FoF Optimization: Human and Process Perspectives

- 09/06/2022
- Diogo Santos | diogo.santos@sistrade.com

Factory of the Future Optimization

Agenda

1. Work Package Context and Objectives
2. Key Capabilities
3. Portuguese Consortium
4. Capability Description and Developments
5. Integration
6. Results
7. Conclusion
8. Future Horizons

Factory of the Future Optimization

Work Package Context and Objectives

- One of the main technical workpackages of the project
- Solve complex, yet concrete, management problems at manufacturing shopfloors:
  - (O1) Understand the human dimension of work (mood, tiredness, efficiency, security...)
  - (O2) Efficiently organize the production in distributed manufacturing environments
  - (O3) Efficient energy consumption - diagnosis and prognosis
  - (O4) Network intrusion detection and mitigation

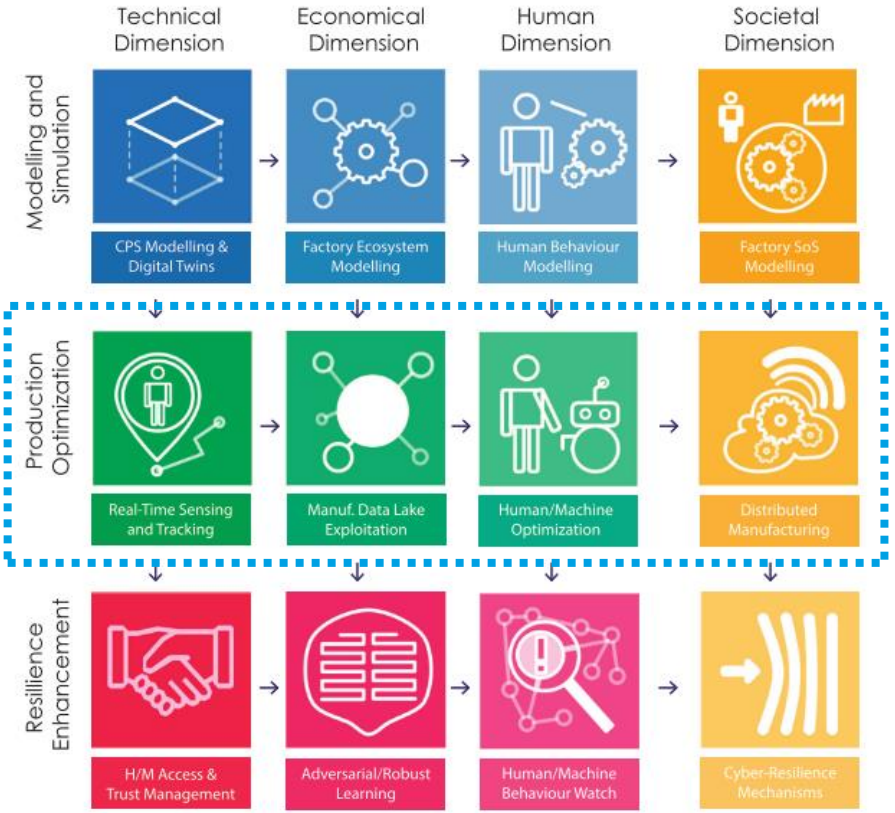
Factory of the Future Optimization

Work Package Context and Objectives

To tackle these problems, the following capabilities were developed:

- RT sensing & tracking
- Data lake Exploitation
- Human/Machine Optimization
- Distributed Manufacturing

(At least) 1system/capability was developed within the portuguese consortium



Factory of the Future Optimization

Portuguese Use Case

Consortium complementarity…

SisTrade Software Consulting, S.A.

