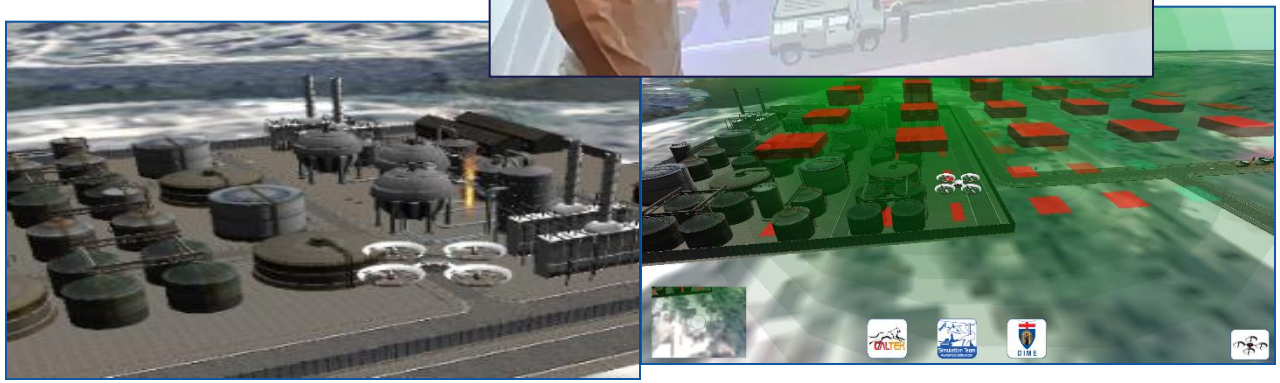
Simulation Team

Simulate or Perish! How Simulation is changing the Game in Industry

Agostino G. Bruzzone
Simulation Team
Genoa University



Simulation Team
www.simulationteam.com

Simulation Team

Who Are We?

Universities, Research Centers and Companies operating worldwide in synergy for developing Innovative Solutions with a particular focus in Modelling and Simulation

DIME Università di Genova

M&SNet Genova

Liophant Simulation

CentraLabs Cagliari

CRiCS Centre for Research In Complex Systems — CSU Australia

CIREM Università di Cagliari

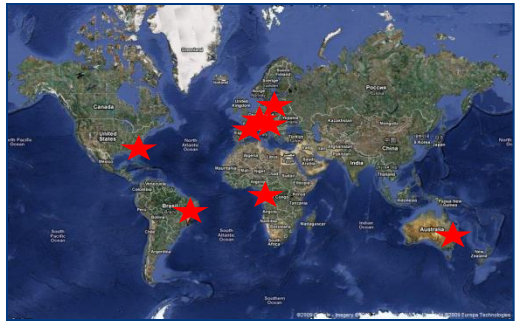
MSC-LES

Universidad de la Rioja

Mik Riga TU

SimCenter Universitat Autonoma de Barcelona

DIPMEC Università Calabria



Rio de Janeiro Brazil

Università di Perugia

LSIS Marseille

IMS-LAPS Univ.Bordeaux

McLeod Institute of Technology & Interopeable Modeling Simulation Genoa

SPIIRAS Russian Academy of Science

Simulation Team

Simulation Team Genoa

The Simulation Team - MITIM DIME of *Genoa University* carries out many industrial projects in cooperation with the large corporations and Small and Medium sized Enterprises; some example of recent industrial simulation project are following:1

ENI	Fleet Management Planning & Scheduling
Group	Chemical Plant Logistics Optimization
Ansaldo	Plant Service Management and Optimization
LAMCE Petrobras	Oil Platform Simulation and Augmented Reality
EDA	Decision Support for Country Reconstruction Activity Planning
Ford Motor	New Production Line Design Based on Simulation

Members of MISS are appointed in several positions in simulation community such as:

- General Director M&S Net (34 M&S Centers Worldwide)
- President Simulation Team (20 Centers Worldwide
- Associate Vice President of SCS and Chairman of Technical Chapter
- Member of NATO SAS, MSG, and NIAG, Project Leader for Marine M&S

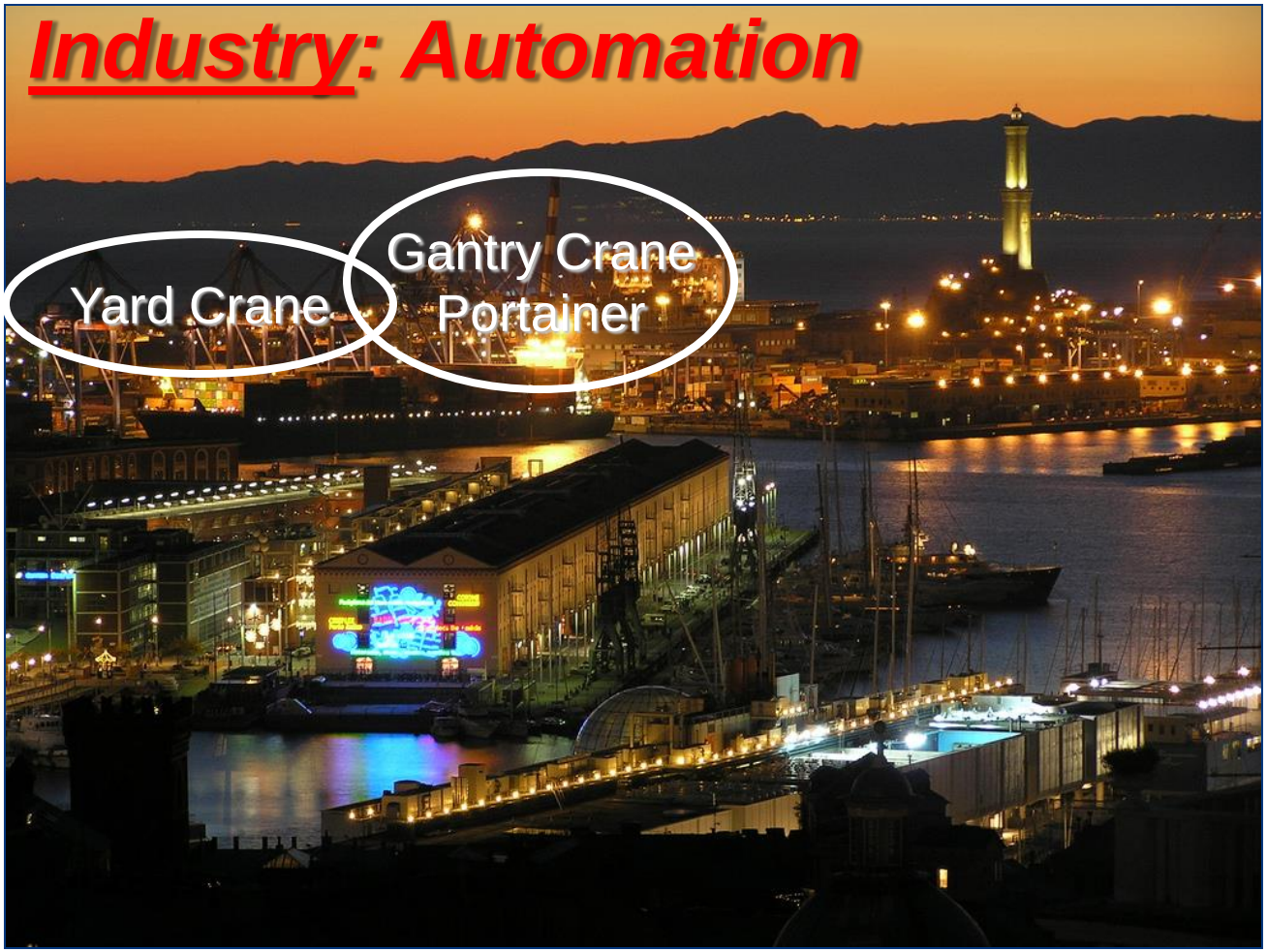
DIME
Università di Genova

Good Morning from Genoa

Good Morning from Genoa

Good Morning from Genoa

Good Morning from Genoa



Good Morning from Genoa

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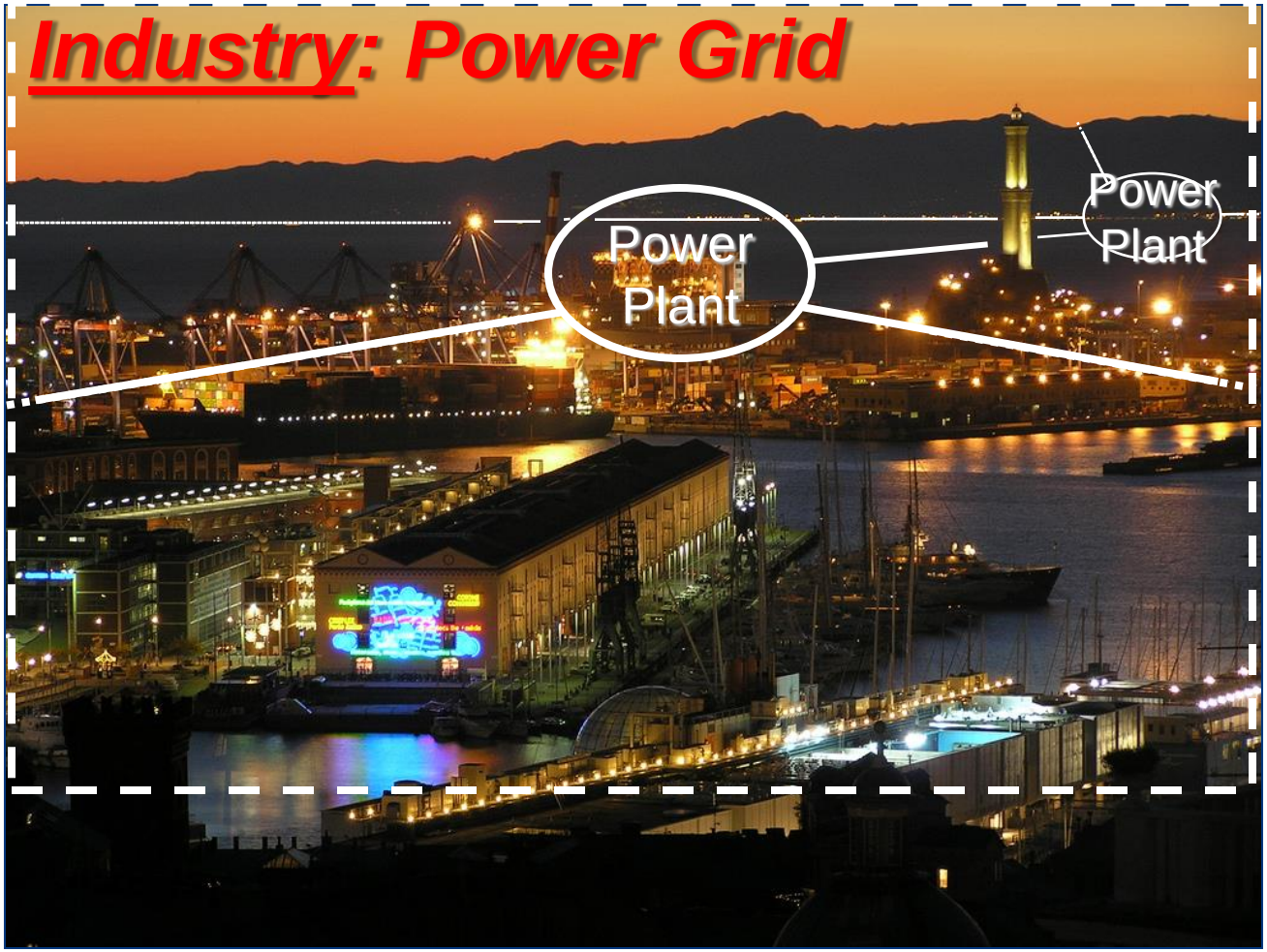

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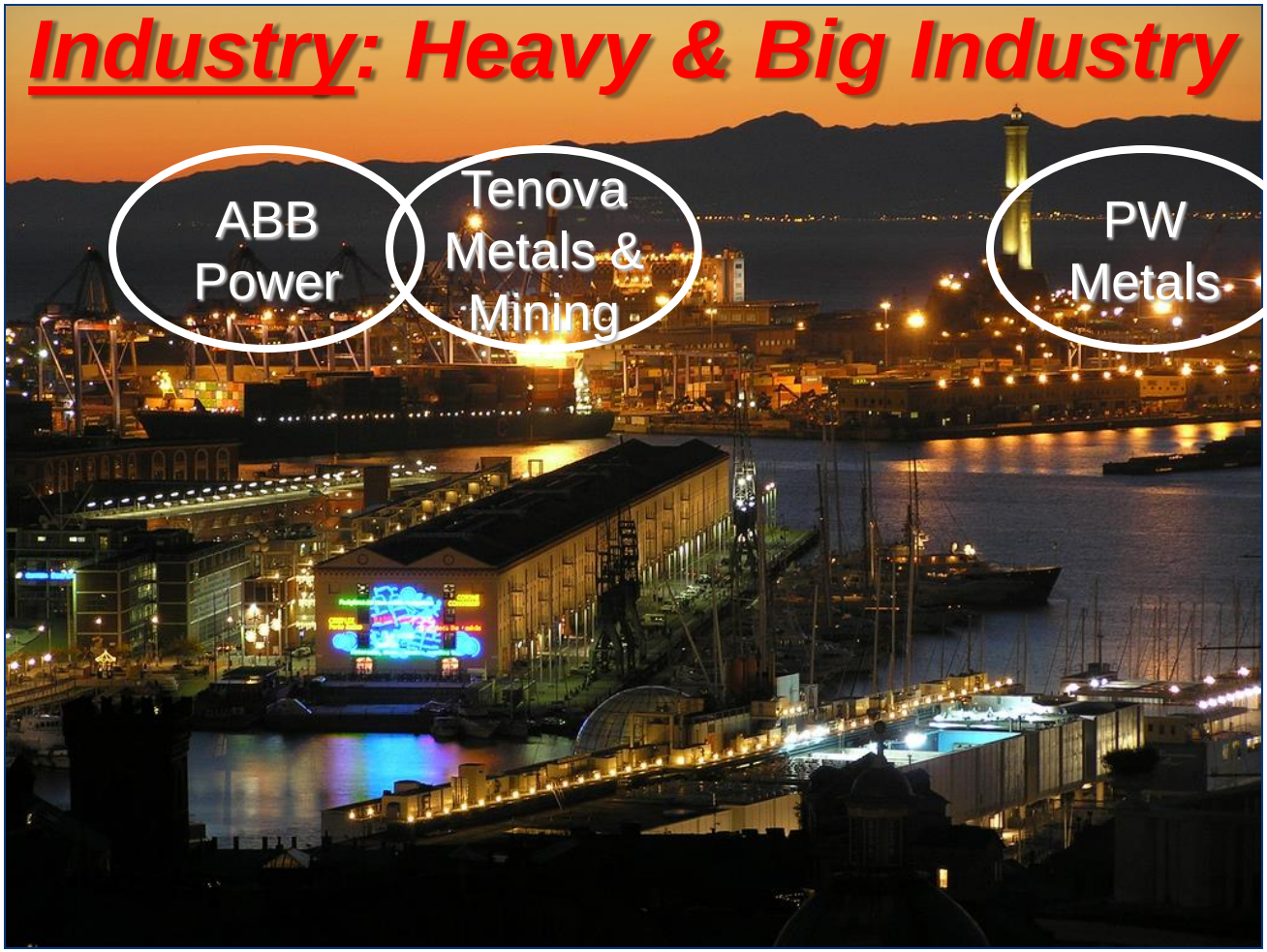

