From Cloud-Native to 5G-Ready Vertical Applications: An Industry 4.0 Use Case

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Context

×Applications under the Industry 4.0 umbrella would strongly benefit from the 5G widespread diffusion.

×Edge computing and slicing can provide the required features by attaching vertical apps terminations in neighboring geographical facilities.

×Customized network slices can be customized to perfectly match the desired features and constraints.

×Verticals lack the required knowledge.

×Telco providers not prone to let third parties orchestrating their resources.

Scope of the Paper

× This paper presents an Industry 4.0 application.

× We highlighted the role played by the MATILDA solution in making the application successful.

× Bridge the gap between the vertical application and the network service domains.

× Transform a cloud-native application into a 5G-ready one.

× Provide verticals stakeholders with a complete 5G slice.

× Allow managing the application in a ZSM fashion.

The MATILDA Vision

×A novel and holistic approach for the overall lifecycle of applications' design, development, deployment and orchestration in a 5G environment

×Design and development of 5G-ready applications

×Separation of concerns between the orchestration of applications and network services

×Application-aware network slices leading to optimal application execution.

Reference Architecture

×5G-ready Applications Layer, oriented to software developers.

×Applications' Orchestration Layer, oriented to application service providers.

×Programmable 5G Infrastructure Slicing and Management Layer, oriented to telecom infrastructure providers.
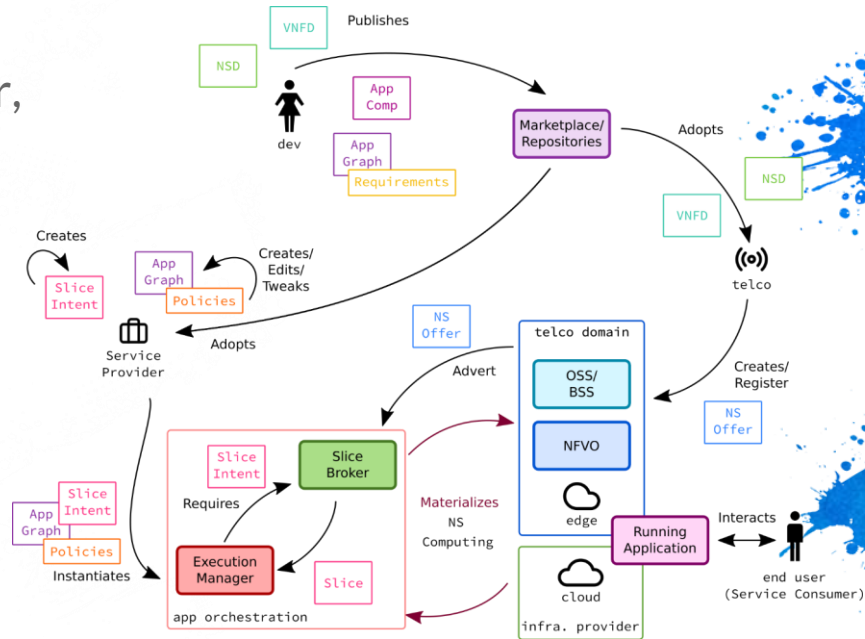
The Vertical Industry Domain

×Simple microservices-based approach for software developers.

×Slice intent metamodel to declare information and requirements to be exploited during the deployment and operation over programmable infrastructure.

×A Marketplace to publish 5G-ready apps and VNFs/NSs).

×Specify policies and configuration options and formulate a slice intent.

×Advanced monitoring and analysis techniques.

The Telco Domain

×Based on the slice intent, the Telco Provider instantiates the slice by activating the required network management mechanisms.

×Instantiation of NSs imported from the MATILDA marketplace.

×An extended OSS controls all the resources/services allowing the entire lifecycle management of the 5G vApp from planning, to first deployment, down to in-life management until their termination.

HRC In Assembly Lines

×Industry 4.0: the automation processes in industrial environments increase.