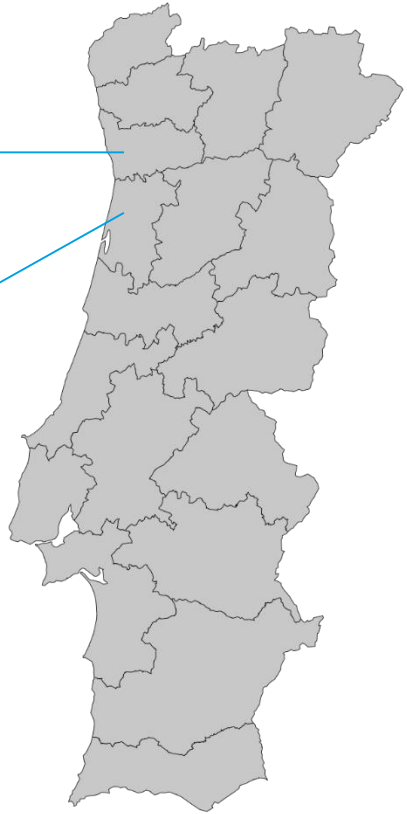
ERP & supply chain provider

isep Instituto Superior de Engenharia do Porto

Research Institute

idepa THE ACCESSORY IS ESSENTIAL

End-user/Pilot



Factory of the Future Optimization

Portuguese Use Case

Idepa - Indústria de Passamanarias

Portuguese SME | Textile Fine Fittings | Acesssories for Brand Value

Well established | 50 years of history

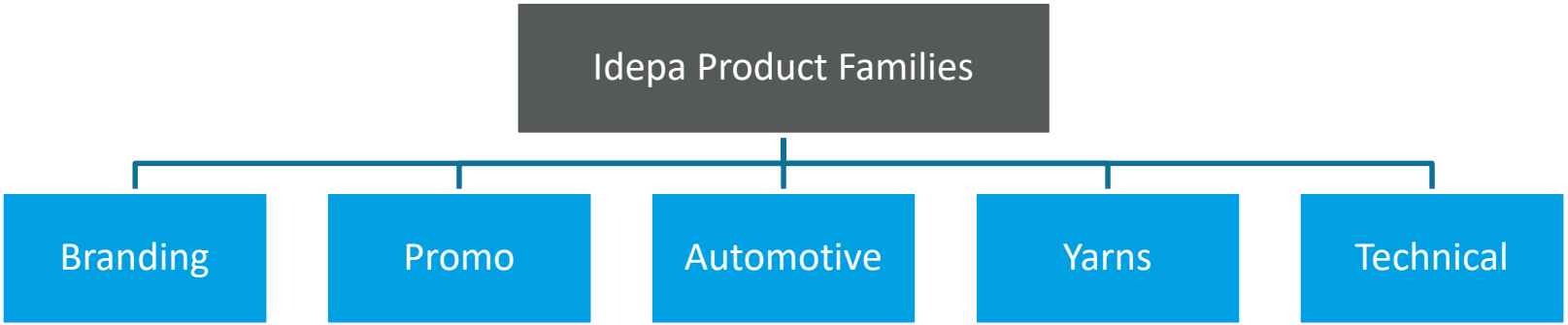
Production Models | Stock | Build-to-order

Wide Range of Processes | Warp and Weft | Jacquard Weaving | Ratière Weaving | Dyeing | Printing | Cut and Finishing

Good Ol'European Manufacturing | Remanescent of the 1st industrial Revolution | European Know-how

Factory of the Future Optimization

Portuguese Use Case



Factory of the Future Optimization

(Cap41) RT Sensing & Tracking Capability

Capability Objective: Extend tracking and geolocation to materials, people, smart manufacturing assets and finished goods; provide data for the situational awareness of the whole process, entities and environment;

Real-Time Sensing and Tracking

Capability Developments:

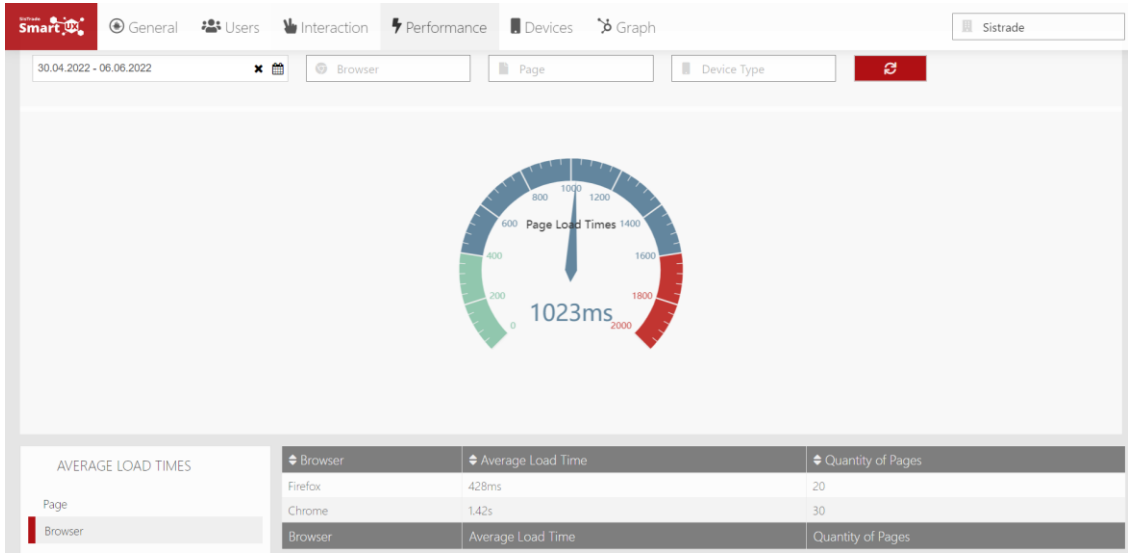
- Shopfloor analysis (existing machines and sensorization maturity level)
- Data aquisition layer (with schema specification)
- Energy Analysers
- SmartIOT Hub

Factory of the Future Optimization

(Cap41) RT Sensing & Tracking Capability

SmartUX is a tool for automatic and non-intrusive Human-machine data collection

- Monitors and continuously gather usability metrics
  - Page Visits
  - Number of Clicks
  - Distance Travelled
  - Exit and Bounce Rates
  - Performance Data
- Allows misusing detection
- Integrated interface
- Anonymous data collection



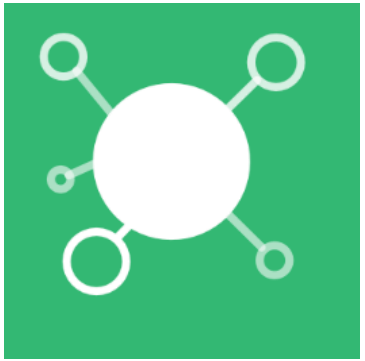
Factory of the Future Optimization

(Cap42) Data Lake Exploitation Capability

Capability Objective: Enabling of opportunities to build new business opportunities based on big data analytics over the manufacturing data thread

Capability Developments:

- Data Lake
- Energy Consumption (diagnosis and prognosis)
- Human Emotional and Physical Behavior Detection
- Network Intrusion Detection
- IoT Sensing