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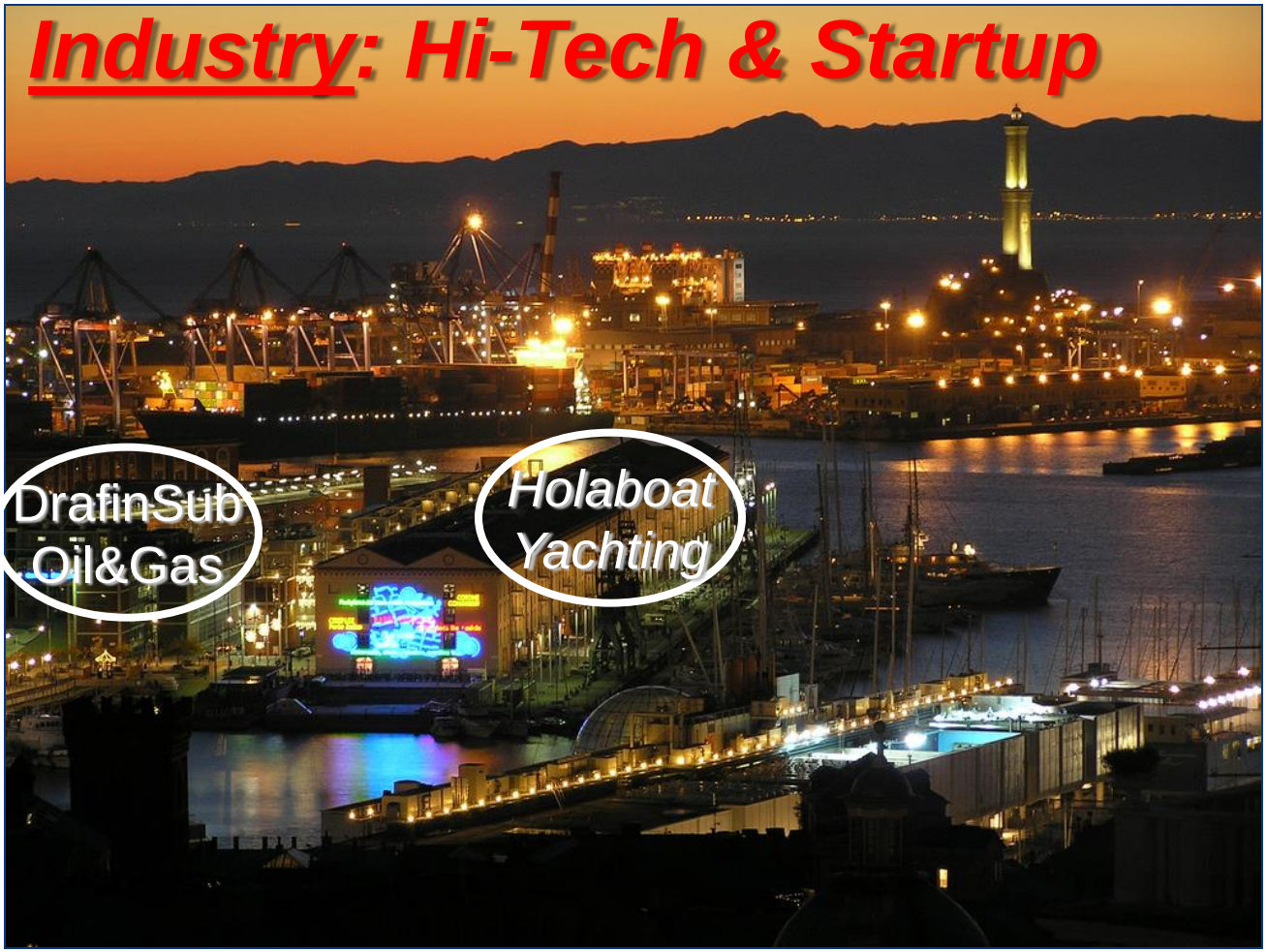

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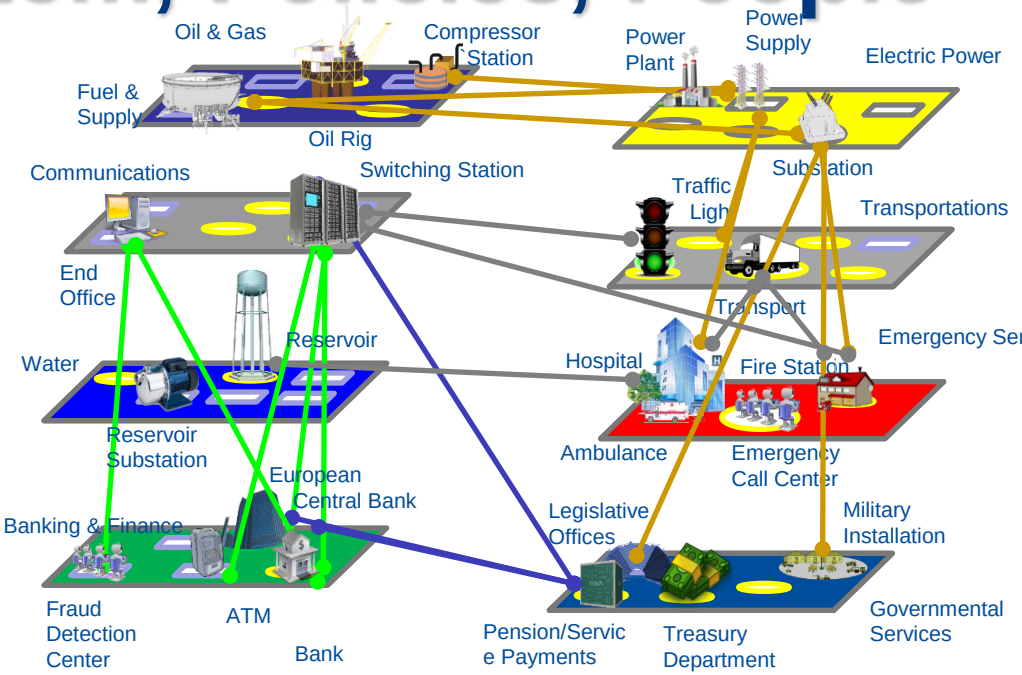
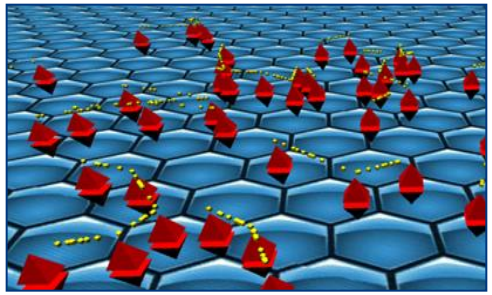
Multi-Layer Simulation for New System, Policies, People

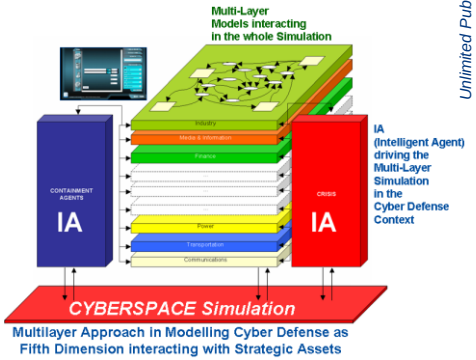
The Modern Systems are usually addressing Multiple Layers and requires to consider multiple aspects for developing

- New System Design
- New Policy Definition
- Table Top Exercise in order to raise Top Management awareness
- Training in procedures and Operations
- Personnel Training and education

The use of Intelligent Agent is crucial to automate Simulation







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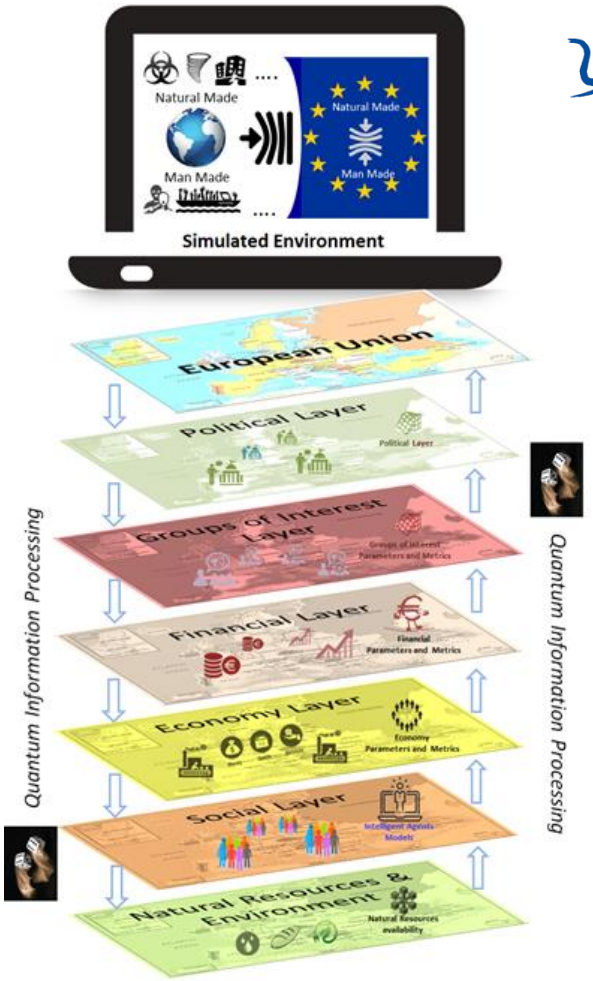
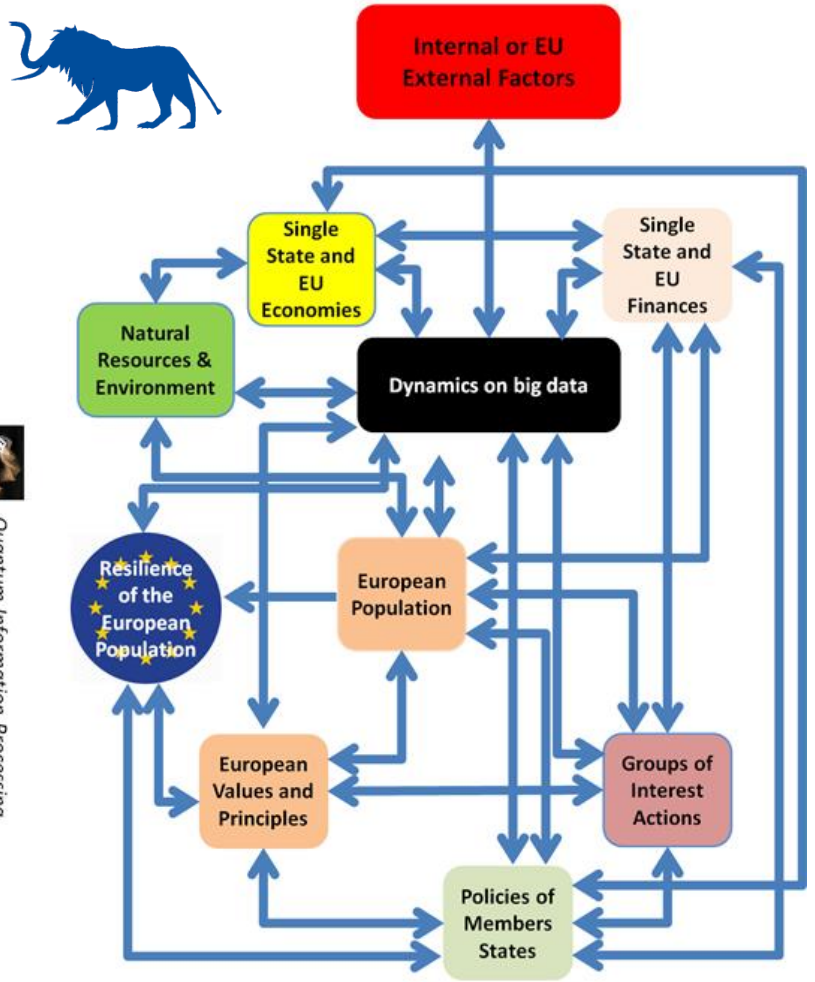
Multi Layers in Complexity: an Example

QuAMRE is an initiative for promoting Analysis of *"European Resilience"* combining Interoperable Simulation and Quantum Computing





Some Open Questions?

- How it is Changing the Industry & World?
- How Simulation enables to survive?
- Way Ahead, Challenges and Opportunities

← 2016! →

Vs.

Game

Reality

Perish in a Game or in War?

- How it is Changing the Industry & World?
- How Simulation enables to survive?
- To Perish in Game Industry… it is just a Game, or it is Real?

Game

Vs.

War!

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Something that could Perish

- 1995 Mercedes from Munich to Denmark, 1600 km
- 1996 Parma University follow lane marks, 1900 km
- 1997 NAHSC, 20 vehicles in I7 San Diego
- 2004 DARPA, failure on running in the Desert
- 2005 Parkshuffle near Rotterdam
- 2007 DARPA, urban challenge won by Chevy CMU

.

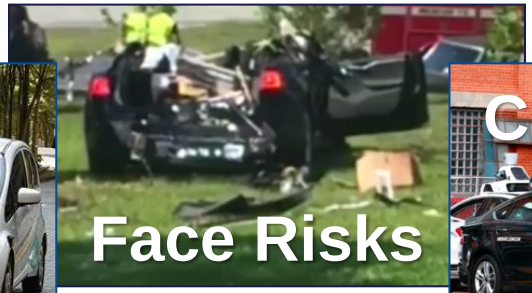
.

- 2014 Vislab 20' in Rush Time →30M$ by Ambarella
- 2016 Tesla first Casualty
- 2016 Nutonomy in Singapore, Self Taxi Service
- 2016 Uber testing in Pittsburgh

18 millions of Taxi Drivers Worldwide

900'000 Truck Drivers In Italy

200'000 Uber Drivers Worldwide



CMU *Carnegie Mellon University*
DARPA *Defense Advanced research Projects Agency*
NAHS *National Automated Highway System Consortium*

2015 Statistics

Industrial Competition: It is a Game or it is War?

夫未戰而廟算勝者，得算多也；
未戰而廟算不勝者，得算少也；
多算勝，少算不勝，而況於無算乎？
吾以此觀之， 勝負見矣。

Now the general who wins a battle makes many calculations in his temple ere the battle is fought. The general who loses a battle makes but few calculations beforehand.

Thus do many calculations lead to victory, and few calculations to defeat: how much more no calculation at all! It is by attention to this point that I can foresee who is likely to win or lose.

Sun Tzu, Art of War,

Laying Plans, 7, 500 BC

The Art for Winning Competition

L'Art de la Guerre se divise en cinq branches purement militaires; la stratégie, la grande tactique, la logistique, l'art de l'ingénieur, et la tactique de détail.

Antoine Henri Jomini, Precis de l'Art de Guerre

1836 AC

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Challenges along Millennia…

440 BC

τοσοῦτοι ἵπποι τε καὶ ἄνδρες διεστᾶσι κατὰ ἡμερησίην ὁδὸν ἑκάστην ἵππος τε καὶ ἀνὴρ τεταγμένος· τοὺς οὔτε νιφετός, οὐκ ὄμβρος, οὐ καῦμα, οὐ νὺξ ἔργει μὴ οὐ κατανύσαι τὸν προκείμενον αὐτῷ δρόμον τὴν ταχίστην.

HERODOTUS, Book 8, 98

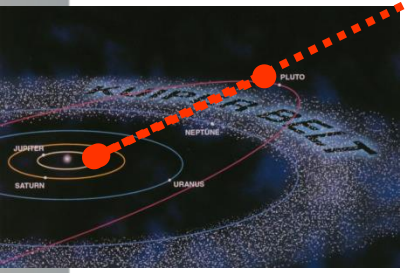
Neither snow nor rain nor heat nor gloom of night stays these couriers from the swift completion of their appointed rounds

… Corresponding Today to…

…Science Fiction!

3 times more Far Away than this Distance!
7 Days To Communicate!

10’000 times more than that!
70’000 Space Shuttles!



Over 20’000 times more Expensive than the full Gross World Product!

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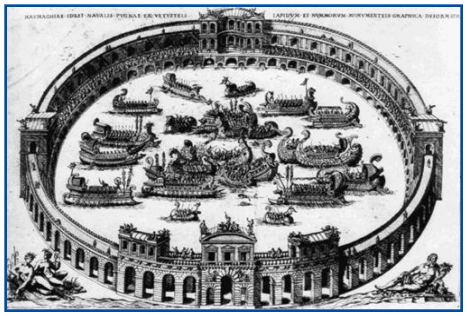
Simulation Origin?

