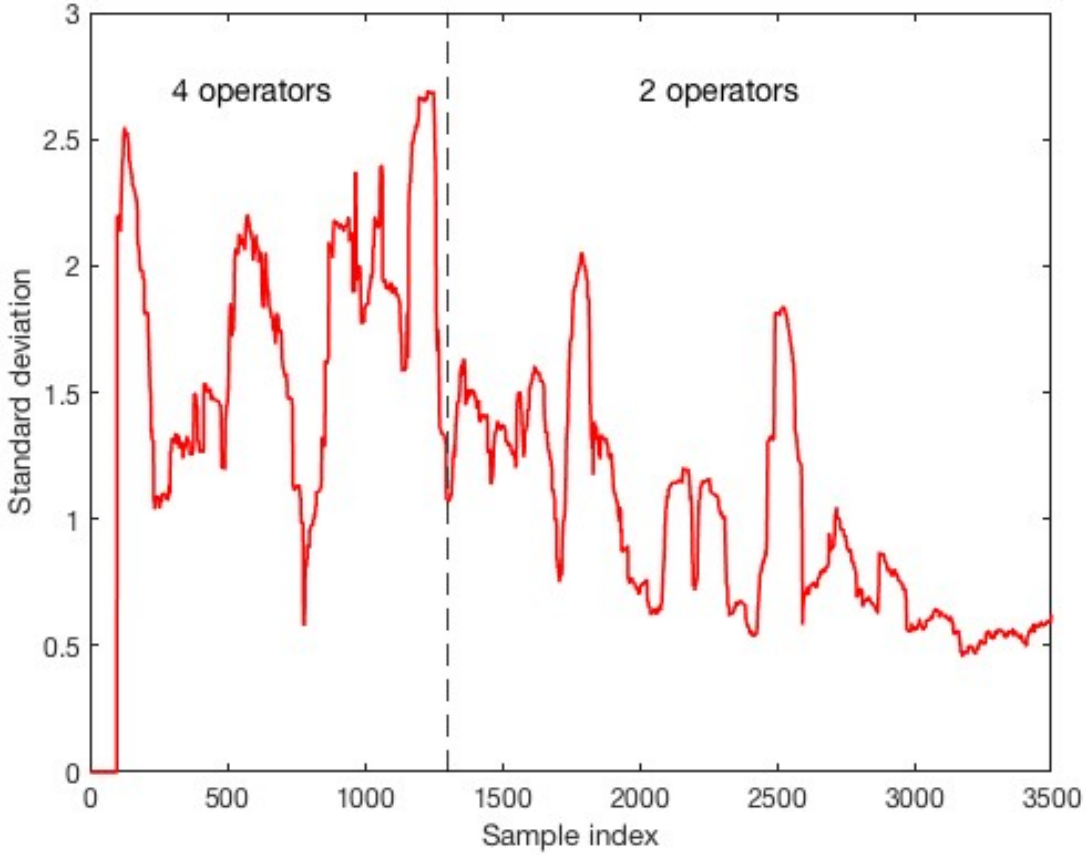


RSSI

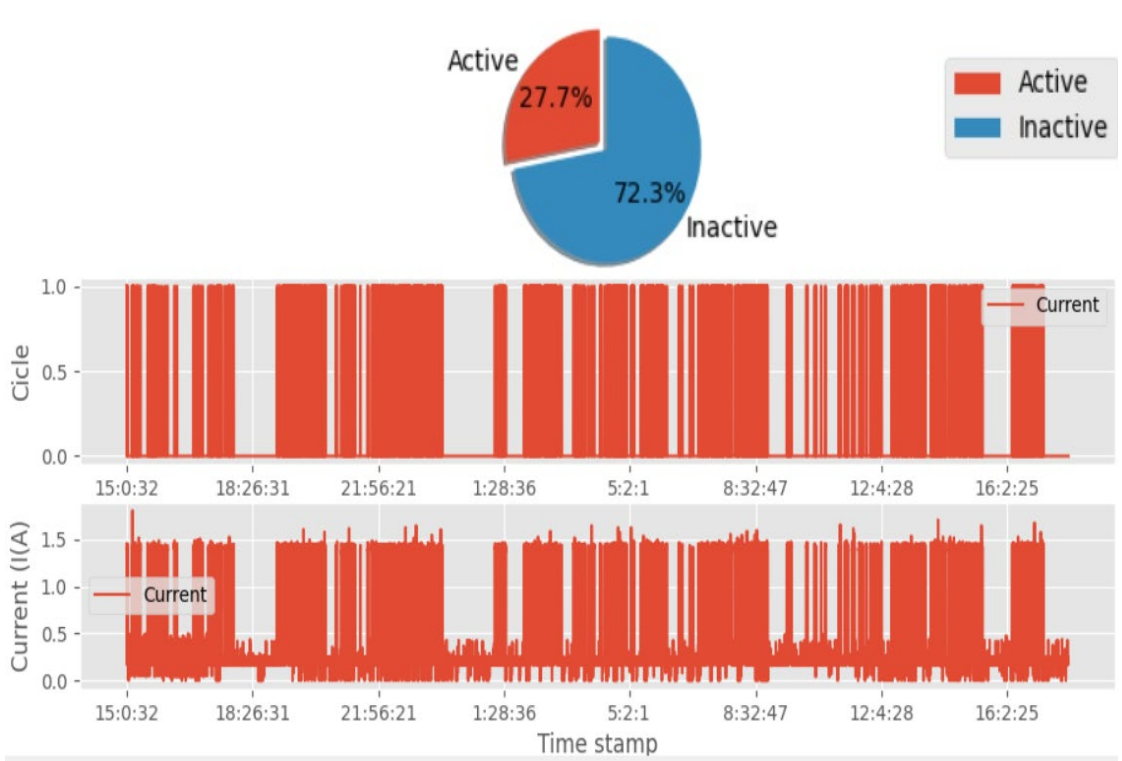
- RSSI VARIATIONS

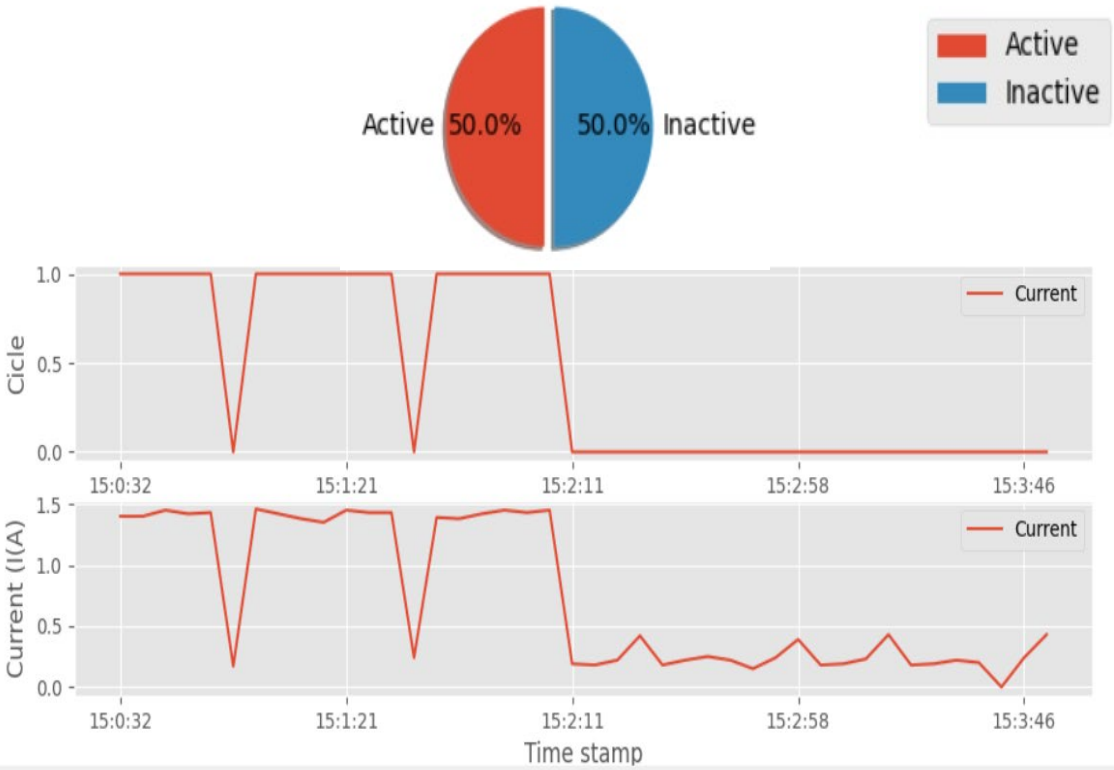


- STD DEVIATION



RD6 Machine Current Measurement





CONCLUSION

The TpM application for Retrofit 4.0 through PoC proved effective contributing to a non-invasive transition process. This consolidated methodology is important to connect business and IoT solution integrating enterprise and factory areas.

Noninvasive PoC was crucial in business understanding and IoT solution prototype.

Real-time recording of production performance, indicating rework, production adjustments, and technical improvements.

Both RSSI and current have proven to be powerful tools for productive management within the context of Industry 4.0. attending costumer requirements in studied case, narrowing control gap which is reflected on production performance data.