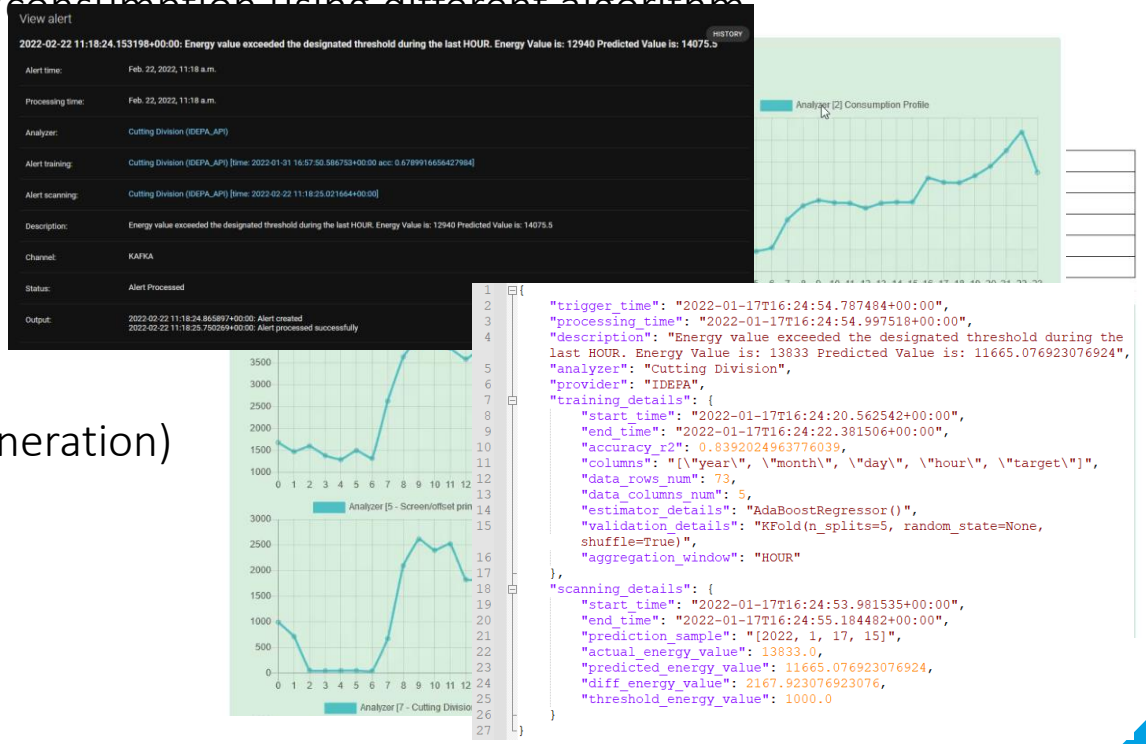
Manuf. Data Lake Exploitation

Factory of the Future Optimization

(Cap42) Data Lake Exploitation Capability

CyberFactory#1 Energy Forecasting Tool aims at providing a multifunctional tool to perform forecasting for power generation/consumption using different algorithm

- Consumption profiling (sections/machines)
- Day-ahead forecasting
- Anomaly Detection (alarm generation)



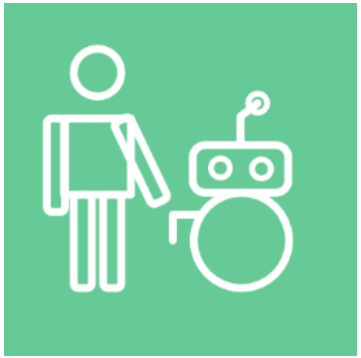
Factory of the Future Optimization

(Cap43) Human/Machine Optimization Capability

Capability Objective: Optimization of human / machine collaboration on the shop-floor

Capability Developments:

- Human Pose Detection
- Human Recognition
- Facial Recognition

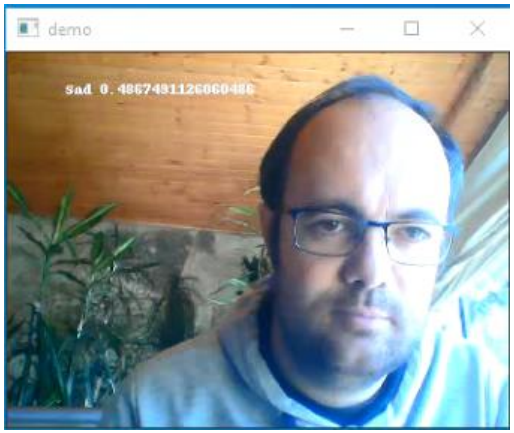


Human-Machine Optimization

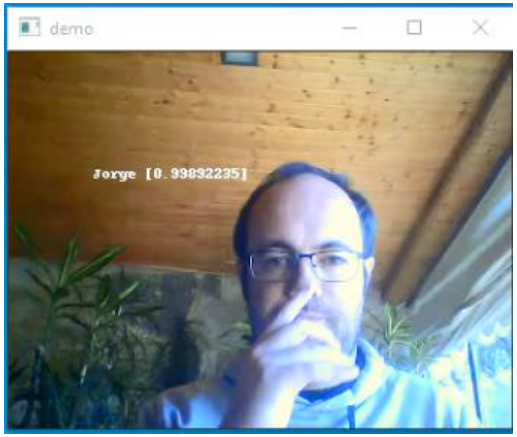
Factory of the Future Optimization

(Cap43) Human/Machine Optimization Capability

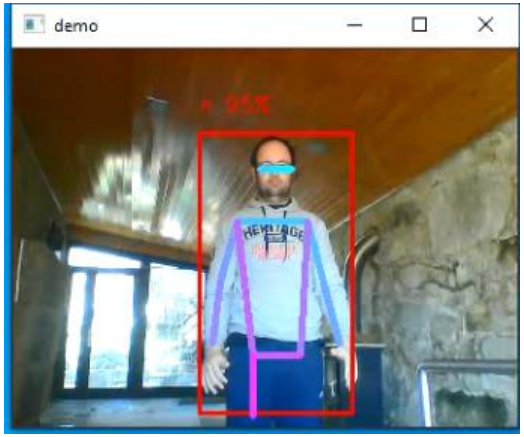
Emotion Detection



Human Recognition



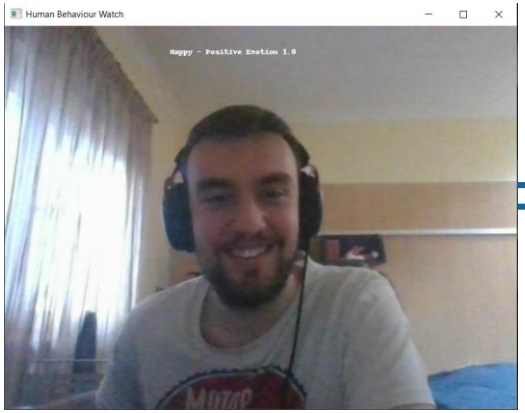
Human Pose Detection



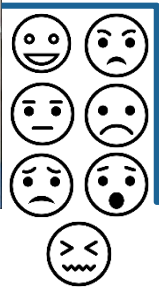
Factory of the Future Optimization

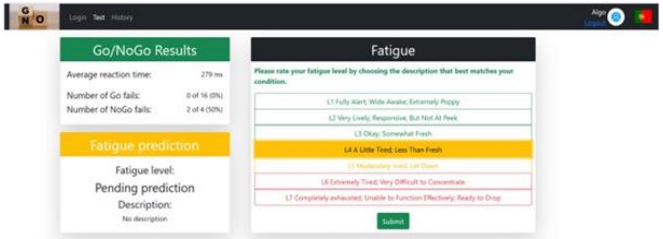
(Cap43) Human/Machine Optimization Capability