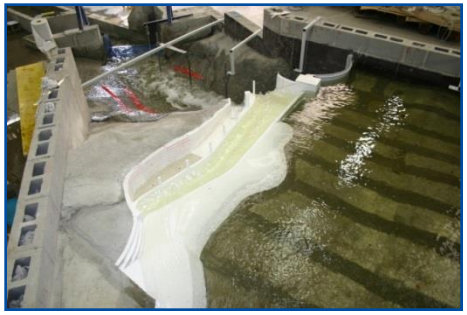
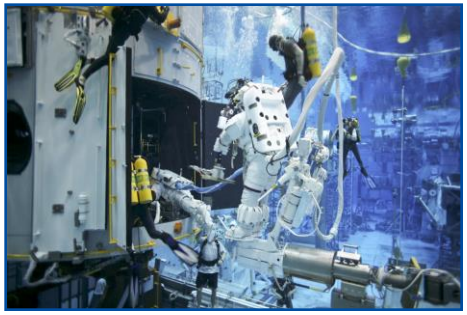
Simulator

Simulator Figurae

Ovid's Metamorphoses, 11, 634, 8 AD

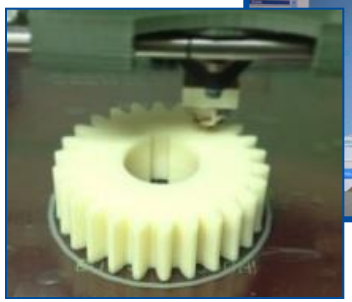


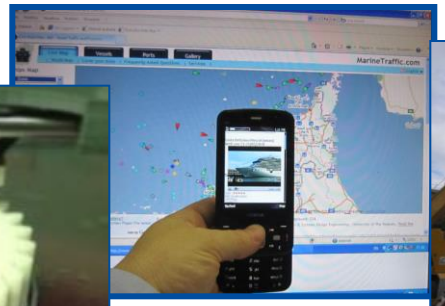



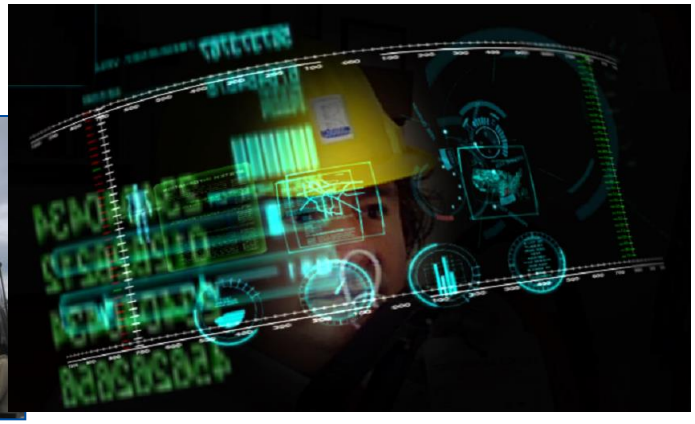

Looking Forward for new decade Technologies

Some of major issues arising will be focused on following issues:

- Serious Games & Simulation for Training
- Mobile Solutions
- Virtual Worlds & Augmented Reality
- Cloud Technologies
- New Industrial Paradigms







Industry

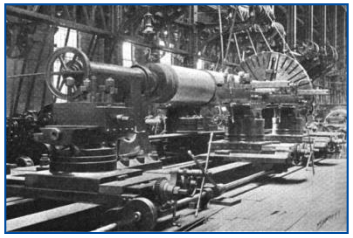
Industry: ***a group of productive Enterprises or Organizations that produce or supply goods, services, or sources of income***

Encyclopedia Britannica

Magna Industria Bellum Apparavit

Cornelii Nepotis, (55 BC), De Viris Illustribus

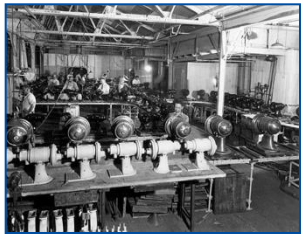
Industrial Evolution



Bethlehem Steel Co.
1899

Ford Motor Company
1910

General Motors
1921



IBM Dayton
1930

Douglas A-20
1943

Ford Motor Co.
1955

IBM 1401
1960

Philips TVs
1970

Toyota
1980

Cocacola Eritrea
1995

Hangzhou Jinding
Aluminium Group
1997

Shanghai Zhonglei
Industry Company
2001

Foxconn
2011

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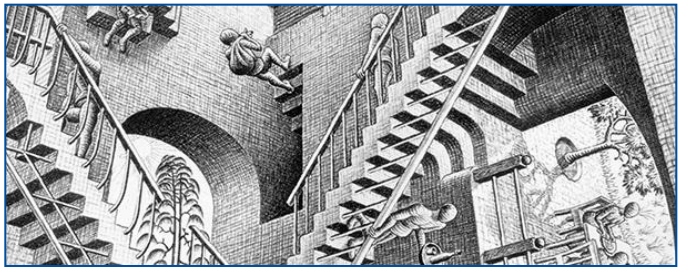


Today: Living in a Paradox

In 2015:

Uber, the world's Largest Taxi Company,… **owns no Vehicles**

UBER

Facebook, the most popular media owner,… **creates no content**

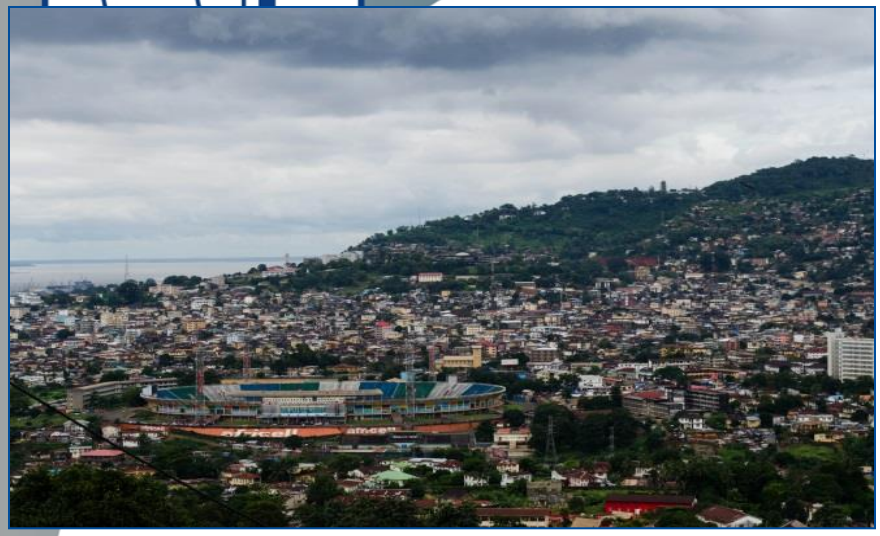
Alibaba, the most valuable retailer,… **has no inventory**

Alibaba.com

Airbnb, the largest accomodation provider,… **owns no real estate**

airbnb

New Locations…



Freetown, Sierra Leone

Ashgabat, Turkmenistan

Asunction, Paraguay

Macau, China

…within a Challenging World

Kiev

Kobane

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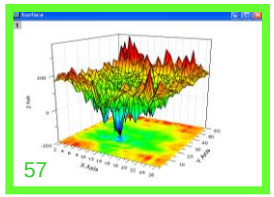


Model Nature

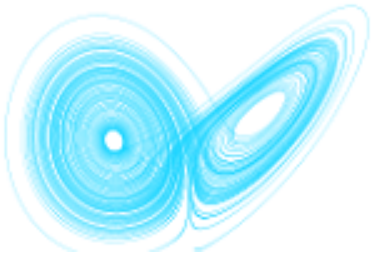
Classification on the base of the Model Nature:

- Deterministic Simulation

  A Simulation based on models where statistical distribution are not in use, including just deterministic behaviors

- Stochastic Simulation

  A Simulation reproducing a system with variables regulated by not known statistical phenomena by implementing pseudorandom variables



Simulation Origins

‘50 now

Defense

Engineering

Training

Decision Support

Interoperability

Simulation based Acquisition

Industry

Manufacturing

Process Optimization

Operations Management

Decision Support

Simulation Team

Simulation Origins

‘50 → now

Defense

Engineering

Training

Bleriot
Recruiter

Microsoft Flight Simulator ™

Decision Support

Interoperability

Simulation based Acquisition

Static M 346 CAE

5DoF F18 Aegis

6DoF Jaguar CAE

V22 Vertical Flight Simulator NASA Ames

Industry

Manufacturing

Process Optimization

Operations Management

Decision Support

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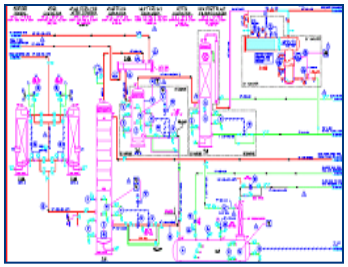
The Future as Opportunity based on Innovation

Breakthrough Technologies are the opportunity to guarantee competitiveness and needs strong support from M&S

Why Modeling & Simulation?

Internal Complexity → ***Complex Behaviors***



↓

Simulation:
More Efforts
More Capabilities
Reusable Models

←

Not Linear Systems
Not valid Simplification Hypotheses
Boundary Conditions are Critical
No Generalization

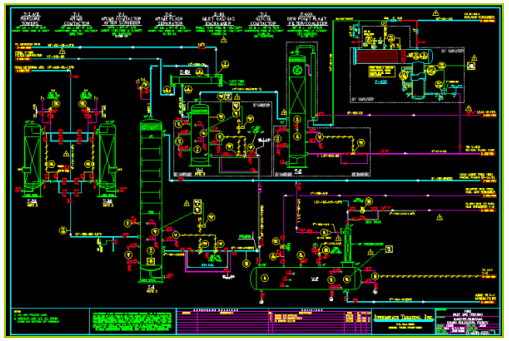
↑

External Complexity → **Many Interaction**

Major Questions

Simulation is able to answer to the following questions:

- **What if ? *(directly)***
- **How To ? *(indirectly)***
- **Why ? *(indirectly)***



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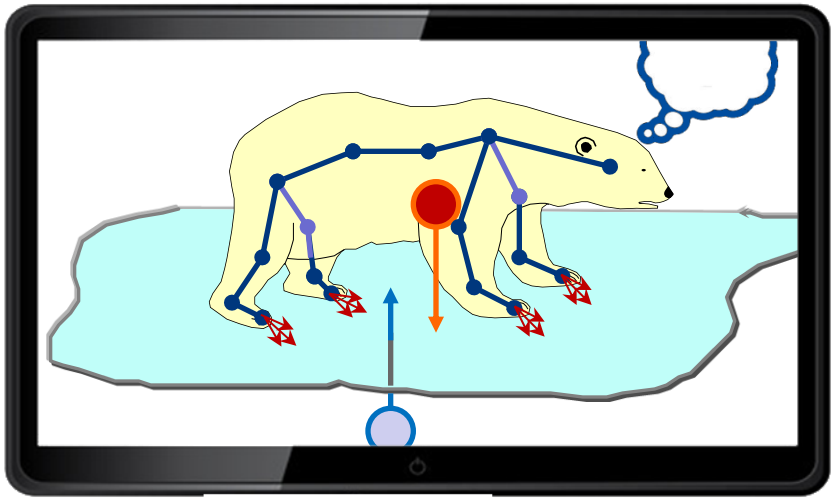
What are M&S and SG?

Simulation is the reproduction of the reality by using computer models. The Simulation allows to build up a ***Virtual Environment*** and to run dynamic scenarios in order to analyze or optimize the real system even before it exists. A **Serious Games** allows to involve players in an virtual learning experience through user Engagement.



Simulation Types

- Interoperable
- Distributed
- Parallel
- Deterministic
- Stochastic
- Man-in-the-Loop

SIMULATION

- Discrete Event
- Continuous
- Combined
- Hybrid
- Real-Time
- Slow-Time
- Quasi-Real Time
- Fast-Time Reality

Simulation, Virtual Reality & Augmented Reality

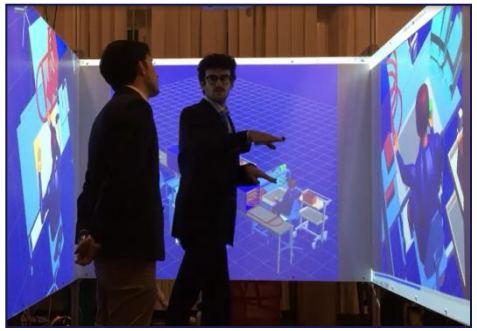
Simulation and Virtual Reality has a double utility **in complex system engineering:**

During Project Development

- System Logic short comes highlight
- Design short comes highlights
- Complex interactions among entities
- High involvement of personnel during V&V
- Emerging behaviors

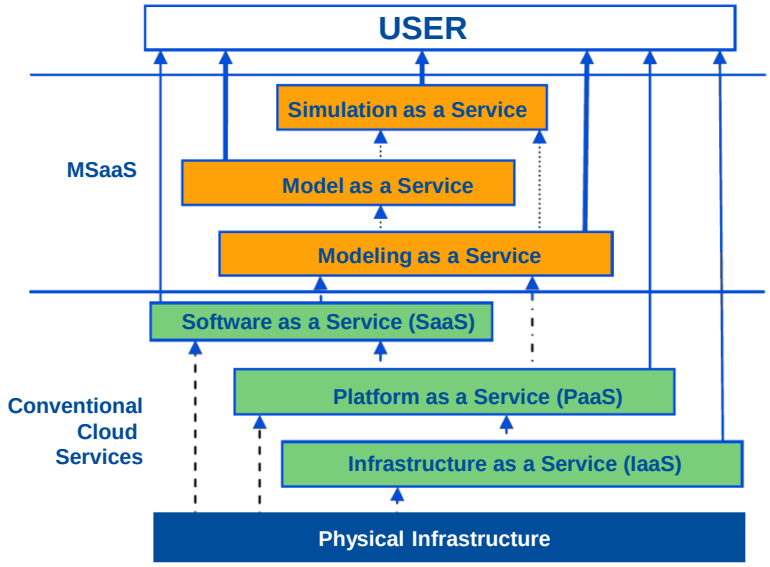
Exposing results

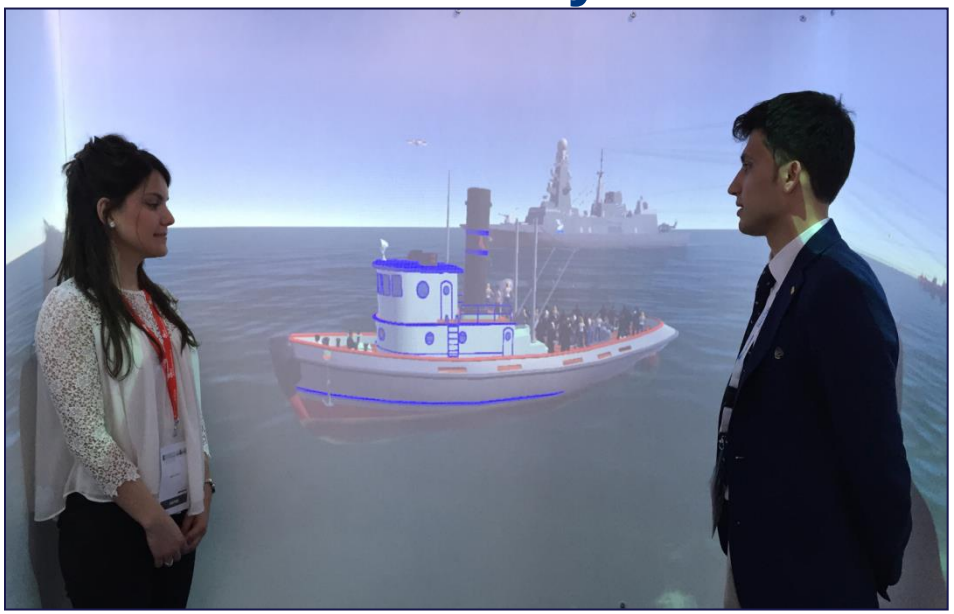
- Direct results presentation
- Training tool for designers, maintenance crew, supervisors
- Direct representation of consequence of alternative choices
- Visual information easy to be valued



Modeling & Simulation as a Service

New Paradigms, based on enabling Technologies (e.g. Cloud Computing, Virtualization) allow to distribute Simulation over a wide community of Users

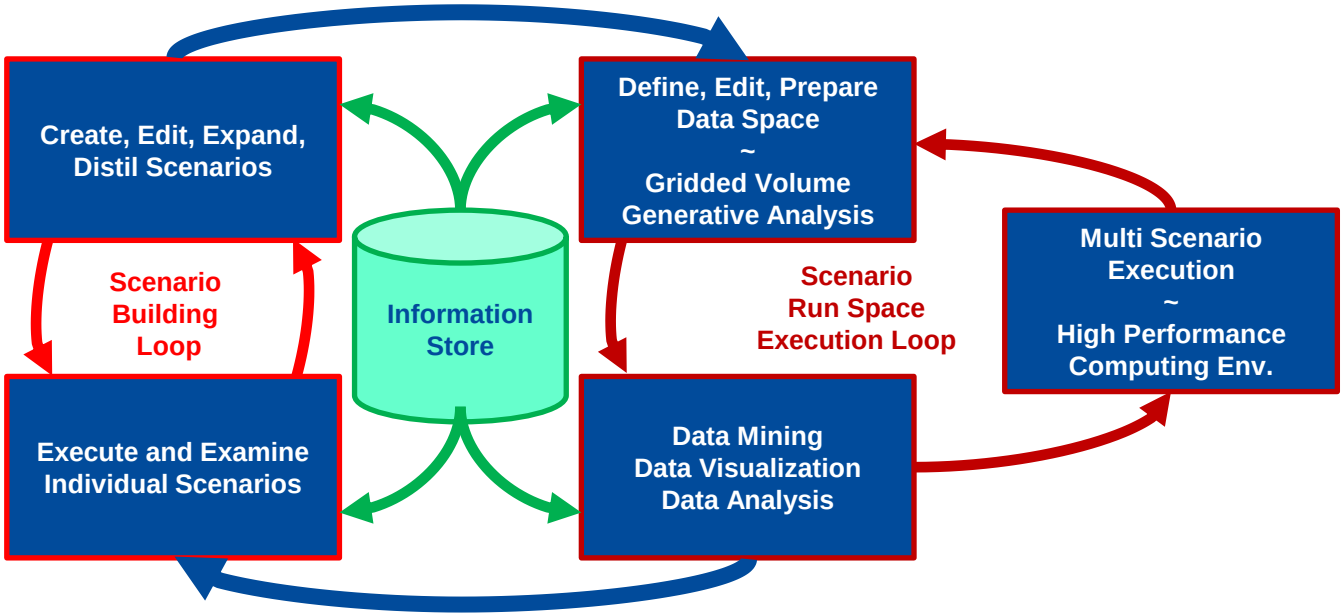




Data Opportunities: Data Farming & Big Data

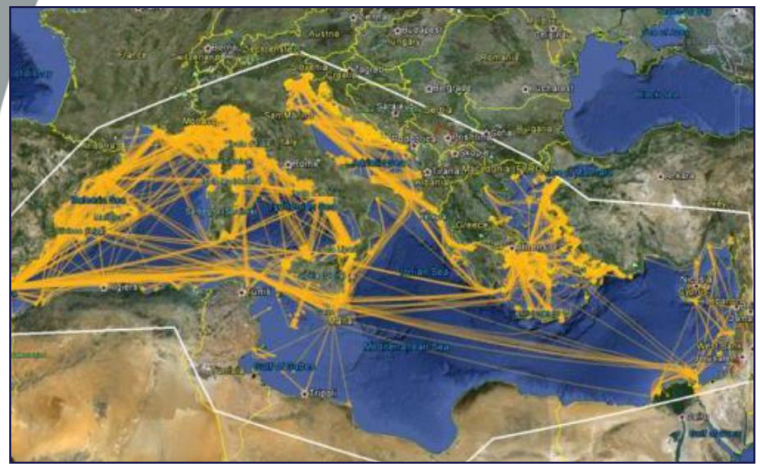
Data Dominance requires to be able to:

- Mine Data
- Extract & Process Information
- Complete Analysis & Draw Conclusions



Enhanced Simulation to Validate Data & Look Forward

On-Line Simulation Concept could evolve into Data Enhanced Simulation through approaches



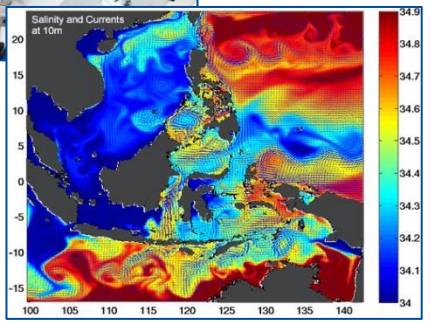
Pattern of Life for Med Commercial Traffics

Data Share on Depth Sounder, Radar, Weather

Whale Watching

Navigation System Industry

Fishing Leisure Industry



Climate Change Models

Sea Control & Safety

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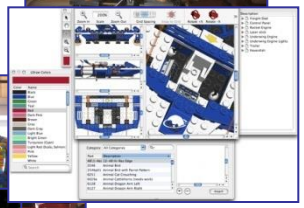
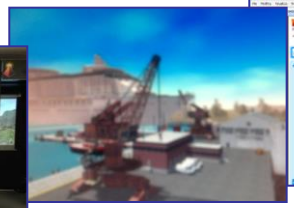
Simulation Opportunities from Serious Games...

There are different incoming ideas from Serious Games:

- New Virtual Environments
- Substitution of Interfaces with Game Devices
- New Opportunities by New Games Device
- Introduction of Massive Multiplayer On-Line Games
- New Web Games
- Physical Devices integrated by Games in Training
- Games as New Learning Approach
- Mobile Platforms





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Human Behavior within **Serious Games…**

Training Education

Frontal lessons — Learn by studying

Training on the job — Learn by doing

Simulation

- Live — Learn by exercising
- Virtual

Computer Based Training

Interactive approach to learning

Serious Game — Learn by experiencing

"Tell me and I forget. Teach me and I remember. Involve me and I learn."
Confucius

…an Evolution Roadmap for Crowdsourcing

Training on the Job

Simulation for Training

Experimenting on the Simulator

Many More Installations
Many More Users

Serious Games for Training

Playing while Learning

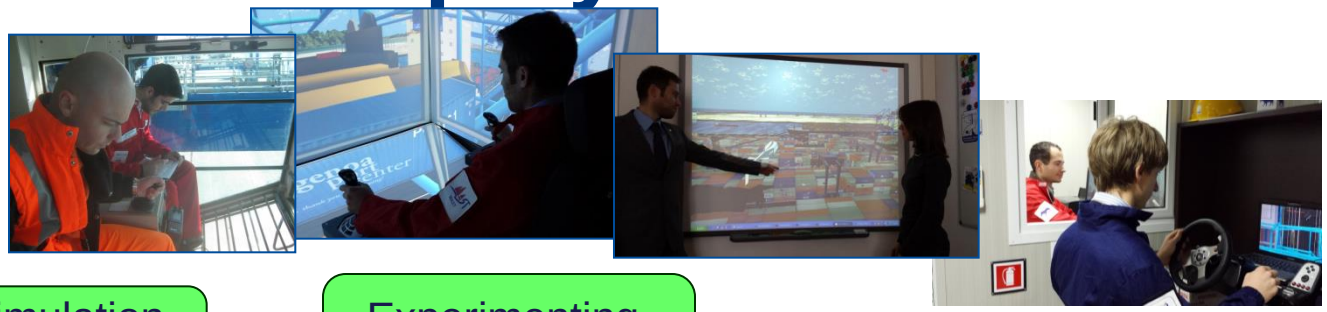
New Utilization Modes

[Nuclear War]
..a strange game, the only winning move is not to play
Joshua in War Games Movie 1983

Experimenting on Games

Simulation Team

…a Serious Games Evolution Roadmap by Simulation Team



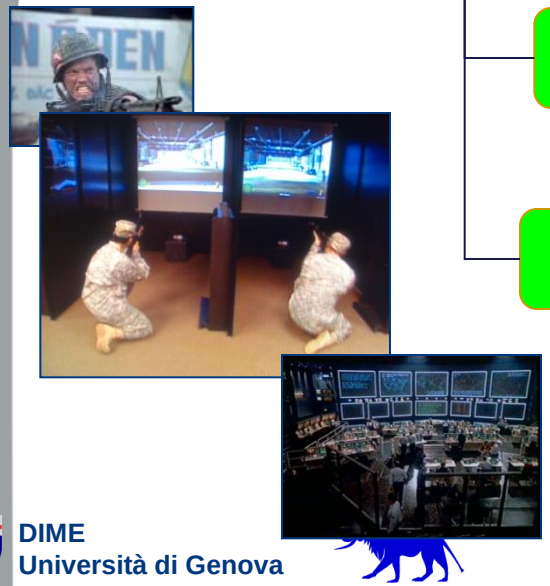
Training on the Job

Simulation for Training

Experimenting on the Simulator

Many More Installations
Many More Users

New Utilization Modes



Serious Games for Training

Playing while Learning

Experimenting on Games

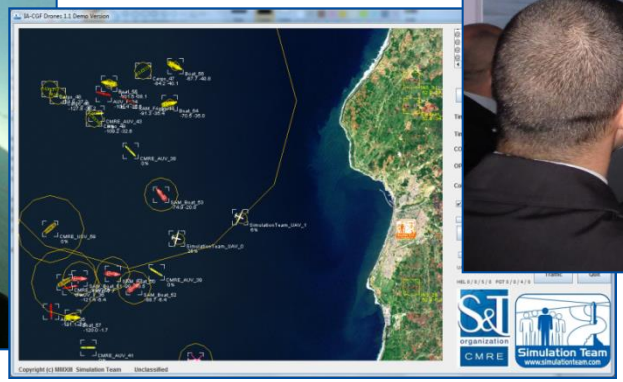
[Nuclear War]
..a strange game the only winning move is not to play
Joshua in War Games Movie

MMO *Massively Multiplayer Online Game*
MMORPG *massively Multiplayer Online Role-play Game*

Simulation Team

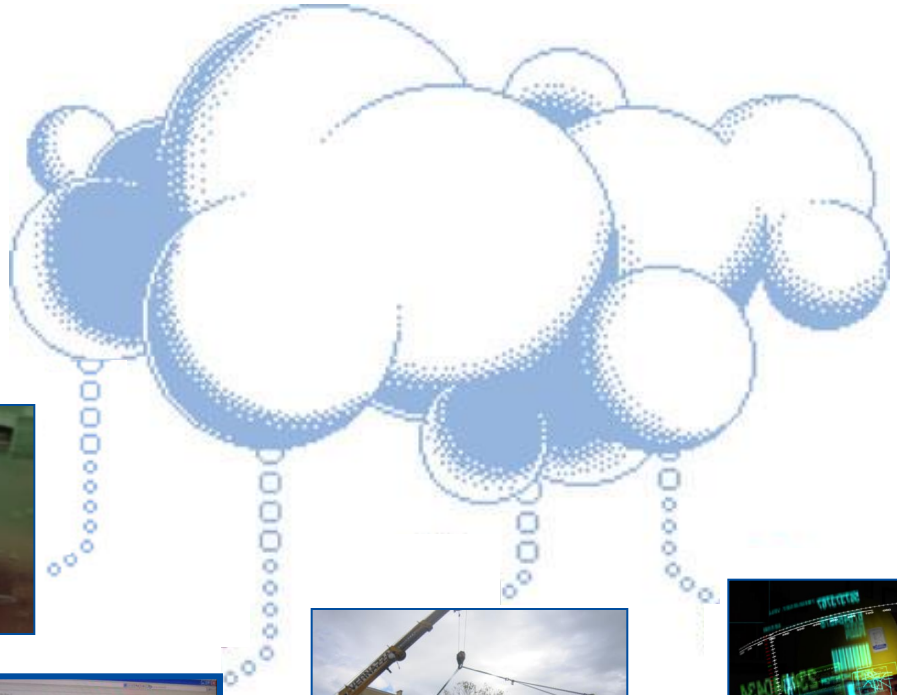
MS2G as Enabler

The innovative concepts of MS2G (Modeling, interoperable Simulation and Serious Games) allows to develop interoperable scalable and reusable simulators with benefits of new immersive solutions. Many entities could be driven by intelligent agents allowing to study complex realistic scenarios.



Simulation Team

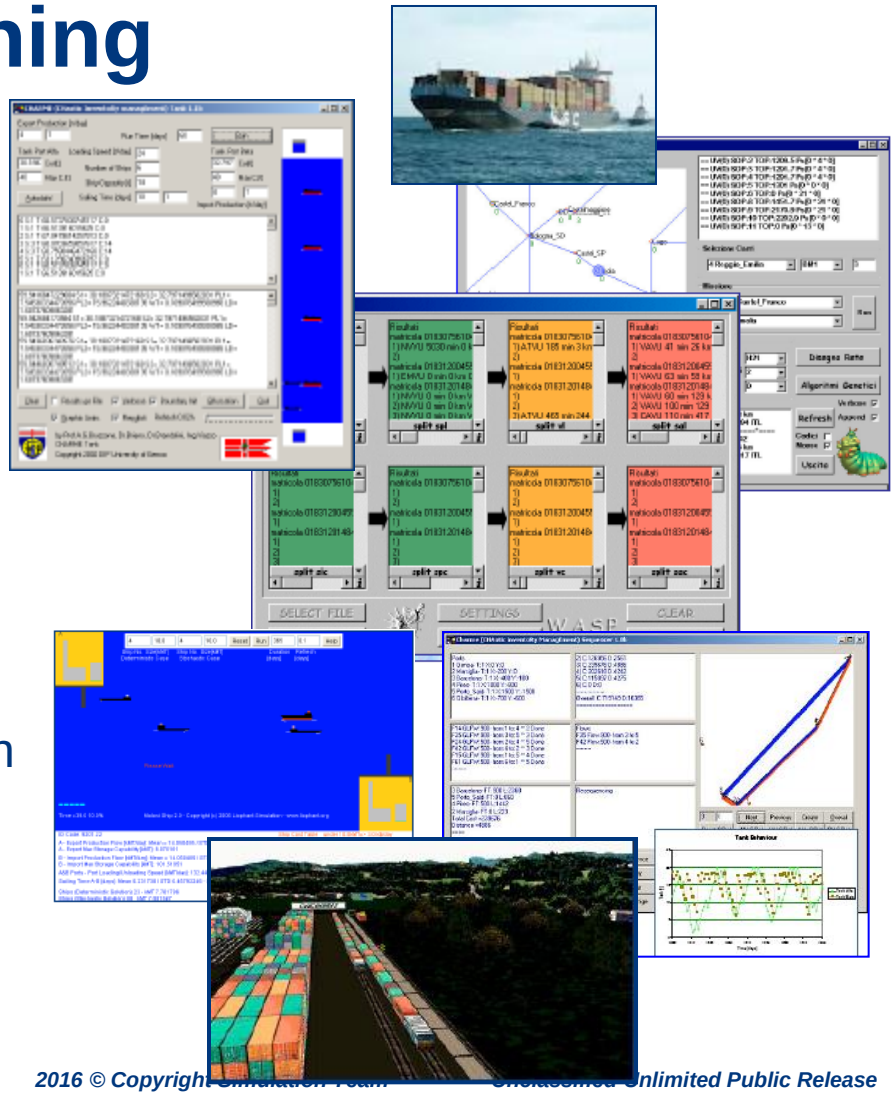
Web, Mobile & Lean Solutions



M&S Resources Allocation and Logistics Planing

Simulation is able to supports Logistics in term of Operation Planning, Resource Management and Optimization

In addition Hybrid Simulation (intended as integration of Simulation with Intelligent Agents and Artificial Intelligence) supports scenarios evaluation and the identification of effective solutions in terms of costs, efficiency, productivity, robustness, etc.



Yesterday Challenges

Logistics as evolving and crucial sector is younger than other areas in Industrial Processes and it was often quartered among other company divisions

Among critical issues it was possible to

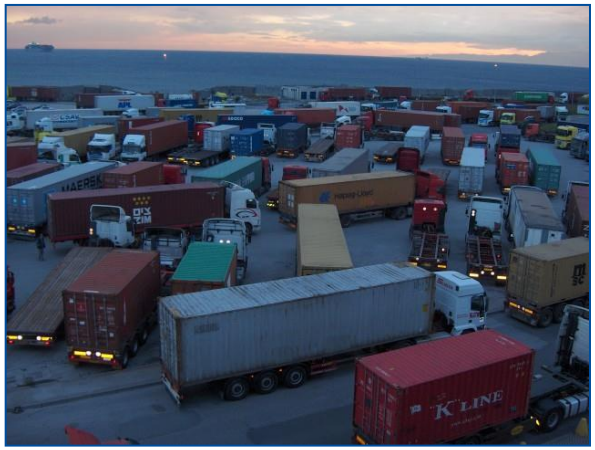
Rank among the others the following aspects:

- **Not to trivalize Logistics even Now**
- **Working Conditions of Logistics operators**
- **Globalization**
- **Supply Chain Management Optimization**
- **Outsourcing**

Current Logistics Shortfalls

Today shortfalls in Logistics included several issues such as:

- **Need of Talents and Skills in Logistics**
- **Last mile & last km**
- **Safety and Security**
- **Sustainability**

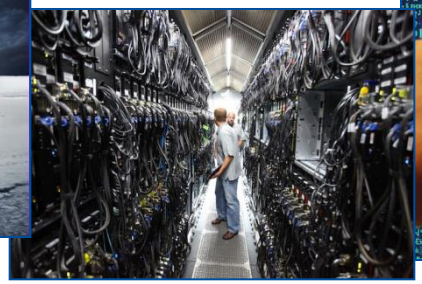


There are also interesting opportunities:

- **New Routes such as Panama Canal, Polar Routes, Amazonia**
- **Price and Service Balance**
- **Service Evolution (i.e. freight bill payment (freight bill audit and payment firms)**

Tomorrow Challenges

- Urbanization and the increasing number of “Mega Cities”
- World Evolution
- Technological advances (e.g. “additive manufacturing”)
- Cyber Attacks to logistics networks
- Harnessing of “big data” to improve supply chain efficiency
- Adaptation to Global climate change.

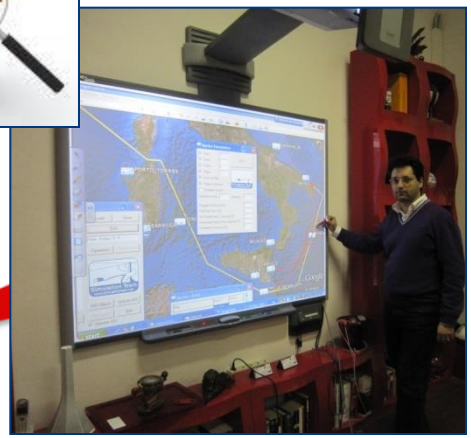


Simulation Team

Simulator's Interoperability Feature

One of the innovative features of the simulator is its interoperability.
It is possible to use this characteristic during:

- Meetings for tactical and strategic decisions on logistics and production (investments and budget)
- Videoconference to evaluate critical operations and scheduling decisions.

