Simulation Team

Virtual & Augmented Reality and Simulation as Enablers for RCM, TPM, Predictive & Distributed Maintenance

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TPM Total Productive Maintenance
RCM Reliability Centered Maintenance

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FuelFx

Objectives

The evolution of M&S, AR and VR is enabling the use of new Solutions. Currently we are active into:

- **Develop new Service & Maintenance of Distributed Assets**

- **Rethink Distributed Assets as Distributed Systems by:**
  - o **Identifying Service Requirements**
  - o **Evaluating Enabling Technologies**
  - o **Defining new Architectures**
  - o **Designing new Embedded Devices**

Eurasia Incusries RTD NDT

- **Develop Solutions for Predictive Maintenance & Service Planning**

- **Develop Applications for Remote Service & Operator Training**

- **Support Implementation of TPM, RCM, Predictive & Distributed Maiantenance solutions in Industry**

M&S Modeling & Simulation
AR & VR Augmented Reality & Virtual Reality

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Total Productive Maintenance

TPM (Total Productive Maintenance) aims to guarantee a continuous improvement of productive effectiveness through engagement of People and Organization of effective small groups. TPM combined together with Total Quality Management (TQM) allows to enhance Productivity, Efficiency & Effectiveness.

The New Emerging Technologies enable today the possibility to get extended engagement and maximum support from the total workforce, keeping people updated on production situation. In this way it is possible to analyze Big Data and to create models able to identify the causes for accelerated deterioration and to evaluate the most effective corrective actions.
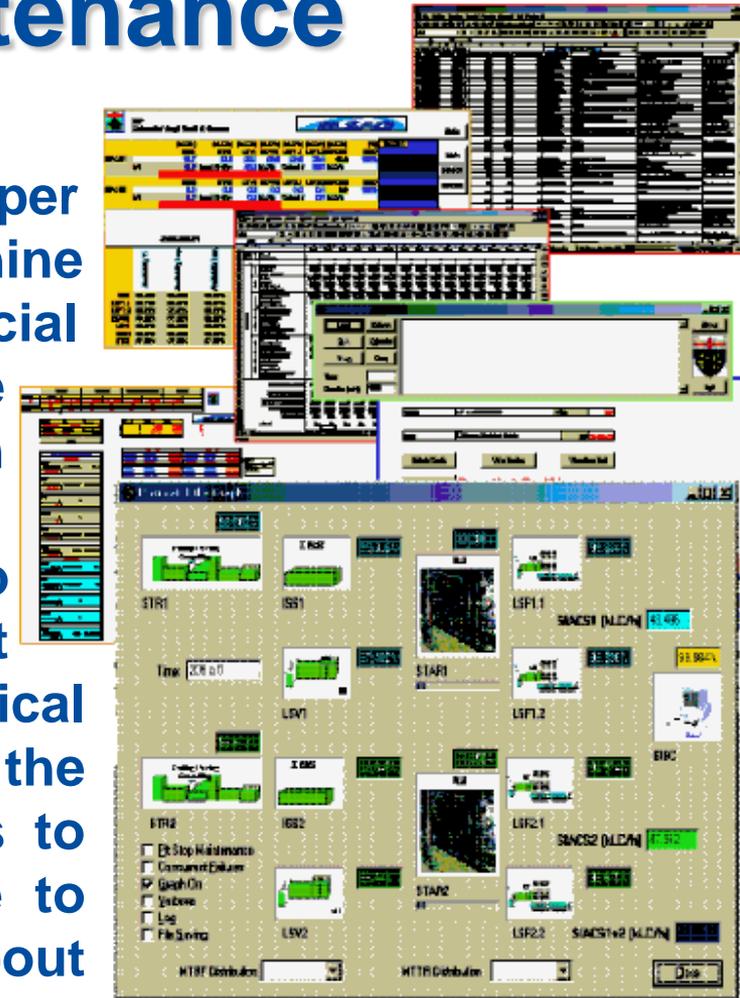
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Reliability Centered Maintenance

Reliability Centered Maintenance (RCM) is a management process devoted to ensure that Systems operates properly by guaranteeing high Reliability levels. RCM allows to achieve improvements in fields, establishing safe minimum levels of maintenance. RCM leads to increase cost effectiveness, reliability, machine uptime and an awareness about Risk Levels on Systems Failures respect operational and organizational issues.

The introduction of Models based Continuous and Updated System Data allows to develop new components of RCM Process that enable further improvements and higher efficiency

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Predictive Maintenance

Big Data Analysis, by adding proper filtering as well as good Machine Learning Solutions based on AI (Artificial Intelligence) Techniques, enables the possibility to predict failures based on symptoms and operational modes.

In this way it becomes possible to anticipate the breakdowns and carry out corrective actions on the incoming critical components, subsystems or systems. At the same time the use of Simulation allows to evaluate the impact of predicted failure to properly finalize the decision making about corrective actions.

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Preventive Maintenance Planning & Risk Analysis

Simulation Models based on up-to-date data of the Systems and Subsystems allows to evaluate alternative Management Strategies, Opportunities for Refurbishments, Rescheduling of Planned Inspections, Minor and Major Revisions to guarantee best levels in terms of Savings, Availability, Profitability, etc.

This allows to evaluate Technical, Operational and Contractual Constraints respect Organizational Assets & Resources used for Services, even considering geographical and accessibility issues to the Machines, Plants and Systems.

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Augmented & Virtual Assisted Maintenance

Virtual Solutions & Augmented Reality Devices allows to improve the Autonomous Capabilities of Personnel deployed on Site and Improve Service.

The Simulation allows to create Educational & Training Program to prepare people on Field by creating Virtual Immersive and Interactive Experiences and transforming Service increasing its profitability

At the same time such Solutions allows to develop Intelligent Agents as Virtual Assistants for Troubleshooting that reduce the request for external assistance and represent a new kind of Service to be provided to Customers. In addition, these Solutions enable to use of Remote Supervised Maintenance directing actions on site and reducing the necessity to deploy Service people around the world to manage contingency even on Plans and Complex Systems

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Distributed Maintenance

Modern Virtual & Augmented Reality Solutions such as SPIDER allows to direct from HQs service activities remotely, guiding the local people to identify and solve the problem remotely. This kind of Distributed Maintenance have a great potential on Vessels, Off-Shore Platforms, Plants and Installations in remote place or highly distributed around. The personal interventions on site are not totally solved, but their impact is strongly reduced, guaranteeing higher reliability at low cost and saving valuable personnel for real critical actions. These technologies are also useful to support the employ of Maintenance Personnel on demand and based on availability periods for continuous support to multiple production sites.