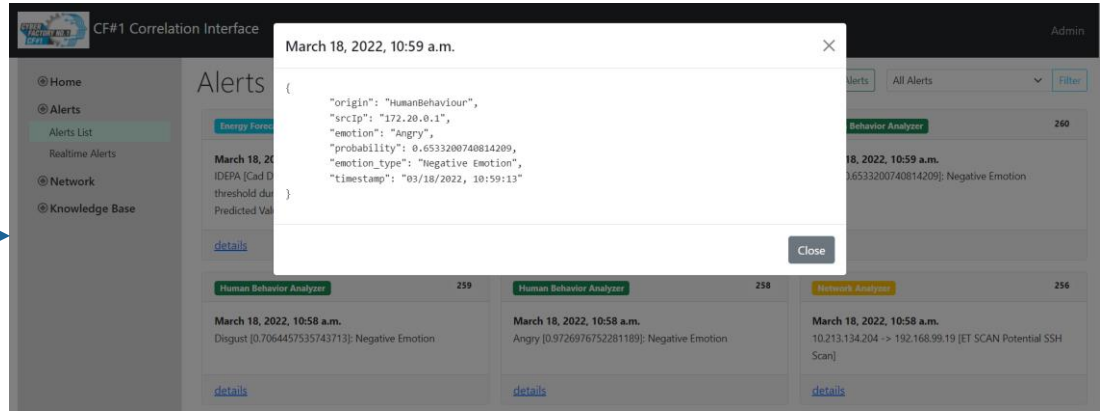
Negative Emotion Detection



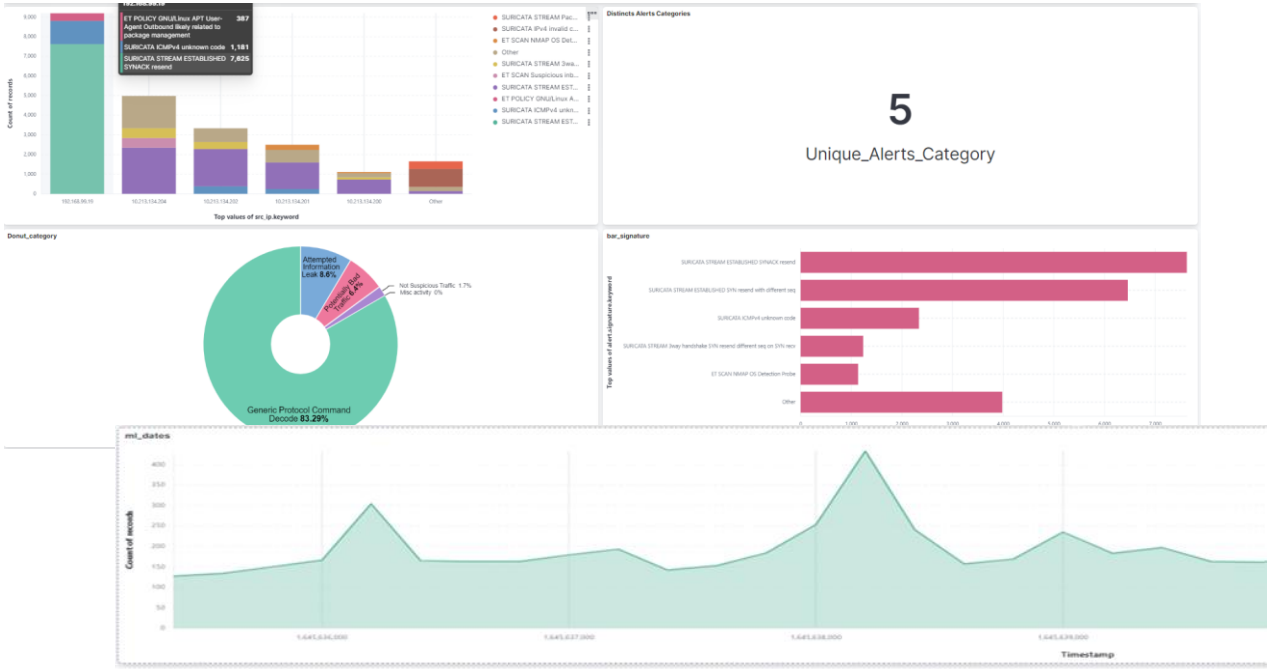
Negative Emotions







Network Analyser




```
{
  "_index": "ml_alerts",
  "_type": "_doc",
  "_id": "8jmSJ38B0lvkqJMhWkCX",
  "_version": 1,
  "_score": 1,
  "_source": {
    "SrcIp": "192.168.99.19",
    "DestIp": "10.213.134.202",
    "SrcPt": "417",
    "DestPt": "36667",
    "Timestamp": 1645636377,
    "Proto": "TCP",
    "InBytes": "20",
    "OutBytes": "0",
    "InPkts": "1",
    "OutPkts": "0",
    "tcp_flags": "...A.R.."
},
```