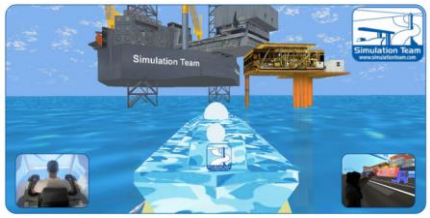


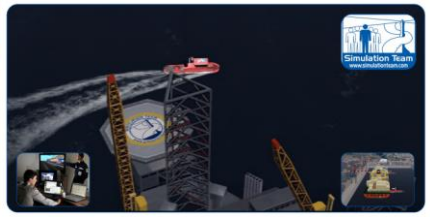
Testing MARLON Simulator through Smartboards in different labs

It also allows to put in contact logistics with production and make their integration in the company's context easier.

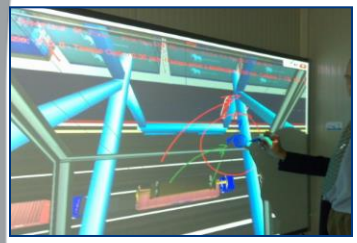
Simulation Team

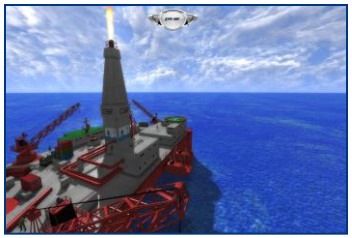
ST_VM: Virtual Marine





The ST-VM is the ultimate Marine Simulator developed by Simulation Team and includes many different Marine components, equipment and platforms as well as New Solutions for Terminal Design, Operator Training, Safety and Security, Procedure Definition, Equipment Design and Virtual Prototyping





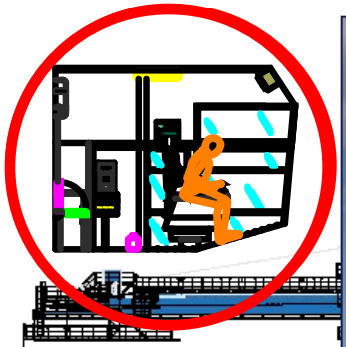
ST-VM is fully containerized real-time distributed HLA Simulator reproducing Port Operations. ST-VM is integrated in a 40' High Cube Container ready to be used on site immediately after arrival.

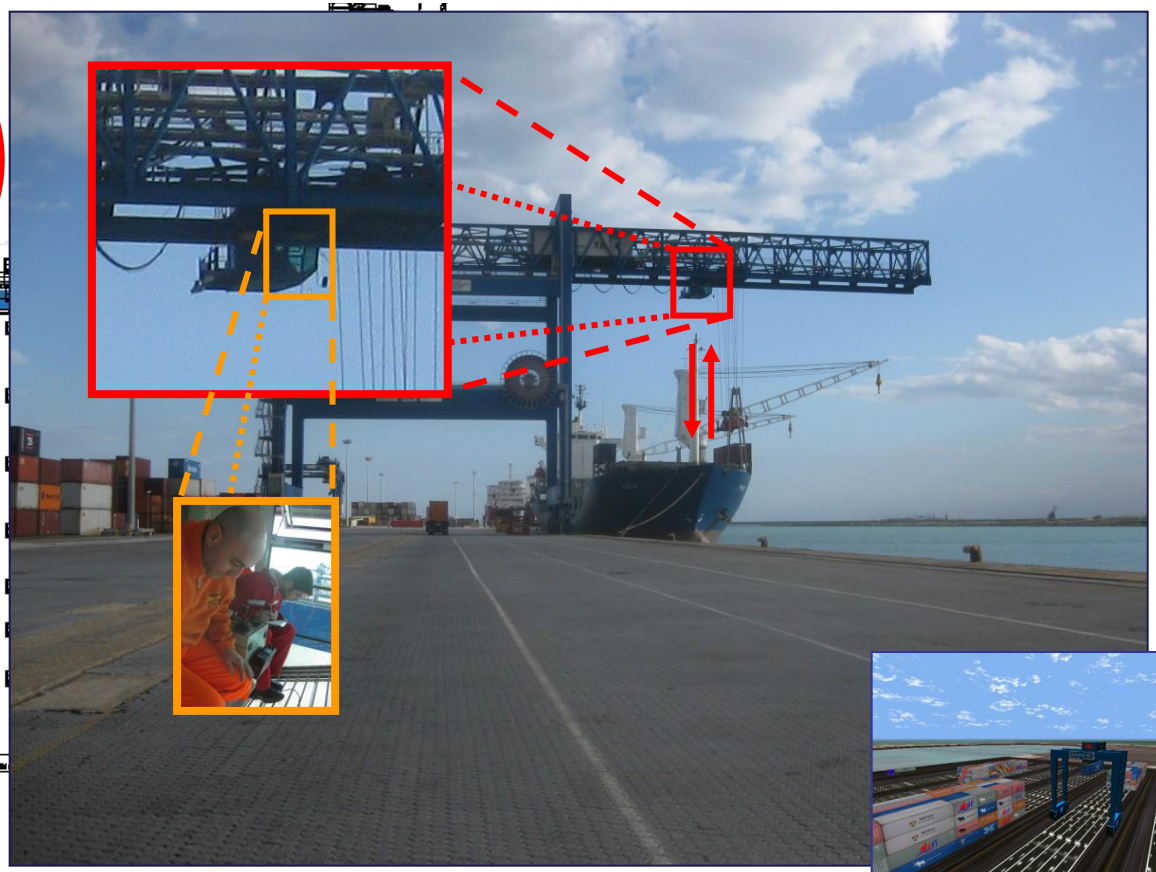
ST-VM Simulator allows to operate all the different Marine Devices in a Virtual World by an immersive Cave (270 ° Horizontal and 150° Vertical), reproducing Sounds, Vibrations, Motion in all weather conditions

ST-VM includes a Full-Scope Simulation for Training Operations & Procedures, an Integrated Class Room, the Instructor Debriefing Room, and secondary Interoperable Simulators of different Marine equipment with other modules (i.e. Biomedical Module for Safety, Ergonomic and Posture Enhancement).

ST-VM World is customizable for each Platform, Port, Crane, Procedure and Equipment.

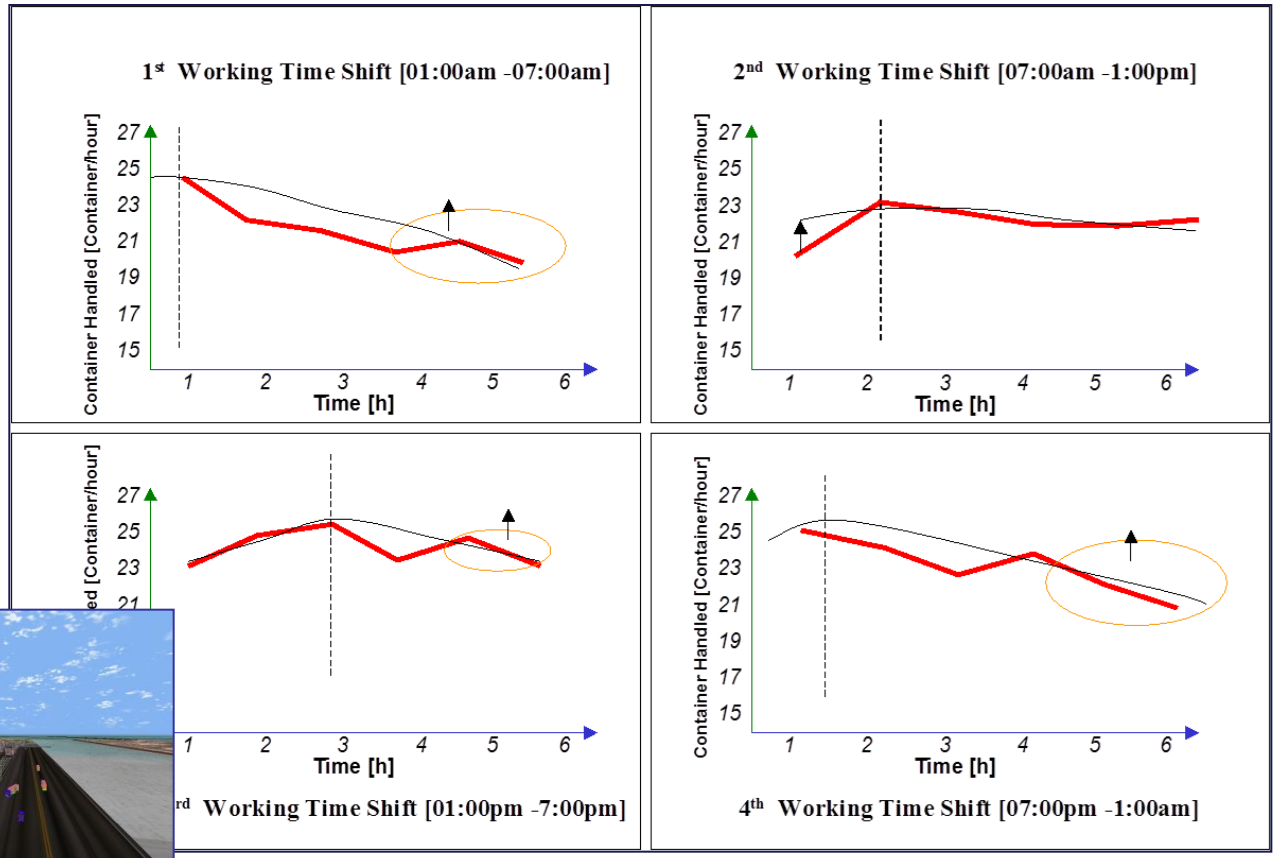
Quay Crane Unloading Sequence from Ship to Truck

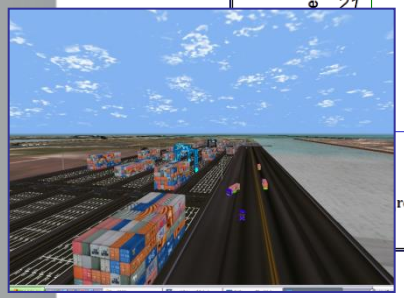




Posture Open Issues for Gantry Crane Operators

Performance Evolution over Time





Crane operators performance curves along the four time shifts (6h each) are decreasing **by a parabolic trend**

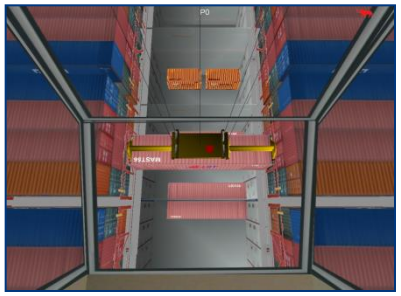
Simulation Team

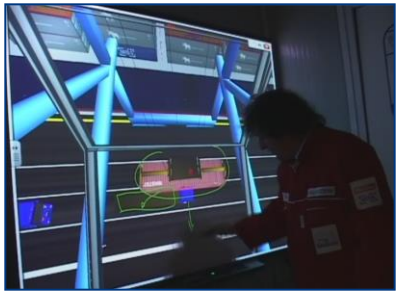
Interoperable Virtual Simulators

The Simulators developed by Simulation Team are an important support in Training both Operative Resources and Decision Makers. The Interoperability of our simulators is based on state of art standards (i.e. HLA High Level Architecture) and emphasize in addition to traditional stand-alone training in Operating, even Concurrent Cooperative Training in Operations and Policies; Simulation Team collect long experience in Professional and Executive Training.

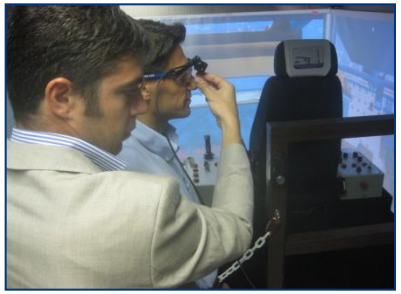
Simulation Team

ST_PT & ST_RS Simulators





Shelter & Facilities



ST_PT Crane Sim

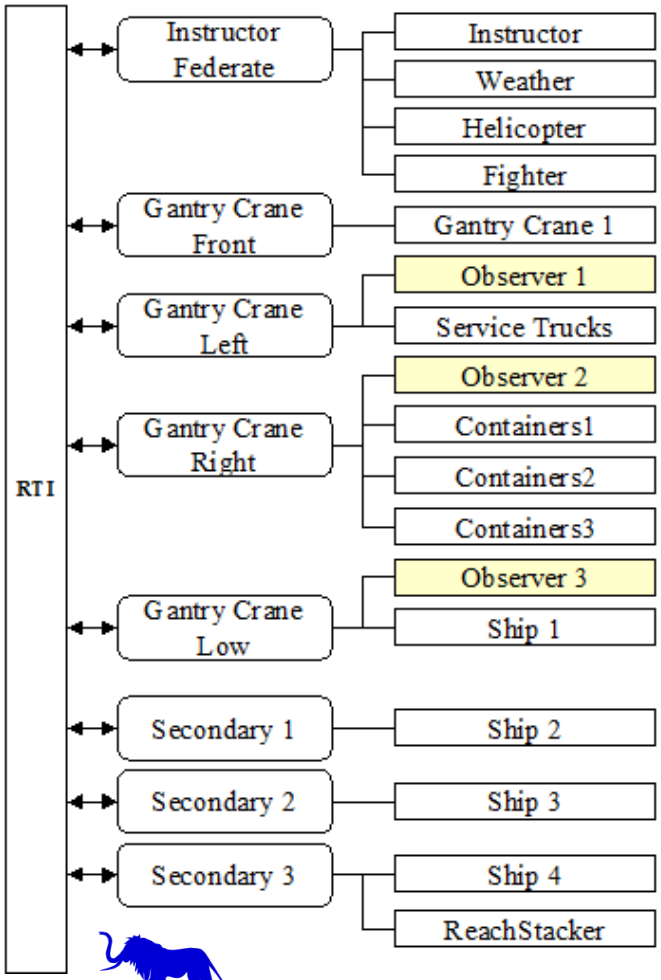
ST_PT Truck Sim

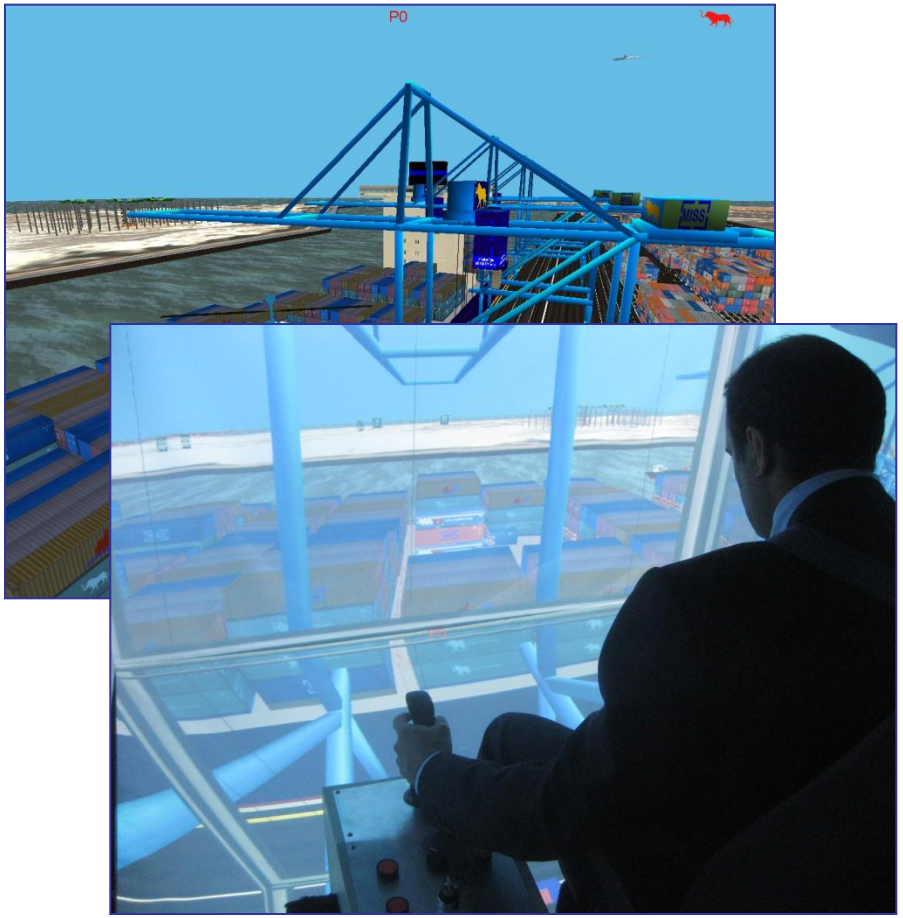
This new generation of simulator is mobile, real-time, scalable and interoperable and compliant with state of art technology and standards