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Simulation Team Solutions

- **Simulation Team Solutions are based on Virtual & Augmented Reality integrated with Plant Data to improve Safety and Productivity**

- **We combine these innovative solutions with Modeling and Simulation on different Systems (e.g.Parmalat,Findus, Verallia, etc)**

- **We are able to create tailored scalable Solutions to be adapted to different Systems and Plants supporting different integrations (e.g. alerts), wearable devices (e.g. tablets, smartphones, glasses) to guarantee dynamic & efficient supervision**

From *buzz words* to Facts: Results measured on the Field

- The Simulation Team carried out many experience, several sponsored by the R&D Department of INAIL in Joint collaboration with R&D Centers and Industries
- Along last 2 years, it was completed a very successful Experimentation SISOM of VR on Industries producing Single Machines for Paper and Food & Beverage Sectors
- The main reason of SISOM big success resulted from creating a *Real Applications extensively tested on the field*, *no just words*
- We are continuously developing tailored solutions for different applications in many Fields

SISOM - Simulation Solutions based on virtual & augmented reality for Maintenance
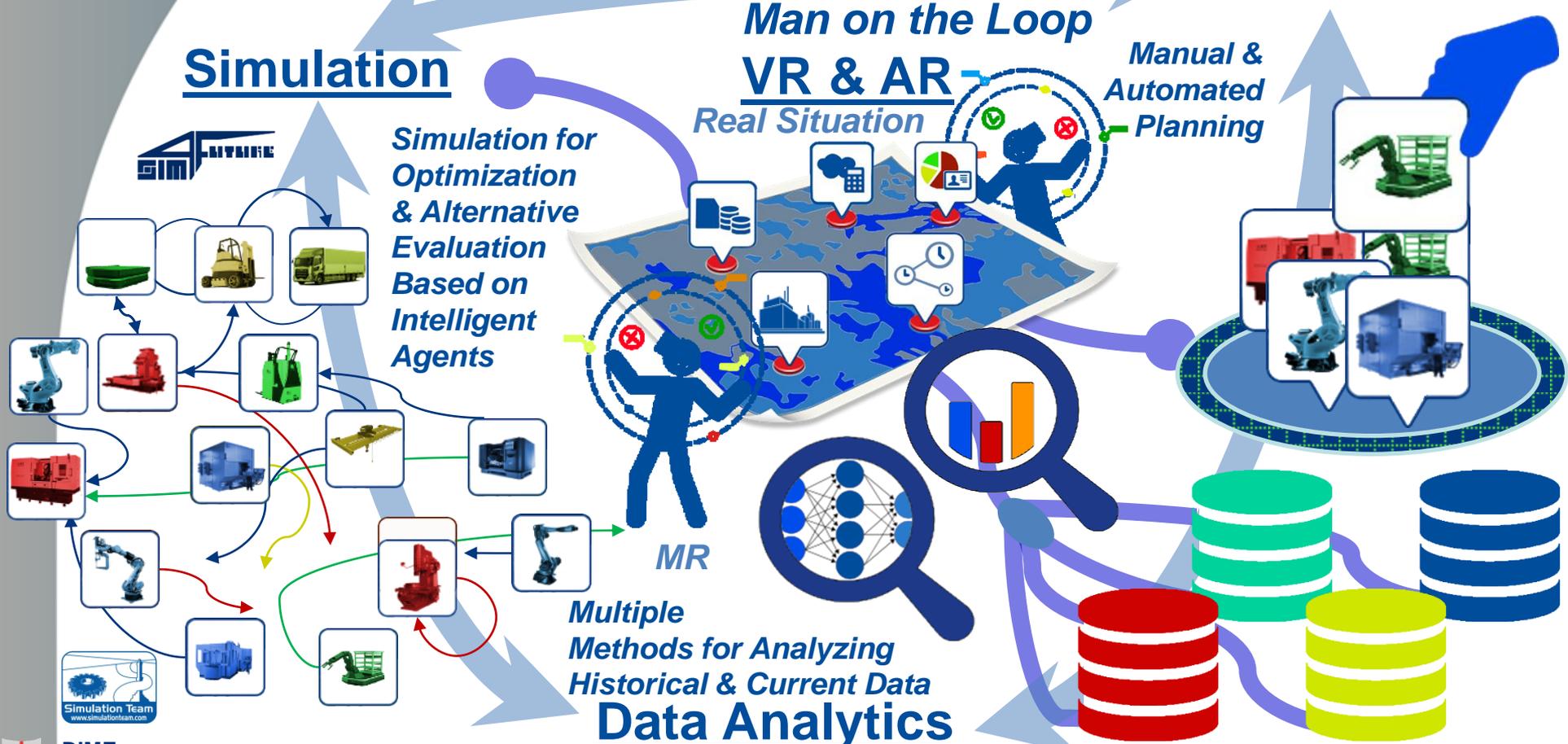
Example of Overall Architecture

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AI & IA
Smart Planner

Man on the Loop

VR & AR
Real Situation

Manual & Automated Planning

Simulation

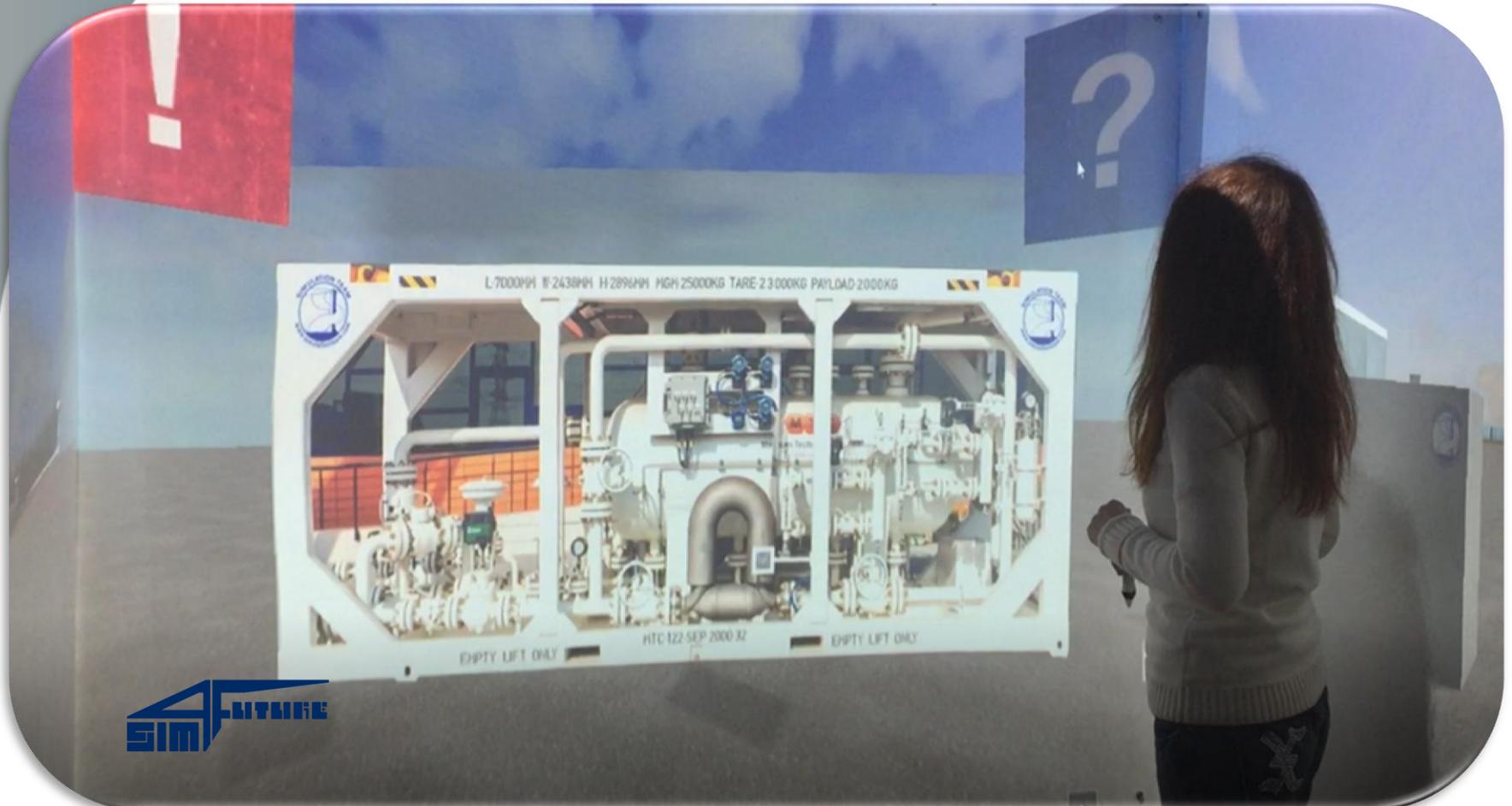*Simulation for Optimization & Alternative Evaluation Based on Intelligent Agents*