Factory of the Future Optimization

(Cap44) Distributed Manufacturing Capability

Capability Objective: Distributed manufacturing capability: enabling to optimize the distributing of production load over a network of factories or fab-labs in real time

Capability Developments:

- Cloud based service scheduling of distributed production

Distributed Manufacturing

Factory of the Future Optimization

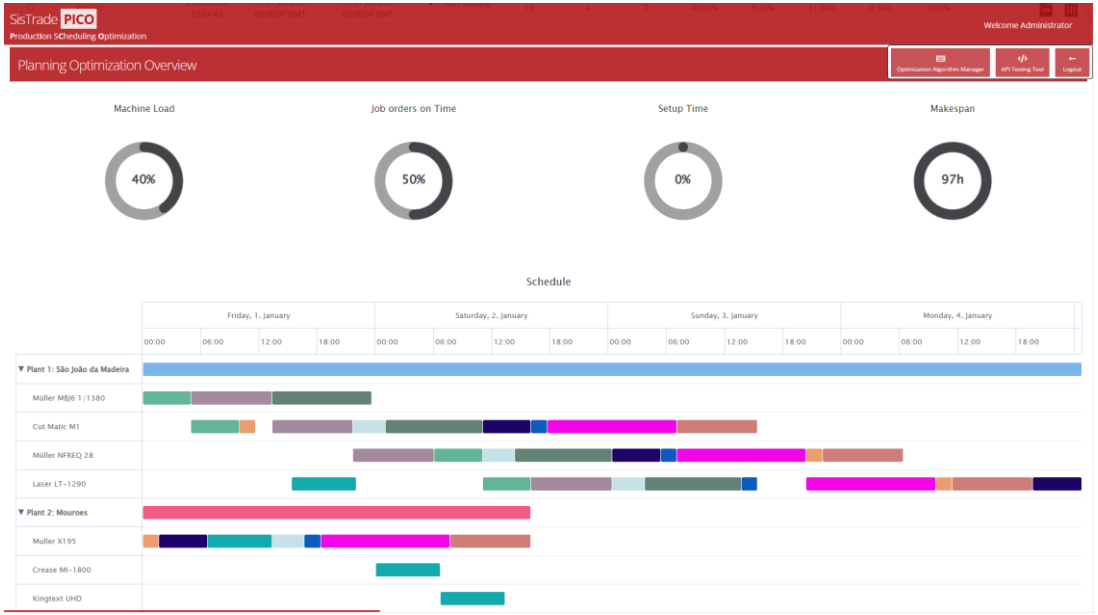
(Cap44) Distributed Manufacturing Capability

PICO is a distributed production scheduling optimization API, with multi-factory representation, multi-domain and multi-criteria decision making

- Scheduling and multi-site shopfloor data exchange
- Multi-criteria optimization
- Automatic optimization features (algorithms/parameters)

Output

Optimized plan (gains comparison)