Simulation Team

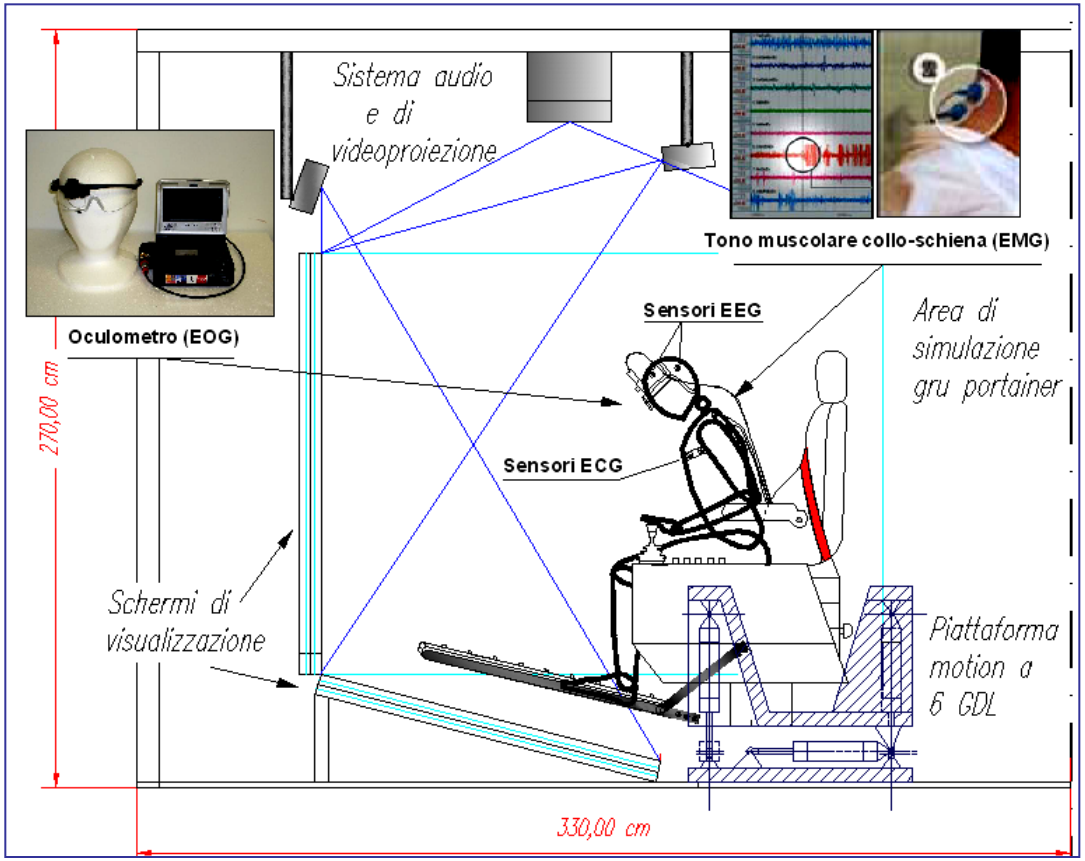
Atout of our Virtual Simulation

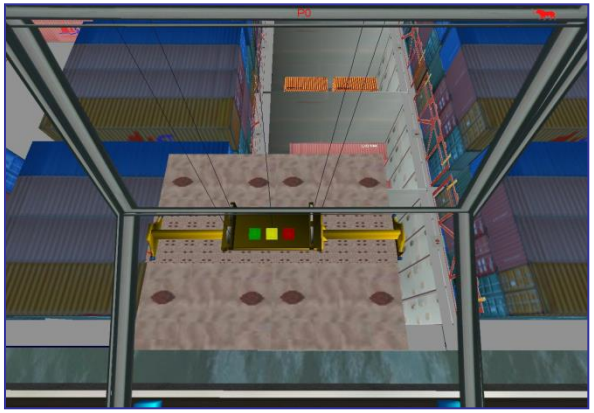
ST_VM Federates

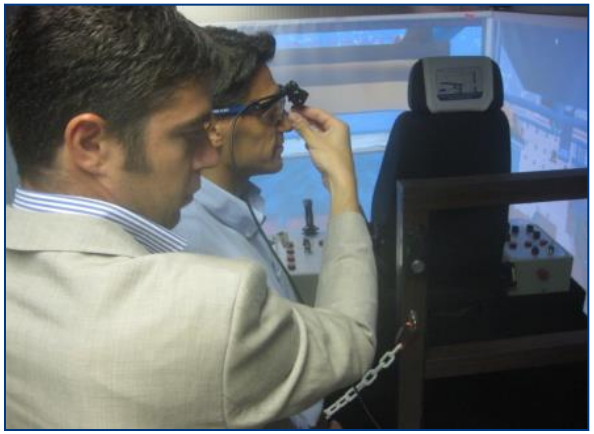




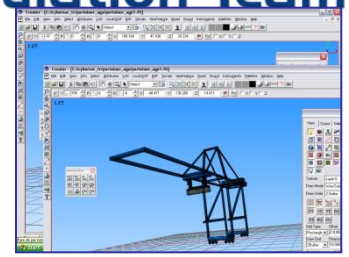
Simulation & Biomedical Devices







Simulation Team



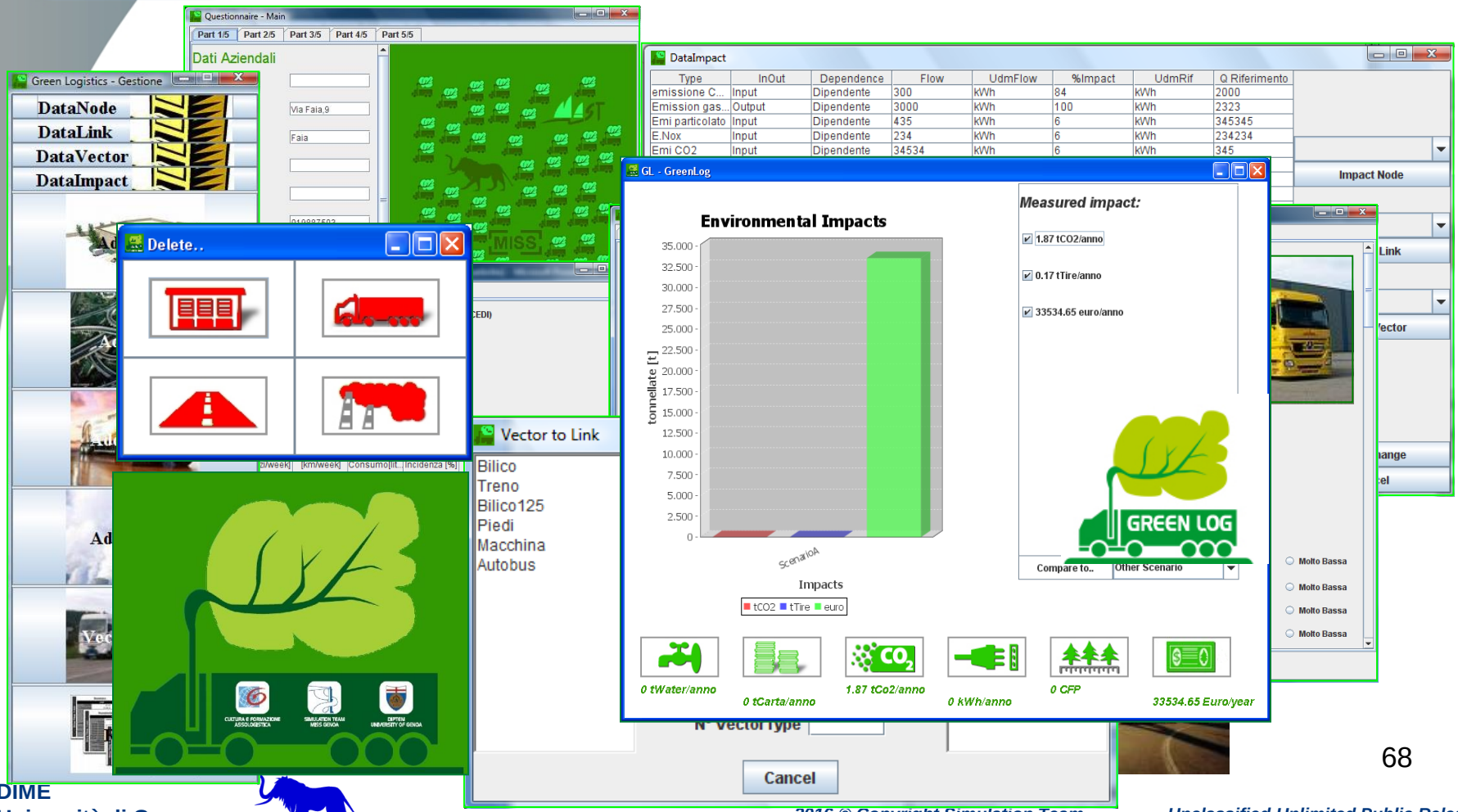
Biomedical Devices

- **The Cagliari simulator has been equipped by following instruments:**
  - ***Eye tracker*: a device for studying the vision process by recording those points the operator's eyes look at during execution of a task, subsequently distinguishing between objects regarded as distractor signals and those considered receptor signals.**
  - ***Dynamic ECG* (Holter): device for monitoring cardiac frequency;**
  - ***Flicker Fusion Unit* (FLIM): objective test for analysing flicker and flicker fusion frequency, that enables to evaluate central-nervous system arousal and assess level of performance (memory, alertness, reaction time);**
  - ***Blood Pressure* Monitor (ABPM, Ambulatory Blood Pressure Monitoring): device for measuring arterial blood pressure;**
  - ***Digital EEG*: device for measuring psycho-physical stress parameter;**
  - ***EMG*: test for evaluating muscle tone.**

Under conditions of psycho-physical stress caused by the complexity of the operator's tasks, these electromedical devices measure the significant parameters associated with the onset of fatigue in relation both to the degree of alertness required to avoid errors, and to the exposure to strain and vibrations reproduced by the motion platform.

Simulation Team

Green Log: a Web Based Approach to Green Logistics



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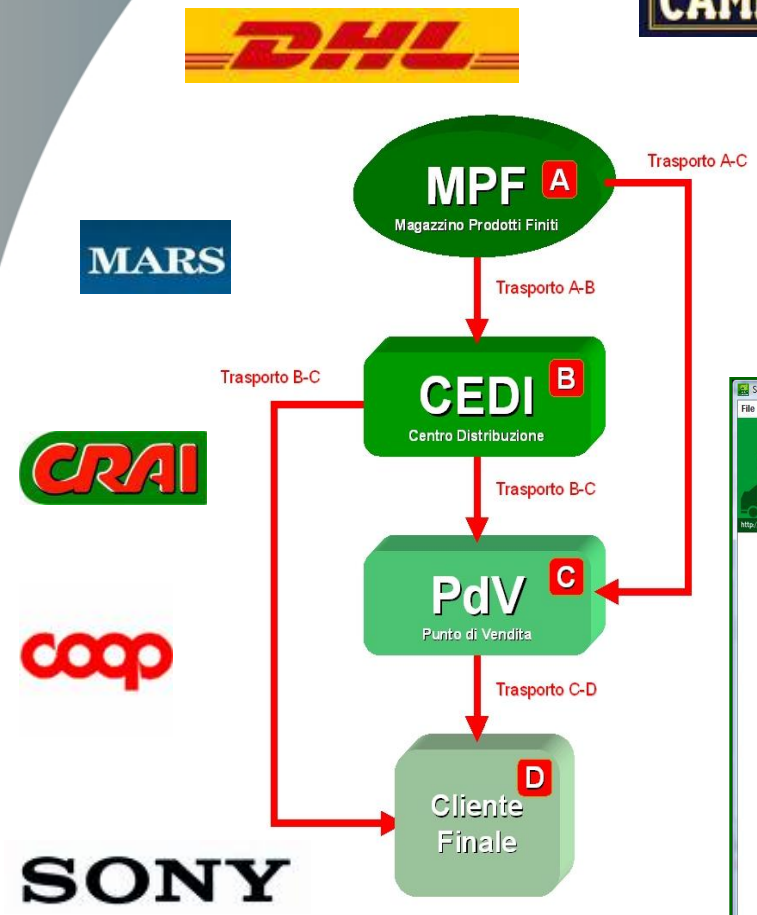
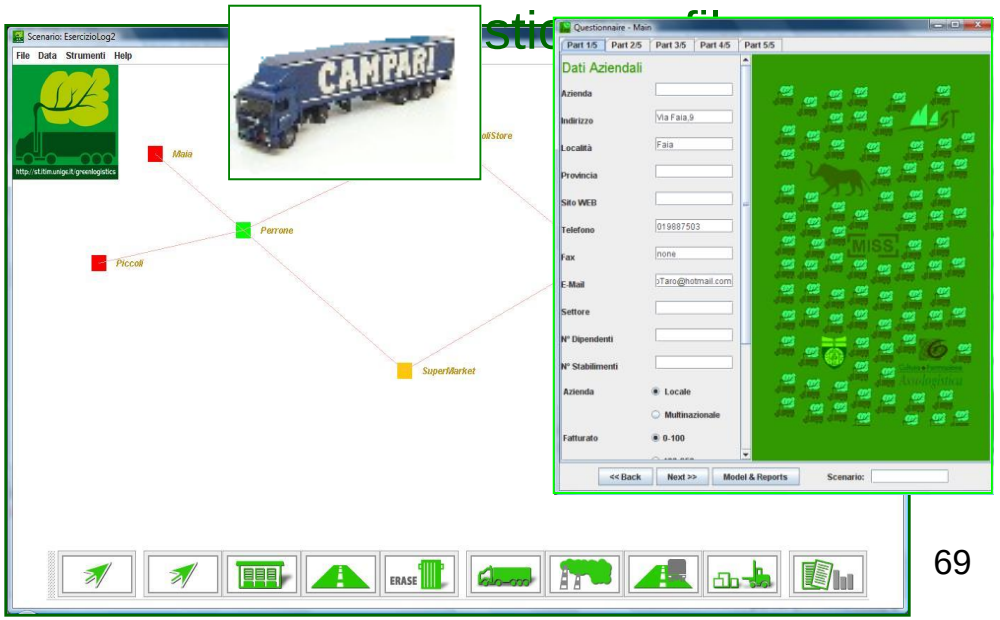
Automated Scenario Generation in GreenLog Sim



- *Green Log* allows to integrate automatically the data collected in the questionnaire in order to create a basic simulation scenario to provide an estimation of the company