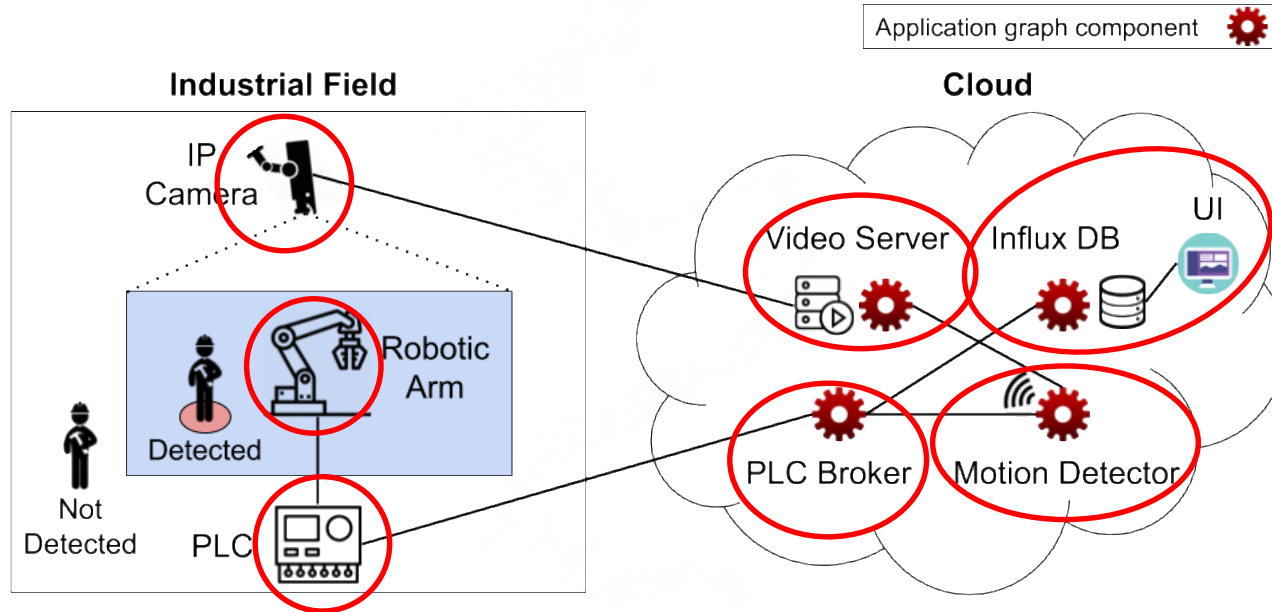×Important requirements for safe collaboration between human beings and machines in the workspace environments.

×Traditional industrial robot production methods cannot meet the needs of the production safety.

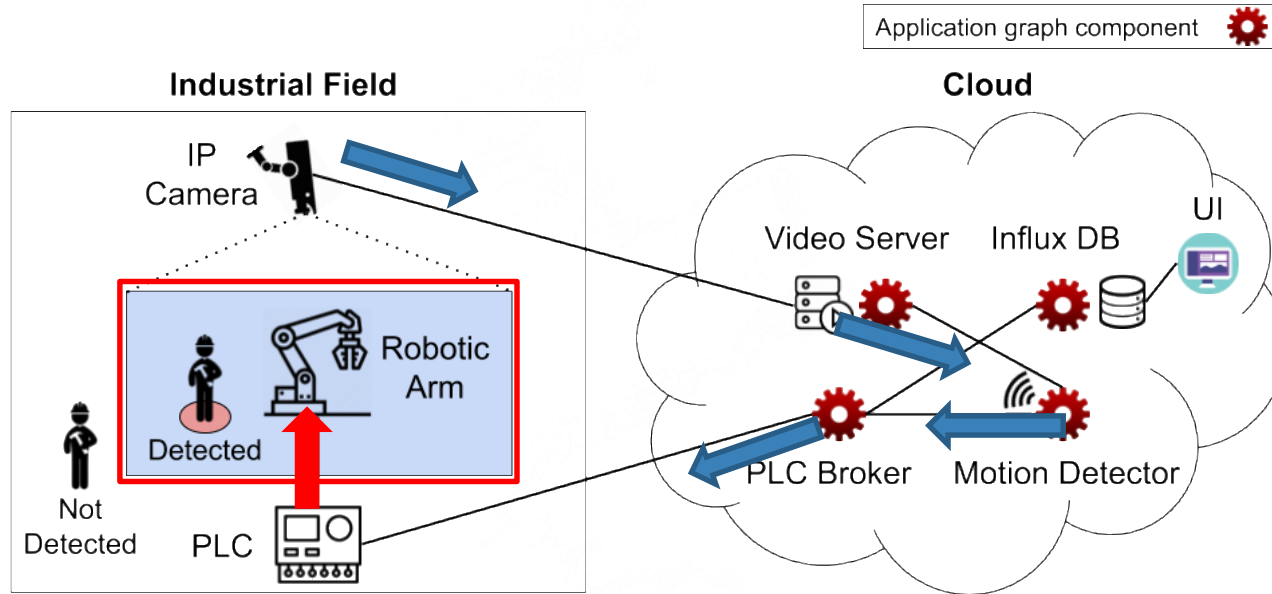×Close contact between robots and workers is a challenging application of Industry 4.0.