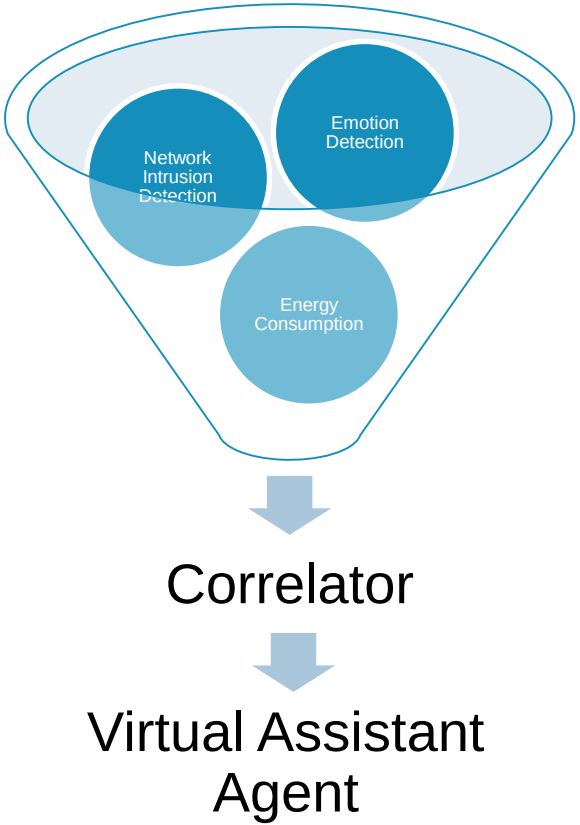


Portuguese Use Case - Integration

- SmartUX was installed on the IDEPA's ERP systems
- The Data Aquisition Layer was connected to the IOT infrastructure
- Energy analysers were installed in all shopfloor sections
- Intrusion Detection System (IDS) was deployed to the IDEPA's network
- PICO API was exposed and connected to the IDEPA's schedulling module
- Correlator and Virtual Assistant Agent (VAA) modules were developed to assist in the integration of the previous modules

Portuguese Use Case - Integration

- Integration steps:
  - All the anomalous events detected are merged by the Correlator
  - The Correlator computes an event that it is sent to the Virtual Assistant Agent (VAA)
  - The VAA can trigger notifications or actions



Factory of the Future Optimization

Portuguese Use Case - Results

From (Pre-Project)	To (Post project)	How CF#1 provide value
Selling products	Selling products + associated data services + Innovative Billing Models	Data Lake Exploitation Data as base for additional services
Data used for monitoring status	Data used to drive better production and management decisions (+efficiency and Resilience, - cost)	Predict Energy Consumption Distributed Optimization Predict Human Emotions and Status
Manual efforts to ensure customer IP Protection	Ai-Driven cybersecurity to ensure Customer IP protection	Detect Cyberthreats at network-level Detect misuse at ERP level Facilitate role Management Automate Response
Don't know how internal systems are used	Know how internal systems are used	Detect Cyberthreats at network-level Detect misuse at ERP level
Few Cybersecurity mechanisms and awareness	Enhanced Cybersecurity Mechanisms, increased self-awareness	Facilitate Role management Facilitate adoption of cybersecurity policies and technologies

Factory of the Future Optimization

Portuguese Use Case - Results

Objective	Metric
Services integrated into the deployed solution	Energy Consumption Prediction; Human behavior analyser; Intrusion Detection System;
Distributed Production Schedulling improvements in production time reduction	Average 37%
Emotion recognization model accuracy	Average 70%
Integration with existing enterprise management plataforms and variables	60 metrics

Distributed Manufacturing

Conclusion

- Achieved step changes in the production efficiency;
- Synergetic effect: Integrated with the resilience capabilities for full synergy extraction (stay tuned for the next presentations!);
- Project developments were key to the transition from a product-driven business to a data-driven service;
- Proven that traditional european industries can fully benefit from smart manufacturing approaches improving its efficiency and competitiveness;
- The breadth of the developments done could only be carried on through an open innovation initiative (such as CF#1).

Factory of the Future Optimization

Future Horizons...

- Increase data aquisition to enable further data lake exploration (e.g. Product quality correlation with environmental and production settings);
- Improvements in user profilling to improve worker condition and satisfaction (i5.0);
- Collaborative IDS with AI Federated Learning;
- Integration of energy forecast with weather forecast for fotovoltaic production and production schedulling for enhanced energy cost reduction and sustainability;
- Dynamic distributed production scheduling with realtime transport cost and material availability data fusion.

Thank you!

- Diogo Santos | diogo.santos@sistrade.com