MR

Multiple Methods for Analyzing Historical & Current Data

Data Analytics

M&S Trouble Shooting, Training & Remote Assistance

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Working together on Real & Virtual Worlds On Site & Off Site

Cooperative Remote Supervision for Operations & Service

Mixed Reality integrating VR & AR for improving Safety & Productivity

Training and Troubleshooting over the whole Production Line by Spider Cave, Tablets & Hololens™

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Many Different Solutions: Glasses & Goggles

There are many different solutions that are available to be adopted as support for VR and AR implementations. Some ones are mostly useful for Training such as HDM. The Oculus Rift is a basic and valuable example of VR while the Hololens™ represents a new supervision solution based on AR. Vice Versa SPIDER, by Simulation Team, is a very advanced CAVE solutions for cooperative activities using MR

CAVE — Cave Automatic Virtual Environment   AR Augmented Reality   VR Virtual Reality   MR Mixed Reality
HDM — Head Mounted Displays   SPIIDER   Simulation Practical Immersive Dynamic Environment for Reengineering)

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SPIDER

Simulation Practical Immersive Dynamic Environment for Reengineering

The SPIDER (Simulation Practical Immersive Dynamic Environment for Reengineering) is an innovative Interactive and Interoperable CAVE (Cave Automatic Virtual Environme developed by Simulation Team. The basic configuration is compact (2m x 2m x 2.6m and could be embedded within a standard Container and integrated in any interoperable simulator.
The SPIDER is interactive throug touch screen technologies.
The SPIDER is fully Immersive including sound and motion.

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Tablets as Intuitive & Simple Approach to AR

Indeed sometime it is more effective to use basic Hardware solutions that result reliable and intuitive for potential users. From this point of view the tablets provide an interesting Man Machine Interface for supporting Service and Maintenance of Equipment and being operated by basic Operators.

verallia

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SISOM Past Project

SISOM Project, completed in MMXVII, allowed to study and implement Innovative Solutions to be applied to real cases to improve Safety, Efficiency and Effectiveness in relation to Industrial Machines. SISOM Project was carried out in strict cooperation with Industries active in Design, Engineering and Production of Industrial Equipment and Machines.

This Project allowed also to complete an extensive experimentation to measure quantitatively the benefits obtained by these Innovative Technologies (e.g. M&S, AR & VR) applied on the field in terms of training efficiency and safety

SISOM - Simulation Solutions based on virtual & augmented reality for Maintenance

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W-Artemys

Wearable augmented reality for employee safety in manufacturing systems

Simulation Team supports W-Artemys by its Labs & Tools (e.g. Cave SPIDER, ST Applications, etc.). The Focus of Genoa group will be on the conceptual modeling and definition of the general architecture, Integration of new Interactive & Intelligent Mixed Reality Solutions, Development of Intelligent Elements, Smart Solutions design and implementation, W-Artemys Demonstration construction, Integration of W-Artemys based on Industry 4.0 and Smart Manufacturing concepts

W-Artemys : Wearable augmented reality for employee safety in manufacturing systems

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Glass Production: An Example

- **Hollow Glass Production is an opportunity to use AR/VR into an area where the Safety Regulation required to adopt proper PPE affecting human senses and interaction abilities (e.g. earplugs)**

- **The Furnaces and the Hot Zone of Production Lines represent areas where the human could have uncomfortable conditions that could benefit from some wearable intelligent AR/VR solution able to direct immediately on the right place and speed up operations.**

- **These Production Plants are pretty wide, so mobile solutions could provide improve in supervision and operations**

- **The Plant was already carrying out preliminary test on tablet use**

AR Augmented Reality   VR Virtual Reality   PPE Personal protective equipment)

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Collaborative Supervision & Service by Mixed Reality

The proposed solution operates on multiple platforms for AR/VR to guarantee flexibility by the innovative technologies in Support and Supervision of the Furnaces and Production Lines

- *Alerts and Key Plant Indicators are made available on Wearable Smart Solutions to direct, quickly and properly, Operators and Supervisors on the right place.*

- *The new Wearable solutions augment the reality by providing additional information on safety/operational issues to be adopted on site*

- *The interoperation between Personnel and AR/VR Wearable Solutions allows to populate new Databases with Lessons Learned and RPG*

- *Smart Systems include Data Fusion and Intelligent Solutions to guide the user in detect problems and identify possible Solution*

- *These solutions are also available for improving effectiveness and readiness on maintenance using remotely experts available on demand*