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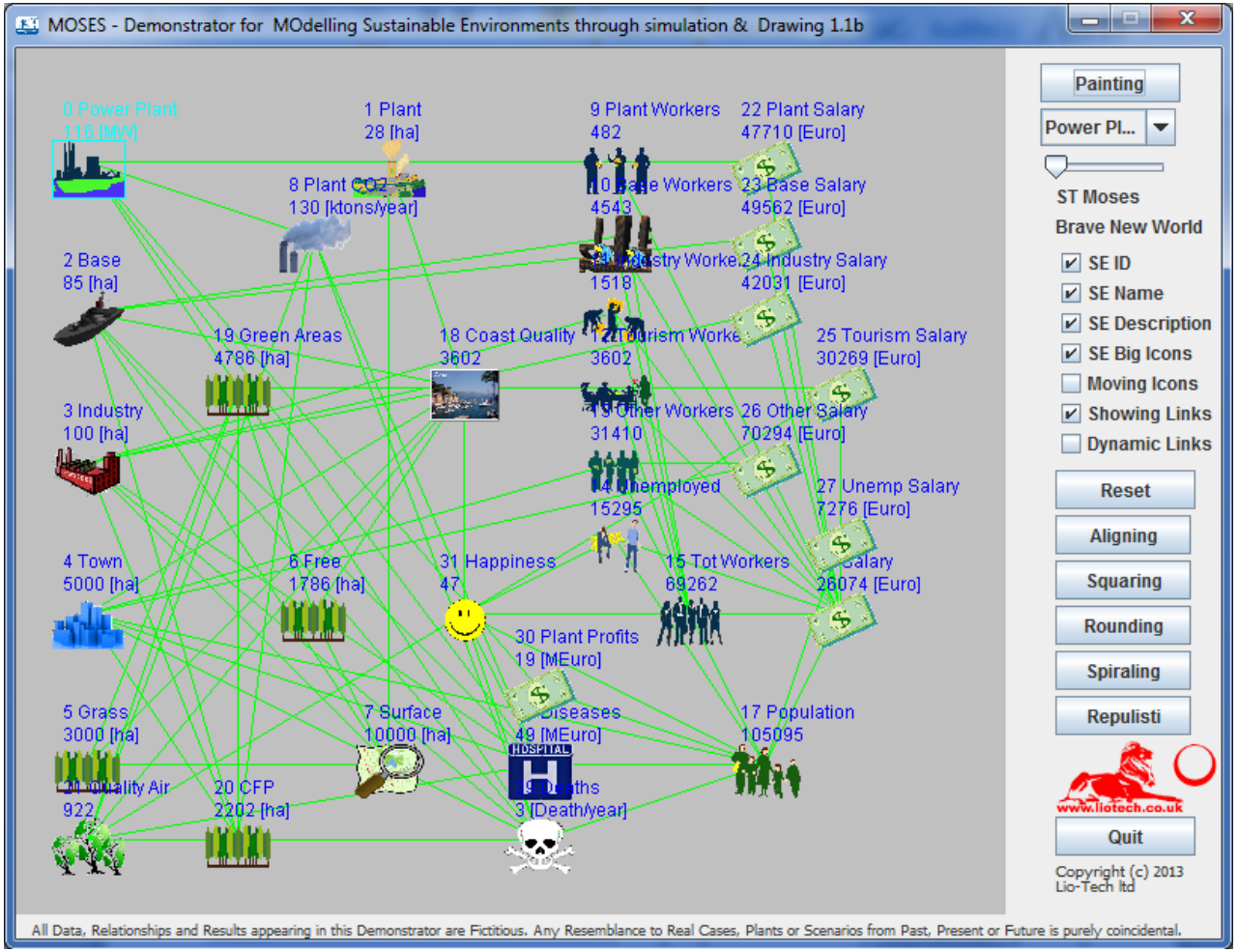
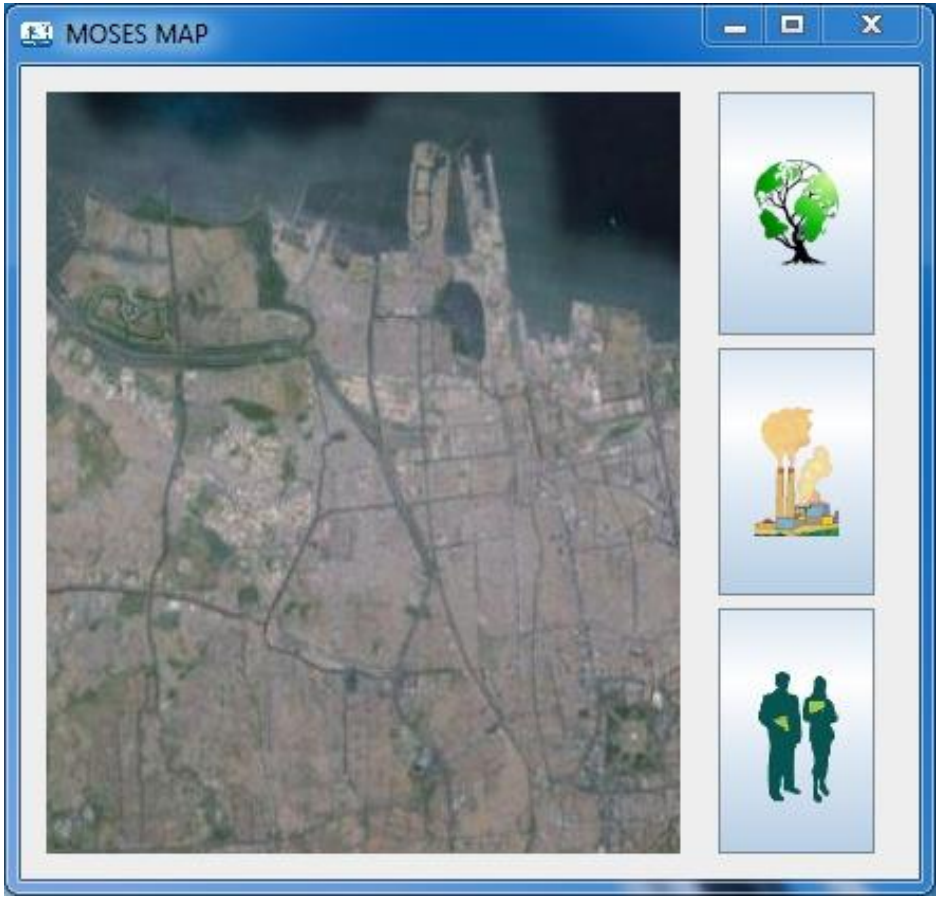
MOSES Simulation

MOSES (MOdelling Sustainable Environment through Simulation) is a sustainability model based on dynamic simulator which has been used as a tool in a game based experience during a MIPET class.



Sustainability Simple Geo Representation

The simulator is equipped with a mapping tool which visualizes the use of the soil in terms of intended use, superimposed to a satellite picture

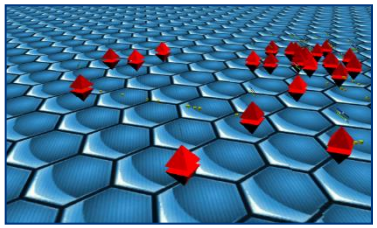


MOSES: a Game for Negotiation & Decision Making

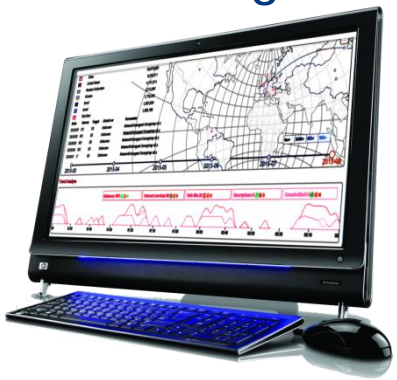
The experience will subdive the students in two groups. All participants will be randomly assigned to their roles. In this experience students will supervised by professional engineers with professional background in the field. One group will play the role of the governmental authority of the region, and it will be equipped with MOSES environment. The second group will take care of the interests of a company which aims at building and operating a coal power plant in a specific virtualized area and economic scenario. These team members will act as the engineers who had to finalize the technical proposals and to draft the design document including the environmental impact assessment. This team will also use MOSES simulator, obviously with a prevailing interest in a subset of output variables which will be different from the one of the previous team and more profit-oriented, while the public authority will focus more on social indicators. The goal of the two groups is to finalize successful the negotiation on the offsets and to adopt winning strategies

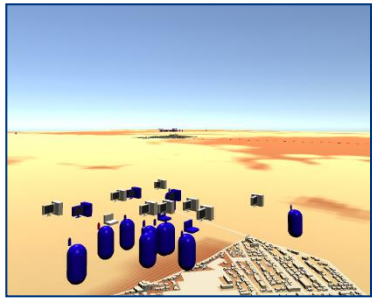
Simulation Team

Port & Cyber Security: MS2G in T-REX



The Cyber Security environment (T-REX) creation by Simulation Team allows to evaluate the impacts on operations and estimates the magnitude. The approach allows to considerate the Cyber Warfare Complexity and the impacts on ICT process and infrastructures.The MS2G (Modeling, interoperable Simulation & Serious Games) approach, make possible to raise users awareness and evaluating the efficiency and efficacy of the defensive actions against cyber attacks.





Simulation Team

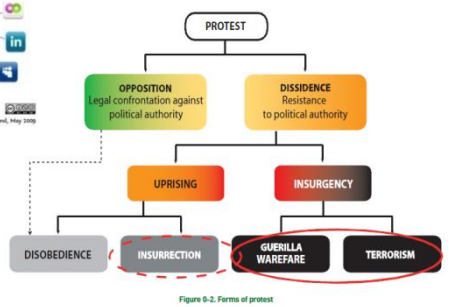
Damage of Cyber Attack: Value Examples

Everyday there are about 3 or 4 serious attacks. USA, France and UK government spent over **17 Billion Dollars** on **Cyber Security in the last years**

The Italian Energy Market generate 80 bEuro/year so every interruption create a damage of **10 Meuro/h**

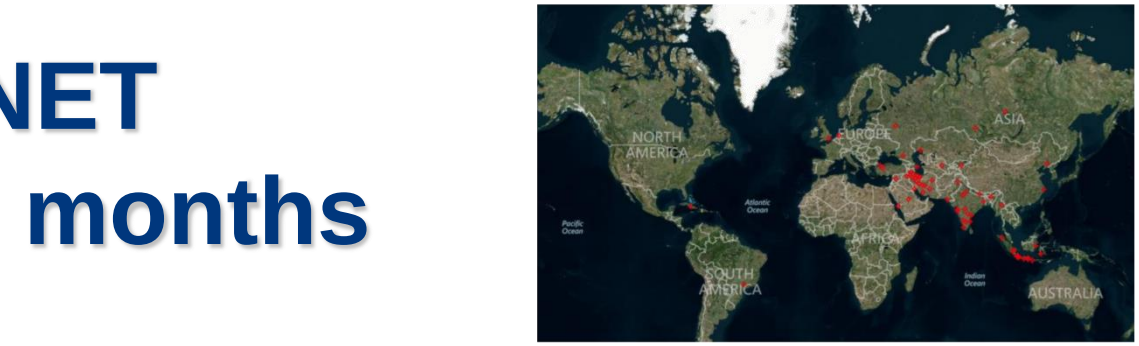
Italian Mobile Network is valueted 25 bEuro/year about 3 MEuro/h

Also State like Afghanistan are vulnerable by this kind of threat: the telecommunication sector in the last five years creates about 60,000 jobs and produces investments of 1 billion dollars

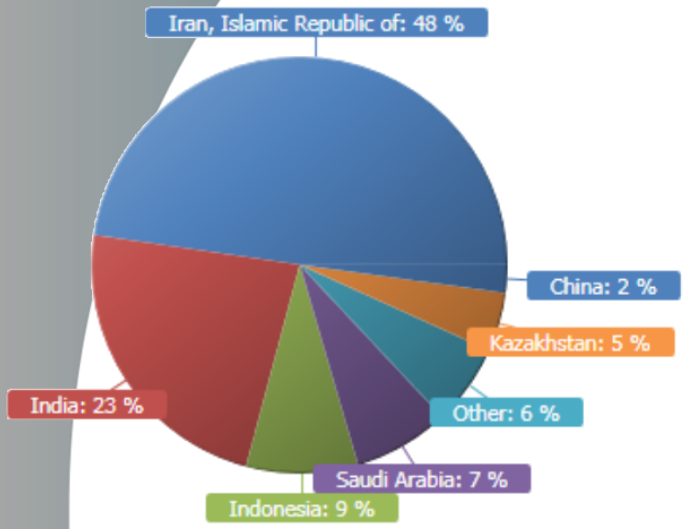


Simulation Team

STUXNET after 42 months



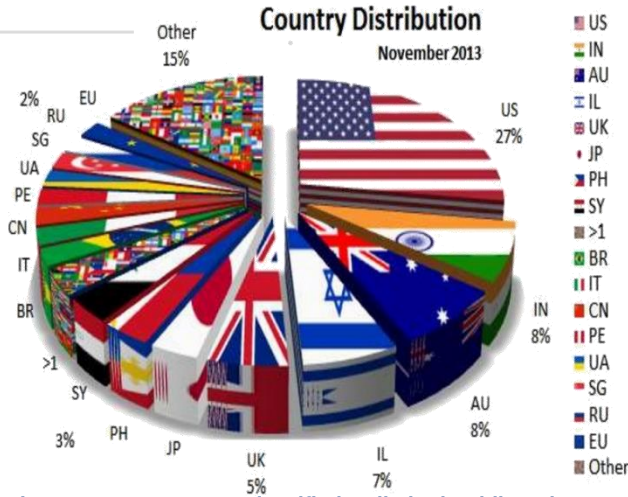
Geographical distribution of Stuxnet infections 2013-2014.



Percentage	Infection Records	Trojan
47.71	198	Iran, Islamic Republic of
23.13	96	India
8.67	36	Indonesia
7.47	31	Saudi Arabia
6.27	26	Other
4.58	19	Kazakhstan
2.17	9	China

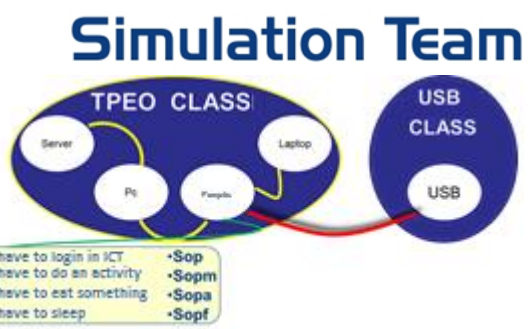
Country distribution of Stuxnet infections 2013-2014.

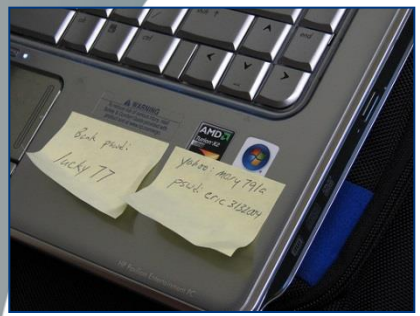
Is a Malware able to discriminate the target and adopt covered and sabotage **tactics**

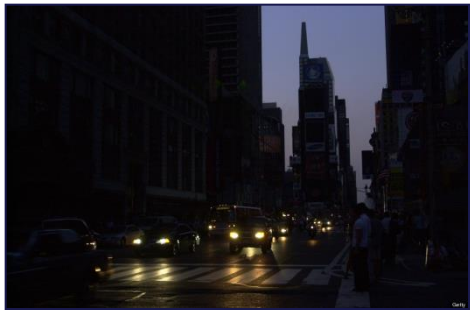


The attack was so dangerous that many **SCADA Systems (Supervisory Control and Data Acquisition.) are still infected after 42 months**