Main Industry 4.0 Requirements

× Challenge: protect the human operators in a shared workplace.

× Detection of possible collisions in real time.

× Adaptive machinery control for run-time human collision avoidance.

× Human-robot separation distance and relative speeds.

× Reduce the safety distance by minimizing the end-to-end latency between movements' detection and reaction time.

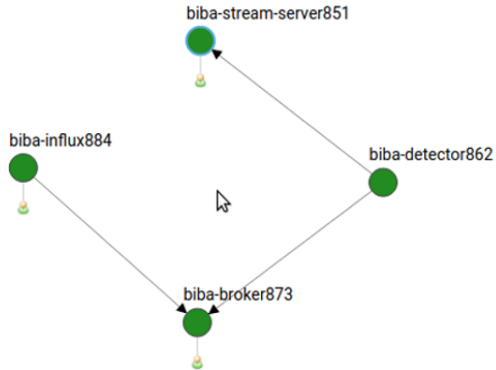× Optimization of both the monitoring and the feedback control process.

Use Case Scenario Description

Application graph component

Industrial Field

IP Camera

Robotic Arm

Detected

Not Detected

PLC

Cloud

Video Server

Influx DB

UI

PLC Broker

Motion Detector

Use Case Scenario Description

Application Graph

KPIs

Operational KPI	Description	Acceptance Threshold	Result
Resource Usage Monitoring	Compute/storage/networking resource usage monitoring	Must be available	Available.
Scaling time	Time required to trigger the scaling after threshold was reached	~ 30s	7s
Availability	Availability of the service upon request	High > 99 %	99.999 %
Reliability	Reliability of an available service	High > 99 %	99.999 %
Network KPI	**Description**	**Acceptance Threshold**	**Result**
Availability	End-to-end continuous measurements of network connectivity, collected statistics used to calculate availability	> 99 %	99.5 %
Reliability	End-to-end continuous measurements of network connectivity	>99 %	99.5 %
Bandwidth	Required for delivering rich video stream to the Detector component in order to make proximity analysis	~10 Mbps	~ 12 Mbps
Jitter	Time-critical communications should be stable and reliable. Timing variation must be minimal	< 1 ms	0.7 ms
Packet Loss	Reliability and high availability of the services in HRC needs to be guaranteed. Therefore, packet loss should be as small as possible.	< 0.01 %	< 0.001 %

Benefits of the MATILDA Platform

×Guaranteed reliability and high availability in distributed manufacturing facilities interconnection.

×Collection and transfer of real-time information enables a better access to remote process control and process monitoring.

×Compliance of end-to-end delay requirements and secure and private end-to-end services support.

×Tools to specify microservice's communication needs and to deploy and onboard the application in a very short time.

Conclusions

×The verticals' lack of knowledge on 5G and the orchestration complexity may hamper the delivery of truly groundbreaking applications.

×MATILDA tackled the integration between the vertical services and the networking environments.

×The ZSM platform supports verticals in converting their apps into 5G-ready ones, providing them with a complete 5G network slice.

×Assess the solution effectiveness with an Industry 4.0 application including a set of KPIs

Thanks for your kind attention ☺

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