Another Example: AR & VR for Autonomous System

Complex Systems, such as Autonomous Underwater System (AUV) require sophisticated Maintenance and Continuous Service even operating at Sea, so the use of Augmented & Virtual Reality is very useful. AR & VR allow to support:
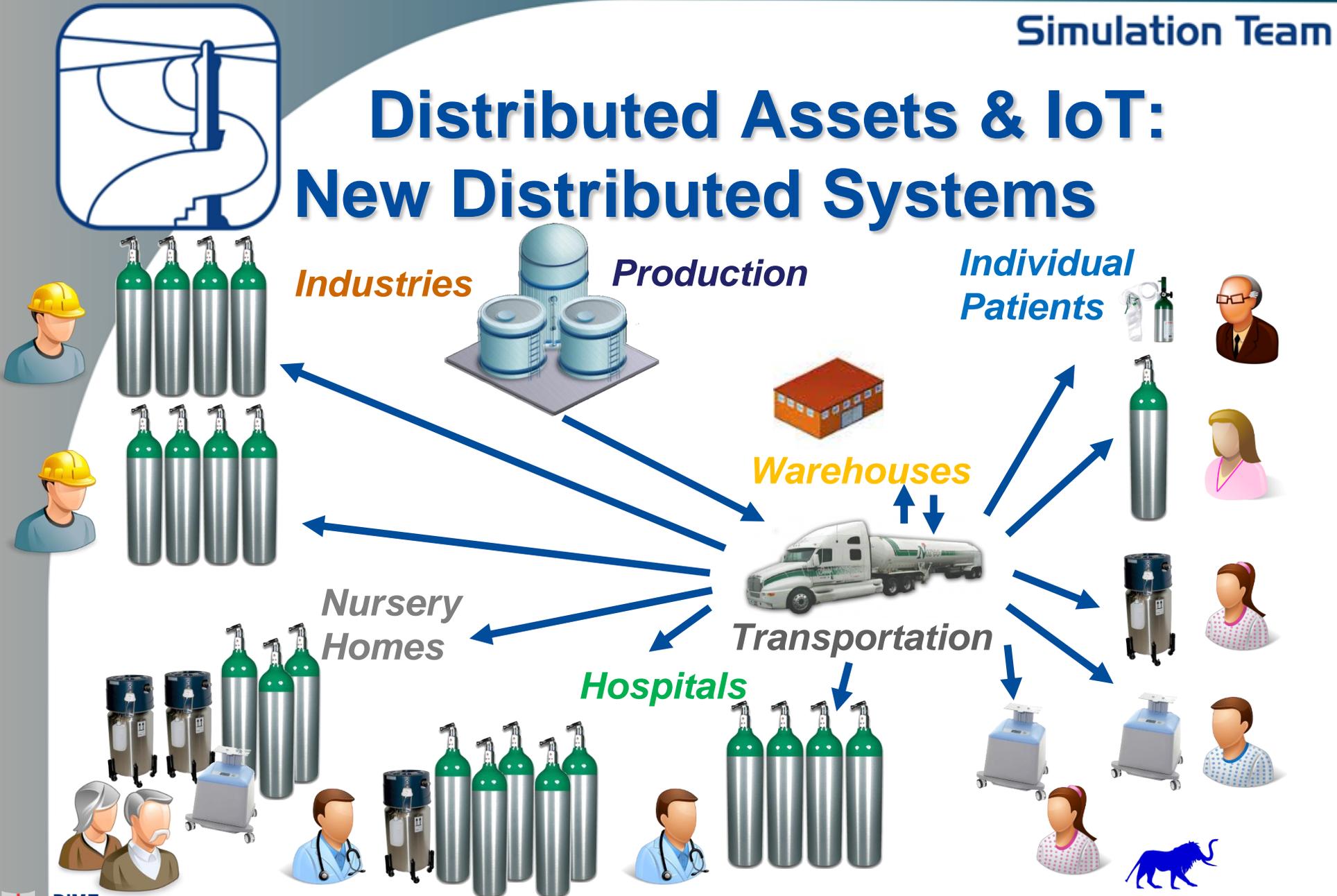
- *Training*
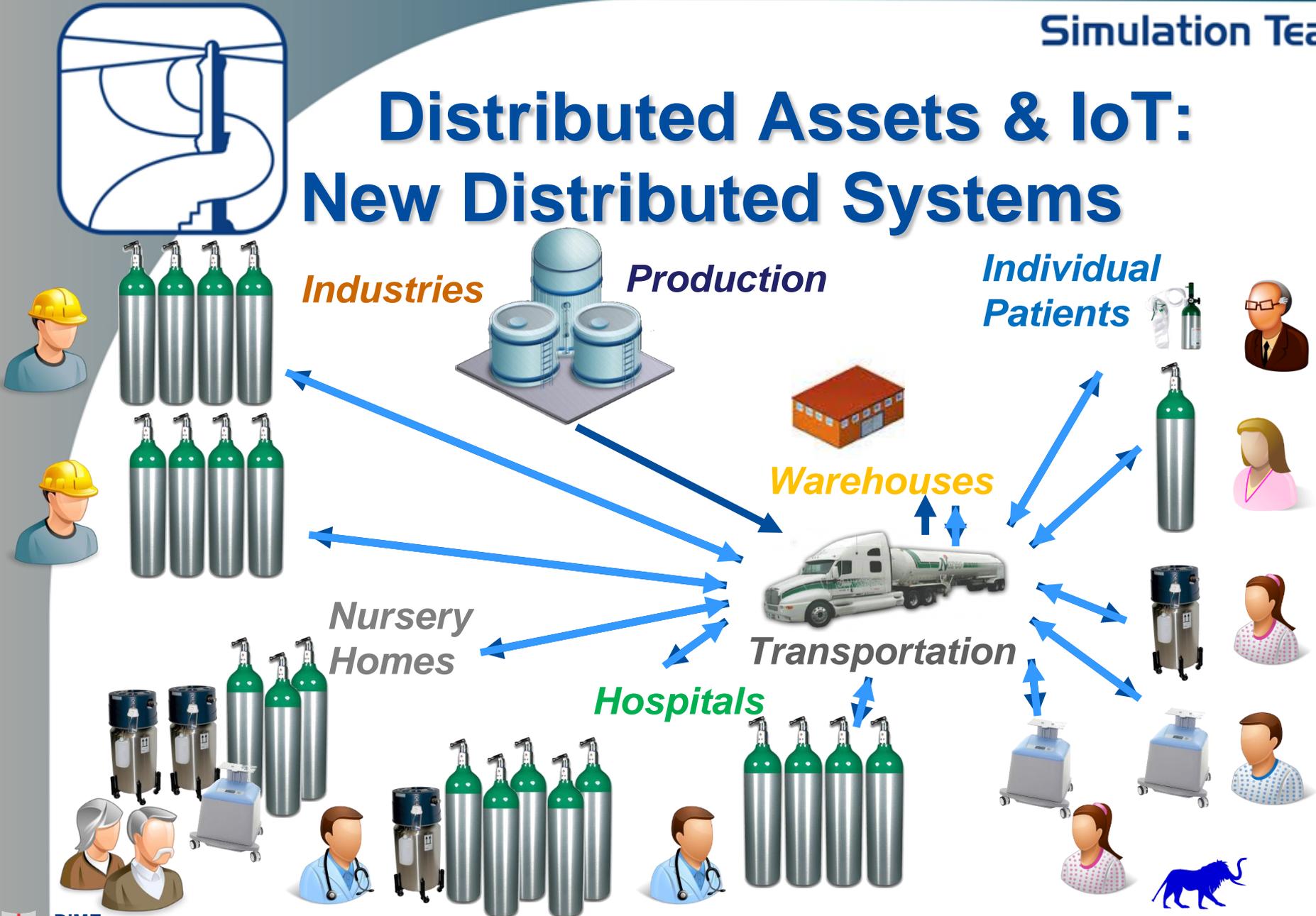- *Operator Support*
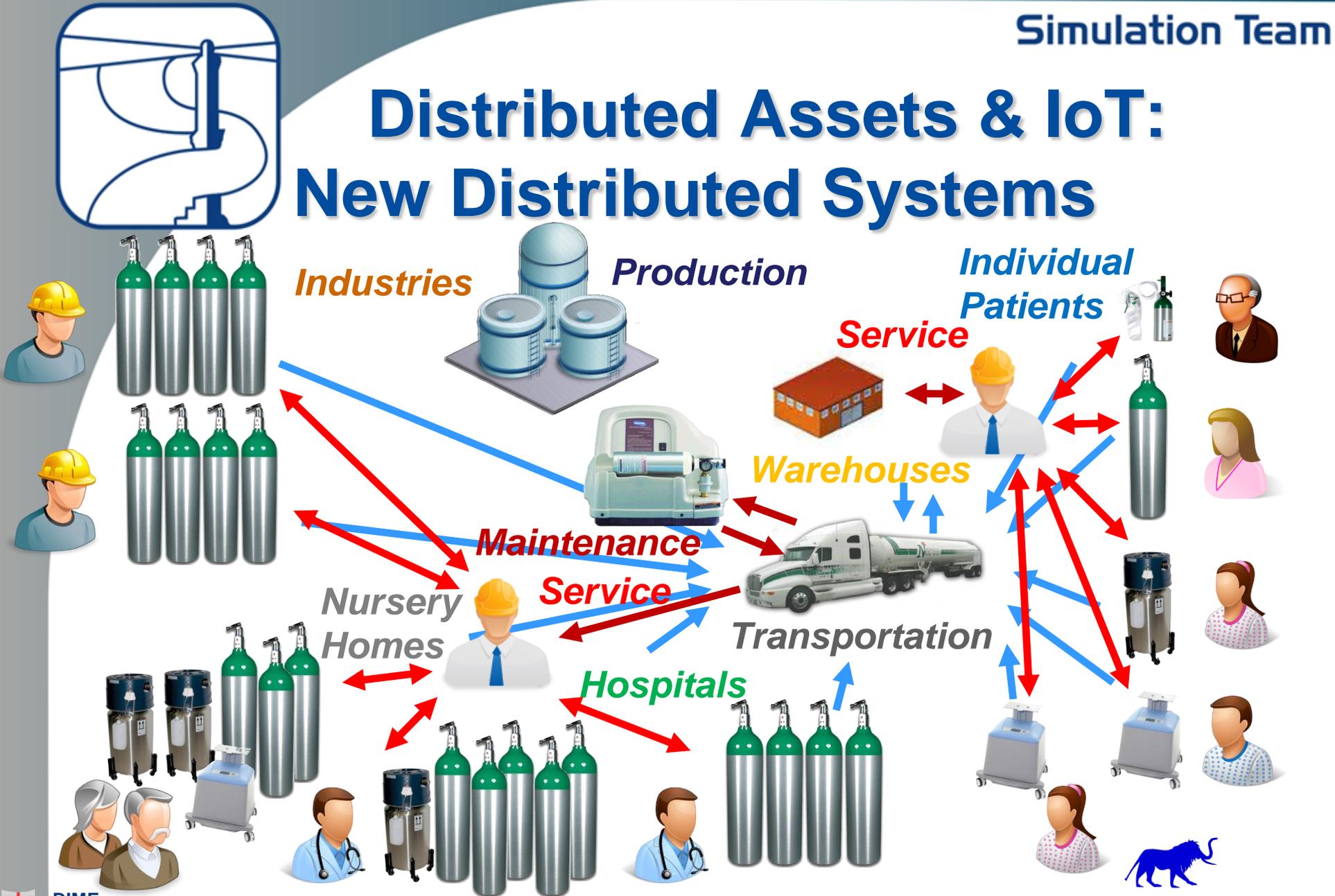- *Remote Supervision*

For Yours Eyes Only ☺

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Distributed Assets & IoT: New Distributed Systems

Industries

Production

Individual Patients

Warehouses

Nursery Homes

Transportation

Hospitals

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Distributed Assets & IoT: New Distributed Systems

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Distributed Assets & IoT: New Distributed Systems

Industries

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Maintenance Service

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Transportation

Hospitals

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Distributed Assets & IoT: New Distributed Systems

Industries

Production

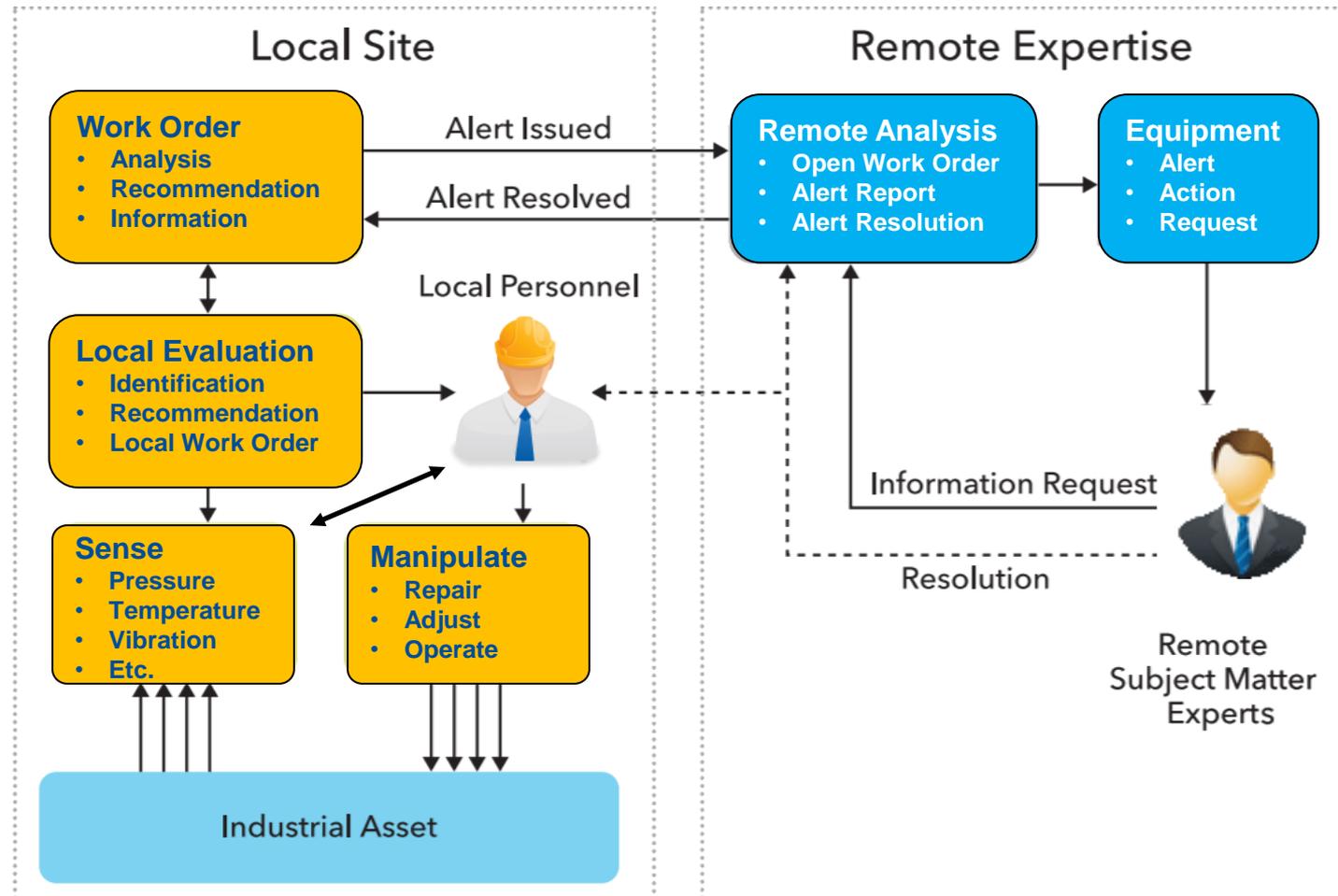Individual Patients

Service

Warehouses

Maintenance Service

Nursery Homes

Transportation
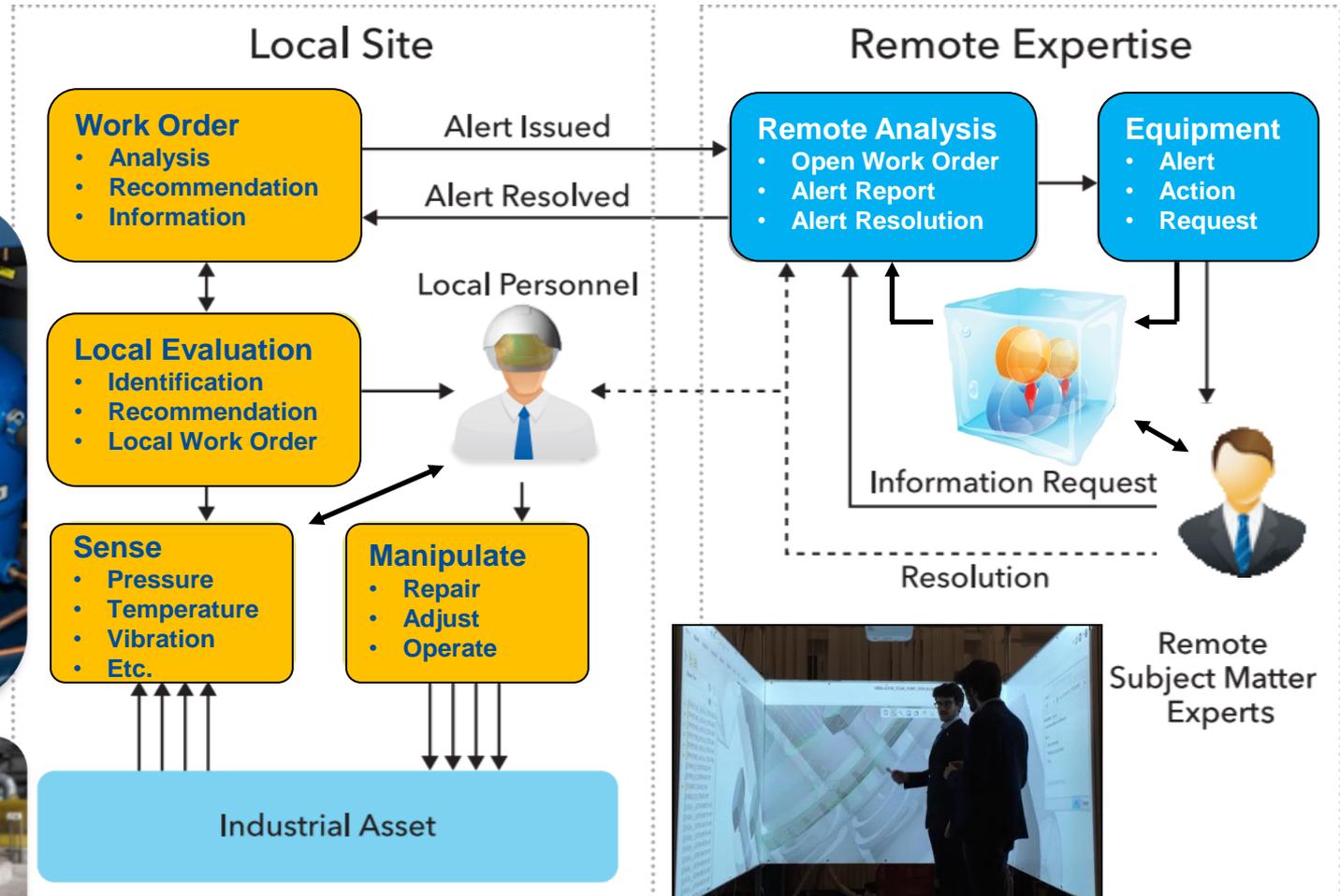
Hospitals

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Distributed Assets & IoT: New Distributed Systems

Industries

Production

Individual Patients

Service

Warehouses

Maintenance Service

Nursery Homes

Transportation

Hospitals

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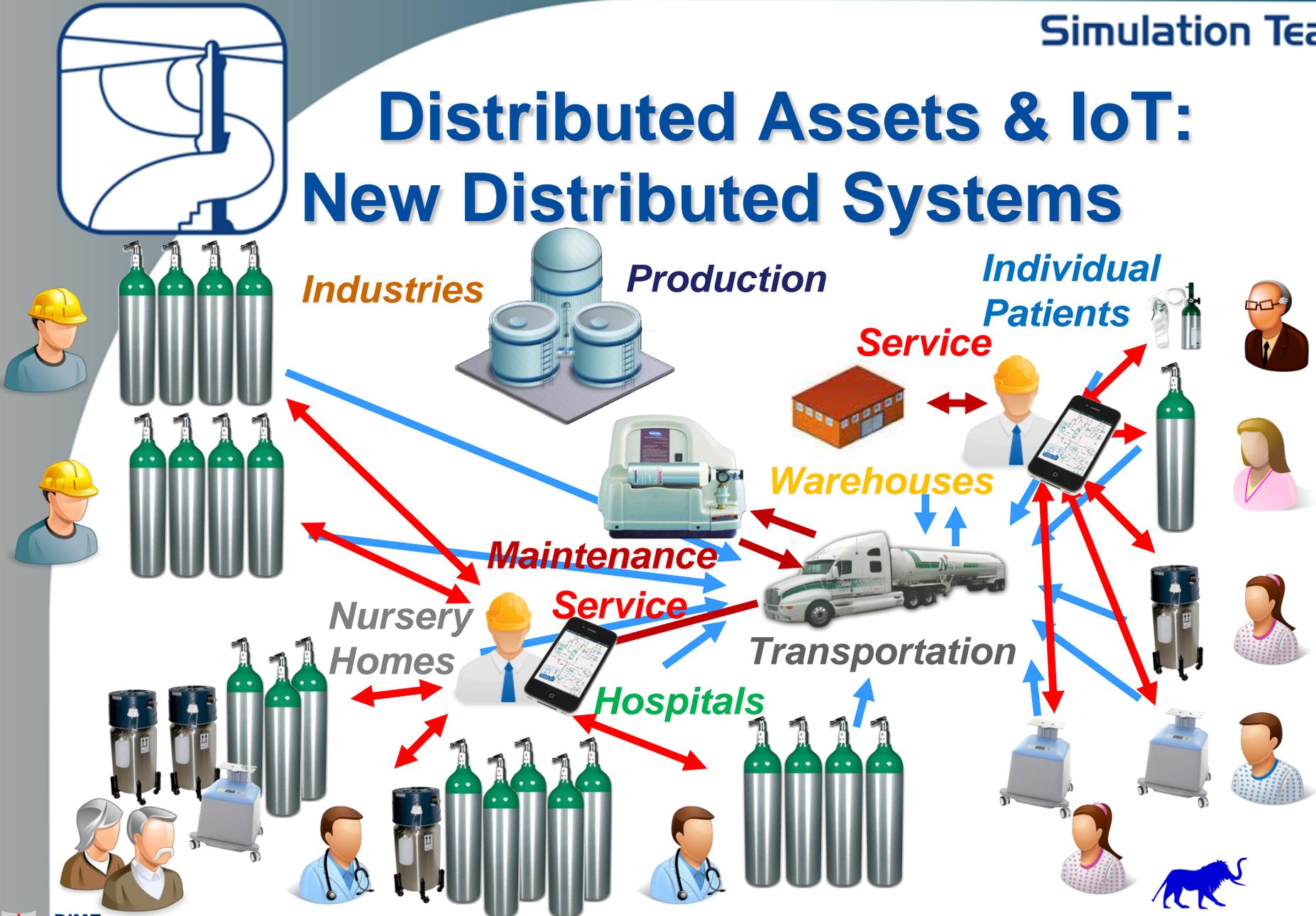
Distributed Assets & IoT:
New Distributed Systems

Industries

Production

Individual Patients

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Warehouses

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Nursery Homes

Transportation

Hospitals

Example of Architecture

Example of Architecture

Local Site

Work Order
- **Analysis**
- **Recommendation**
- **Information**

Alert Issued

Alert Resolved

Remote Analysis
- **Open Work Order**
- **Alert Report**
- **Alert Resolution**

Equipment
- **Alert**
- **Action**
- **Request**

Local Evaluation
- **Identification**
- **Recommendation**
- **Local Work Order**

Local Personnel

Information Request

Sense
- **Pressure**
- **Temperature**
- **Vibration**
- **Etc.**

Manipulate
- **Repair**
- **Adjust**
- **Operate**

Resolution

Remote Subject Matter Experts

Remote Expertise

Industrial Asset

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Virtual Reality for Simulation & Augmented Reality as Benefit

The Use of Virtual Reality allow to realize Virtual Prototypes of the Products and Processes and to test on them the new Solutions.

Such Virtual Simulation support Design, Training and Management and the relative Virtual Worlds becomes available for Augmented Reality Applications & Distributed Maintenance

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Examples in Design: VIP-STRALO

Virtual Prototype by Simulation in Transportation and Logistics`

VIP-STRALO goal is the creation of innovative solutions based on Interoperable Simulators for SBDVP (Simulation Based Design and Virtual Prototyping) applied to Logistics, Transportation and Automation Sector.

VIP-STRALO involves the creation of interoperable demonstrators of systems such as:

- **LOCARS: Logistics Crane Simula**
- **FEBO: Federation of Barges**

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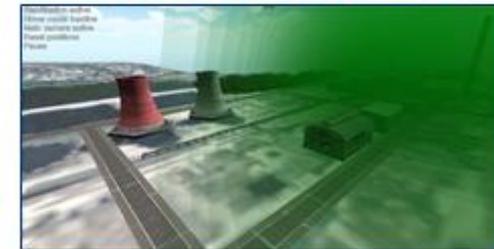# Virtual Simulation & Augmented Reality

The Simulation Team is active in several initiative combining Virtual Simulation with Augmented Reality. These applications include the combining of Simulators with Virtual and Real Worlds

Human Body

Digestive System
Left Lung
Right Lung
Skeleton
Heart
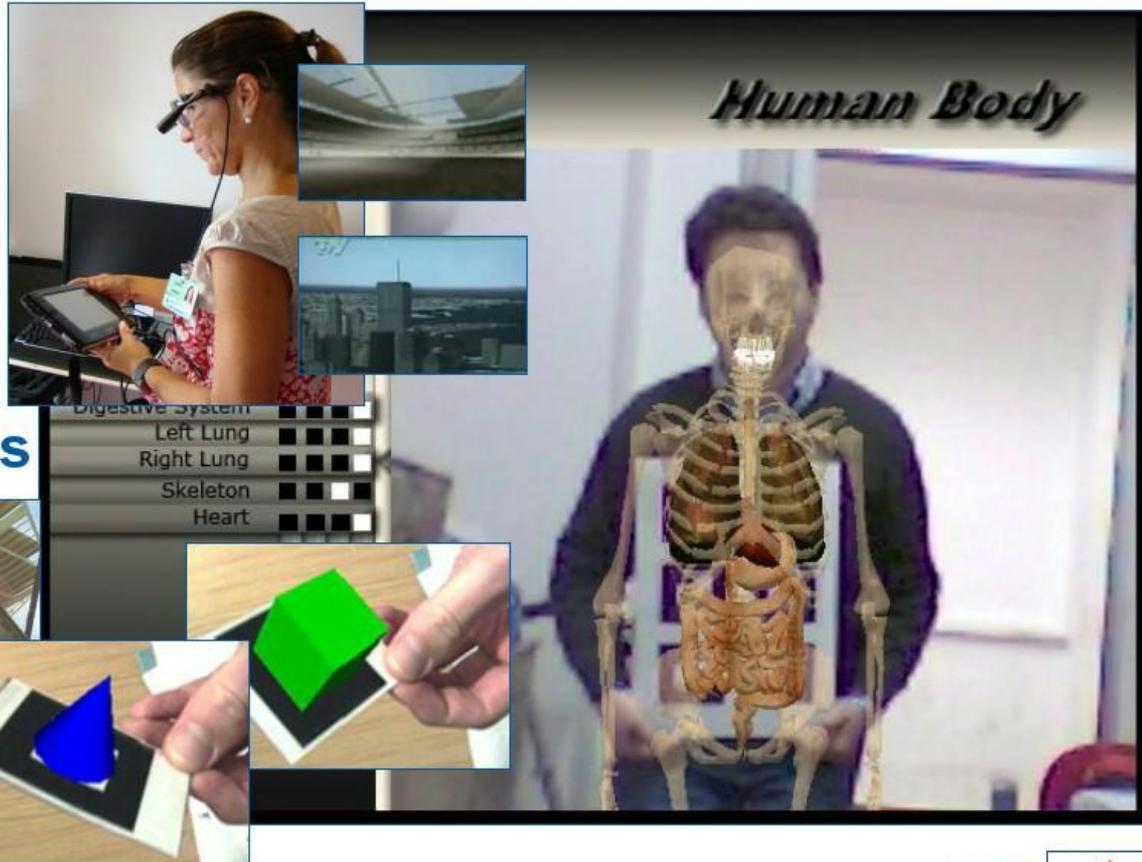
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ARTEM
Augmented Reality TErrain interoperable Module

ARTEM (Augmented Reality TErrain interoperable Module) is a Module integrated through High Level Architecture with MS2G (Modeling, interoperable Simulation & Serious Game) systems.

ARTEM allows to present over smartphone and other mobile device the situation in real-time geo-referenced dynamically respect the on going simulation.

ARTEM provides the opportunity to train personnel directly on the field using details models and simulator that interact dynamically with personnel and assets during the exercises.

The system allows to visualize real and virtual assets as well as different effects on the terrain.

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SISOM

Simulation Solutions based on virtual & augmented reality for Maintenance

SISOM is a Solution based on Virtual and Augmented Reality for Maintenance in Vessels and Plants. SISOM uses simple Tablets, mobiles and/or laptop to represent the real skid/system with augmented information; by this approach, SISOM guarantees safe and intuitive procedural instruction interactively overlapped to the real equipment (e.g. trouble shooting, dismounting, emergency shutdown, etc.), as well as training procedures, remote dynamic supervision and testing. Indeed SISOM could be integrated with HLA Simulation to support training. SISOM supports both predictive, preventive and corrective maintenance.

OUTSIDE REAL

Virtual & Augmented Reality, Speech Recognition & Simulation

OUTSIDE REAL : is an innovative HLA Simulator integrating real camera with Augmented Reality for providing additional information on the scene (e.g. dynamic data on the element detected by a camera). The system includes also interactive speech recognition solution, SOPHOS, for requesting additional information or changes in the representation mode.
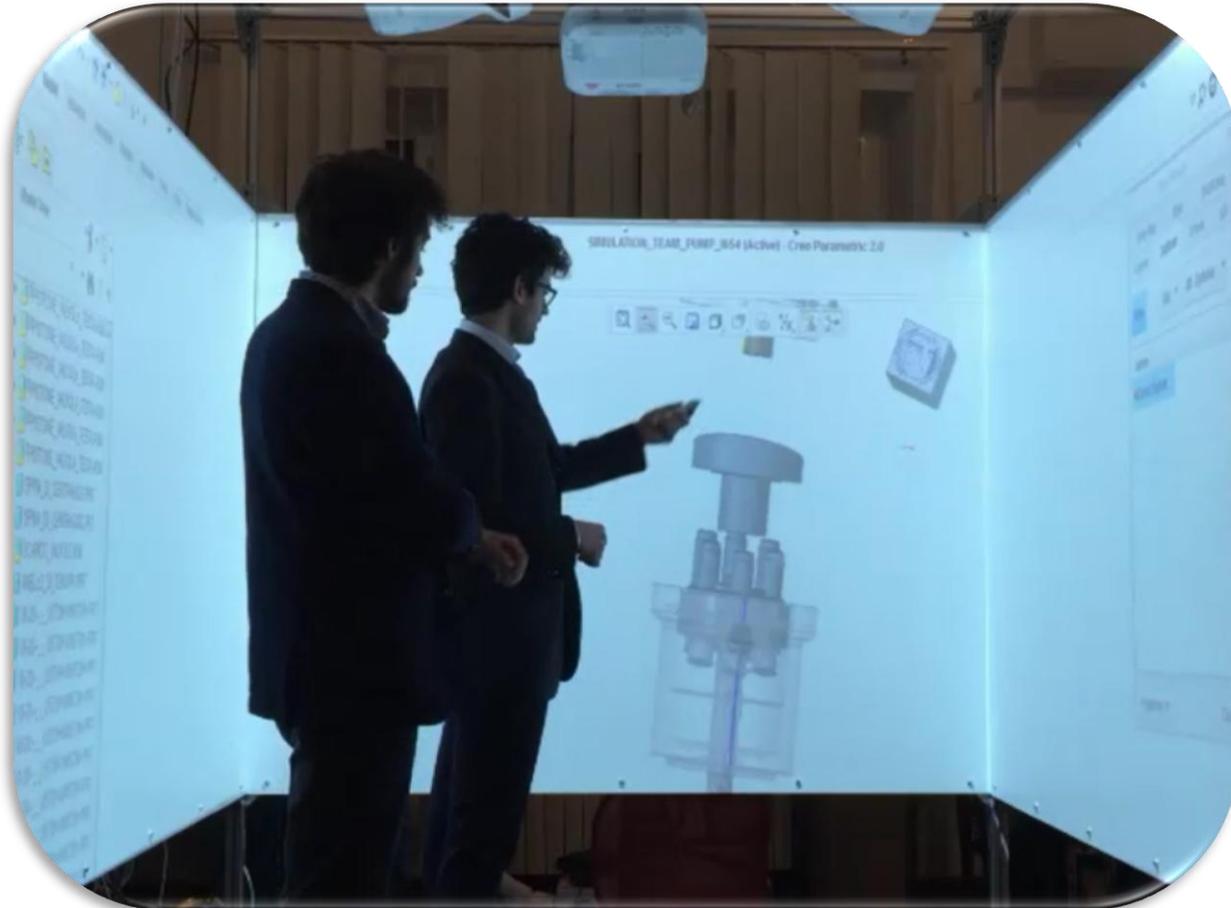
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Collaborative Remote Supervision & Service

The Central Subject Matter Experts (SMEs) become able to check remotely the Status of the Different Distributed Assets, to Track Them as well as to conduct Supervised Service Operation with the Service Operator or, directly, with final Users

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Many Different Solutions

In facts there are many different solutions that could be adopted to support VR and AR implementations some one are mostly seful for Training and Supervisions such as Head Mounted Displays.
Oculus is a basic and valuable example

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Tablets as Intuitive & Simple Approach for AR

Indeed sometime it is more effective to use basic Hardware solutions that result reliable and intuitive for potential users. From this point of view the tablets provide an interesting Man Machine Interface for supporting Service and Maintenance of Equipment and being operated by basic Operators.

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Use and Innovative Interfaces

The new architectures are designed to incorporate hi-tech technologies for continuous development.
It is possible to address:
- **Monitoring & Tracking**
- **Remote Test & Troubleshooting**
- **Supervision**
- **Remote Service Support**
- **Mobile Service Support**
- **Availability Improvements**
- **Distributed Service and Maintenance**
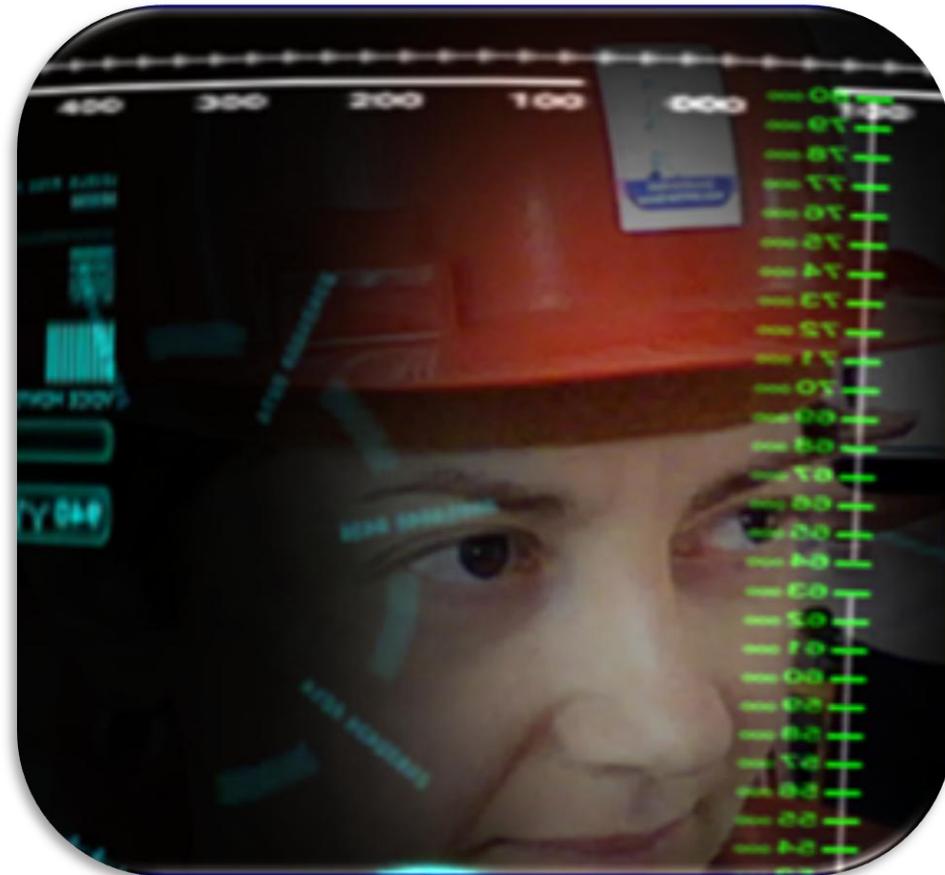
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Simulation Team and its Experience

This Presentation confirms the potential of modern use of Virtual & Augmented Reality for TPM, RCM, Predictive Maintenance and Distributed Service. The proposed Solutions and Examples demonstrate the effectiveness in supporting local operators as well as remote supervisors. The Simulation Team approach provides a very effective framework for Training use as well as for Operational On Site & Remotely Assisted Service

Current edge solutions confirm the potential to reduce costs and to increase reliability; this is expected to lead to further reinforce the outsource services and the competitiveness in commodities service. Simulation Team achieved experience over a wide spectrum of cases and it is available to develop a new solutions tailored for specific Industrial Applications.

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Conclusions

M&S, AI & MR allow to put Innovation at work in Industry 4.0 with real examples Simulation Team is far ahead from Theory into Industrial Experimentation.

This allows to measure and evaluate the real benefits & to enhance new solutions design by integrating new enabling technologies.

Virtual & Augmented Reality are a major advantage to support Supervision of Production Lines in Industrial Plants as well as a potential improvement for Safety, Training and Services in Systems and Vessels. Many Applications Fields get great benefits from these technologies solving problems, but also providing Great Opportunities for Service. The proposed approach guarantees the possibility to support Systems Operators as well as Supervisors. Indeed this approach provides also very effective framework for Operation Support, Training and Education as well as for On Site & Remotely Assisted Service.

References

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.... Questions?