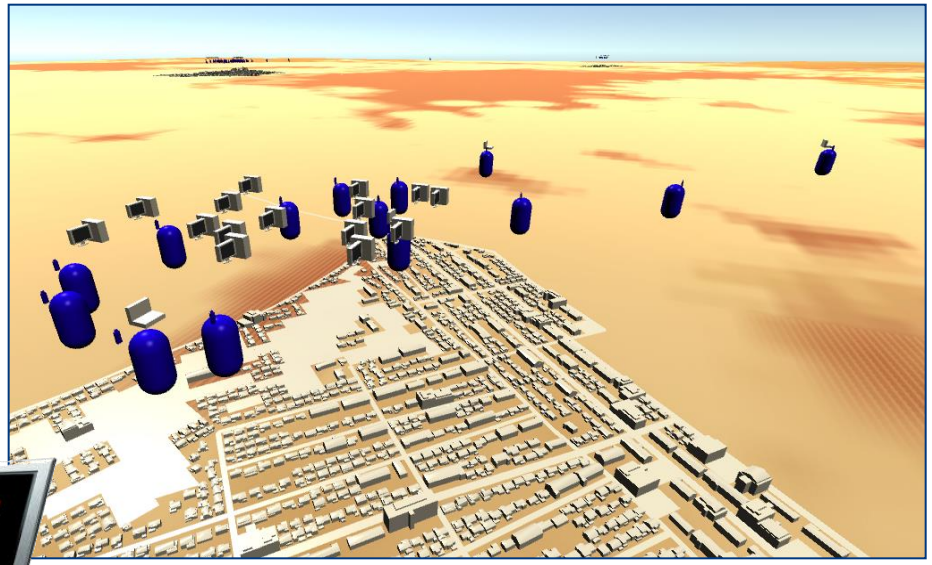
Social Networks vs. Social Engineering





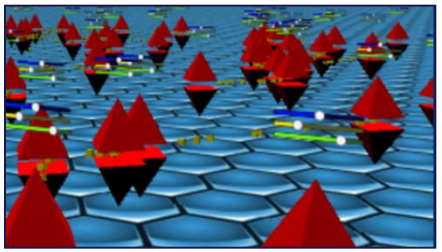


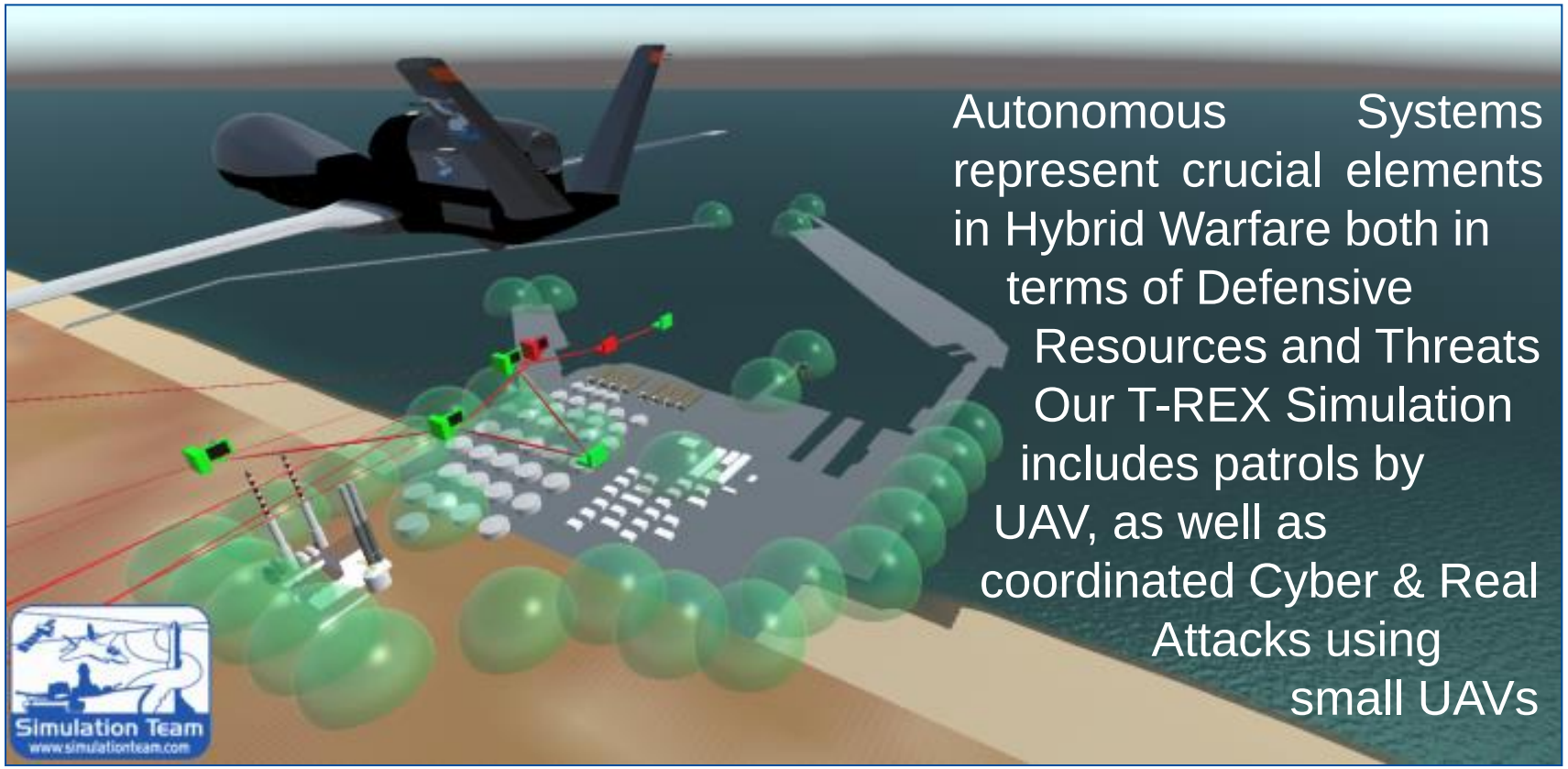
The Cyber Security weaknesses are often in social Engineering instead in Cyber Space itself.
But often the damage are not related to data.



Simulation Team

Hybrid Warfare & Autonomous Systems



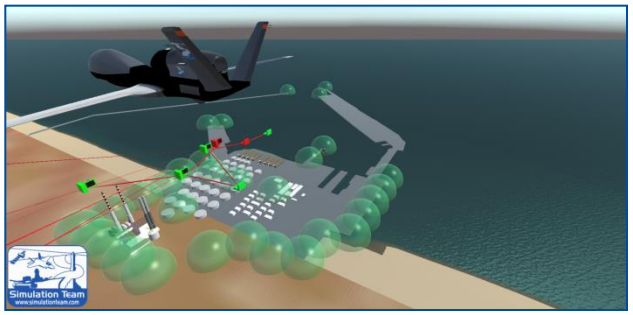


Autonomous Systems represent crucial elements in Hybrid Warfare both in terms of Defensive Resources and Threats

Our T-REX Simulation includes patrols by UAV, as well as coordinated Cyber & Real Attacks using small UAVs

Simulation Team

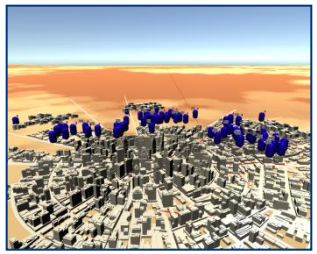
T-REX
Demo Actors



- The T-REX includes: Port, Oil Terminal, Tank Farm, Power Plant, Desalination Units, Security Systems, People, Threat Network, Media, Communications, Traditional Assets as well as Different Autonomous Systems and Other Critical Infrastructures
- The Oil Terminal & Port is protected by Legacy Systems and UAV, USV, AUV in JISR from a threat network.
- The cyber layer of T-REX includes computers, laptops and mobile IoTs (internet of Things) as well as firewalls and procedures.
- The threat network includes terrorist agents able to adopt different operative modes such as “sleeping”, “stand by”, “planning action”, “preparing action”, “executing action” on different layers by using conventional attacks & drones.

UAV	Unmanned Autonomous Vehicles
USV	Unmanned Surface Vehicle
AUV	Autonomous Underwater Systems
JISR	Joint Intelligence, Surveillance and Reconnaissance

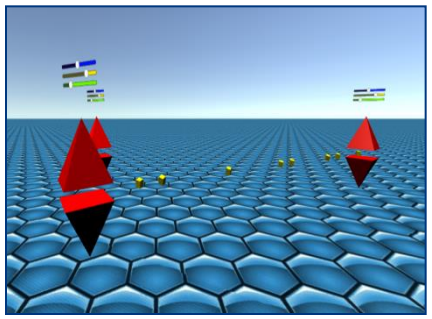
T-REX and MS2G Paradigm



- T-Rex (Threat network simulation for REactive eXperience) and adopts MS2G pardigm (Modeling, interoperable Simulation & Serious Game) that combines Complex System Modeling and intuitive Serious Game framework.
- T-REX is a stochastic discrete event virtual interoperable simulation able to perform fast time runs in order to evaluate vulnerability reduction as well as risk assessment respect hybrid warfare scenarios.
- T-REX includes metamodels dedicated to reproduce specific aspects (e.g. communications) that could used for fast simulation or substituted by federating details models made by specific tools (e.g. an OPNET simulator reproducing in details the communication protocols and hardware devices)

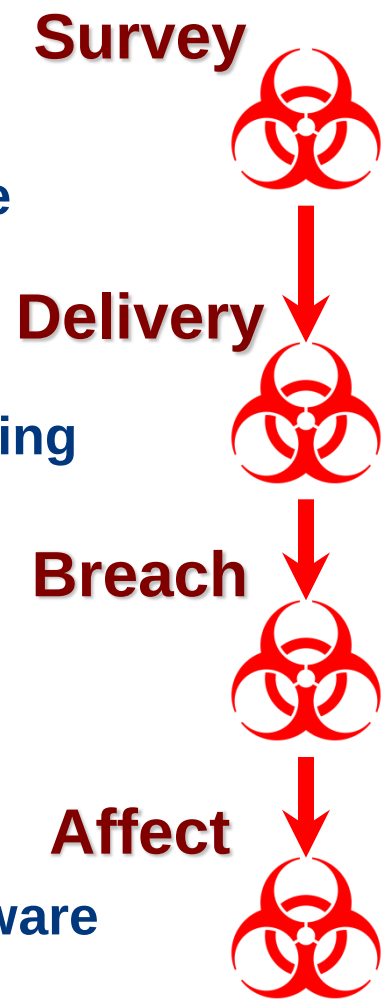
T-REX and Cyberspace

- ***Cyberspace*** is modeled as a corresponding space to the ICT (Information and communications technology) with a topography related the logic and structure of the configurations and interconnections.
- Cyberspace in T-REX is constituted by nodes and links, characterized among the others, by the ***Integrity***, ***Availability*** and ***Confidentiality Levels*** that evolve dynamically for each element
- by this approach it becomes possible to conduct actions on ***Cyber Elements*** (e.g. an IP Address, a PC) and see the effects on the operational layer as well as on the social one.

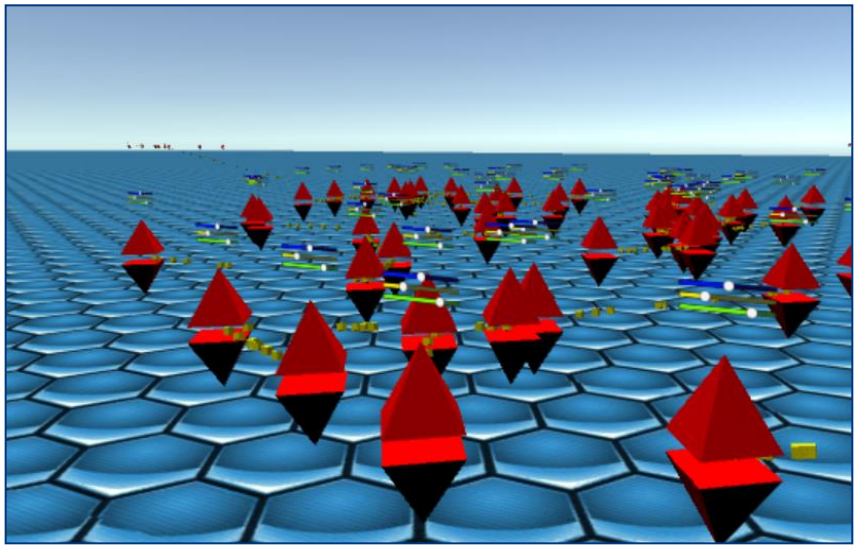


Cyber Attacks Models

- Denial of Service
- Defacements
- IP Spoofing
- Password Cracking
- Sniffing
- Pishing
- Trojan Horses
- Worms
- Viruses
- Unpatched Software

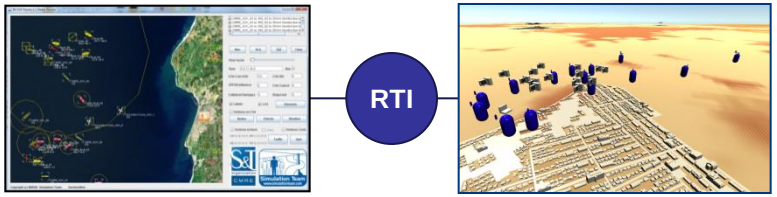


Cyber attack are similar to traditional attack but they are different in terms of time, distance and available resources



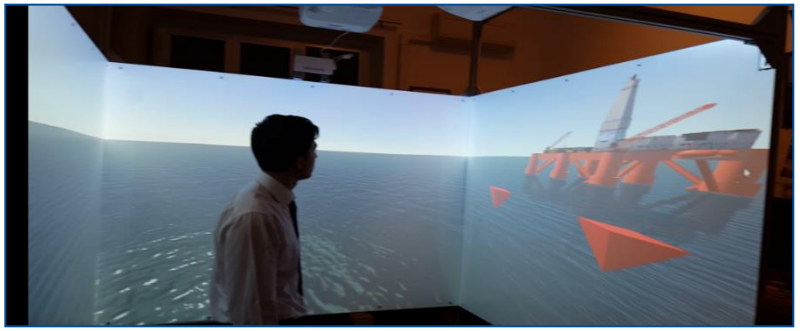
Simulation Team

T-REX & HLA

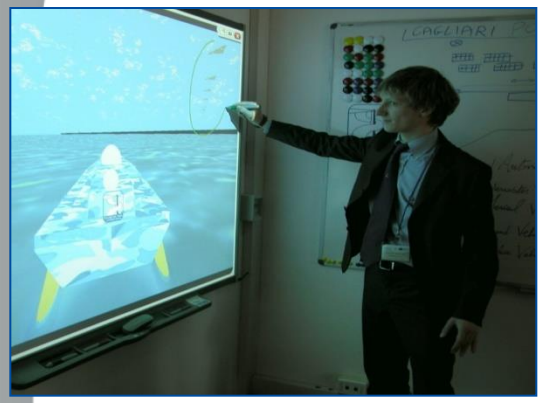


- The native HLA (High Level Architecture) structure of T-REX simulator guarantees Interoperability and allows to keep this environment open for being federated with other simulators
- T-REX has been already tested integrated with JESSI (Joint Environment for Serious Games, Simulation and Interoperability), a virtual interoperable environment with many different models to simulate complex heterogeneous networks including traditional and autonomous platforms (e.g. UAV, USV, UGV, UUV, Vessels, Aircrafts, land vehicles, missiles, etc.) that operates over a joint scenario (i.e. air, land, sea, space, cyberspace) and with SPIDER (Simulation Practical Immersive Dynamics Environment for Reengineering)

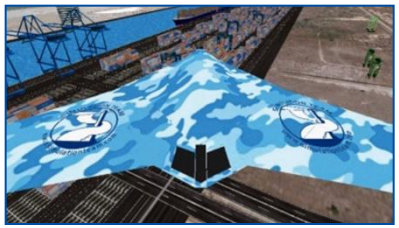
M&S as the Enabler



M&S (Modeling & Simulation) is a strategic enabler for investigating, experimenting & validating concepts, solutions & systems within complex multi domain scenarios:



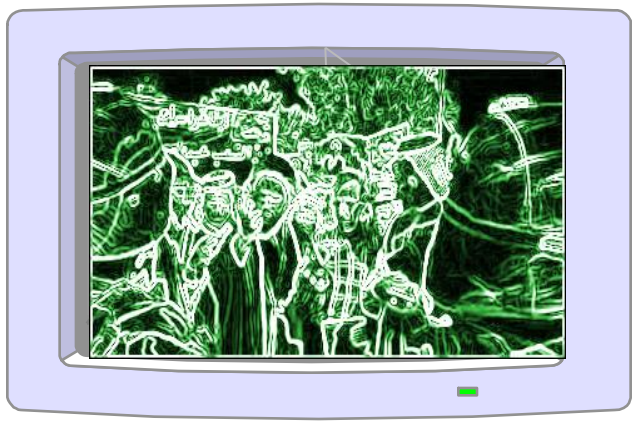
- Reproducing a Complex Environments
- Reproducing joint interoperability among different Systems, Sub-Systems, Products & Services
- Simulating Entities, Objects, Units and their they interactions
- Simulating different Aspects (e.g. demand , operations, etc.)



Simulation Team

Decision Making in Complex Scenarios

Decision Makers are facing complex scenarios more and more. In these contexts New Technologies, New Industrial Paradigms, as well as Human Behavior Modifiers (HBM) related to market evolution are crucial elements and many of these objects and systems interoperate. So it becomes necessary to use Modelling & Simulation (M&S). So today is necessary to simulate new Systems and Solutions and the Complex Related Systems



Fundamental Properties of a Complex System

- **Self Organization**
- **Non-Linear Interactions**
- **Adaptation**
- **Heterogeneity**

Complex System properties lead to Emergent Behaviors

What is Meant by a Complex System?

Many contrasting views

Biology, Computer Science, Engineering, Economics, etc.

Complex System: two pertinent definitions

A system composed of interconnected parts that as a whole exhibit one or more properties (behavior among the possible properties) not obvious from the properties of the individual parts[1] (Reductionism vs. Holism)

A system having many interrelated, interconnected, or interwoven elements and interfaces[2]

Simple System Very Predictable. Traditional engineering methods apply.	**Complicated System** Satisfies functional requirements, but cannot ensure under all possible conditions/ states
Chaotic System (Non-Deterministic) Random perturbations give appearance of complexity. Solved using Robust Design	**Complex System** Must architect system to behave correctly by tailoring the emergent behaviors

Functional Domain: Simple / Complex

Physical Domain: Simple / Complex

- Architecture[3]:
  - Structure of components
  - Relationships (Complex information exchanges, system interfaces, functional interoperation, etc.)
  - Principles & guidelines governing evolution over time

1. Joslyn, C. and Rocha, L. (2000). *Towards Semiotic Agent-Based Models of Socio-Technical Organizations, 2000.*

2. Crawley, Edward. System Architecture – course notes. MIT, 2005.

3. IEEE Std 610.12

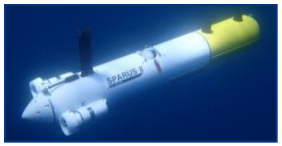
Source Mavris, ASDL, GATECH

Figure adapted from Balestrini-Robinson, Santiago. "A Modeling Process to Understand Complex System Architectures," 2009.

Complex Systems

A Complex System is an entity obtained as composition of interconnected elements, able to exhibit one or more properties and or behaviors not obviously deriving from the properties of its individual parts.

Multidisciplinary Nature of the Complex Systems



Complex systems are addressed by multiple competences, multiple backgrounds, multiple technical languages

From System Engineering to Complex Systems

- **Today Engineering is mostly focused on creating systems that aggregate many different functions and components, with high degree of interactions and often including interoperability issues…**

e.g. we are moving from designing

… a phone…

… to a smartphone

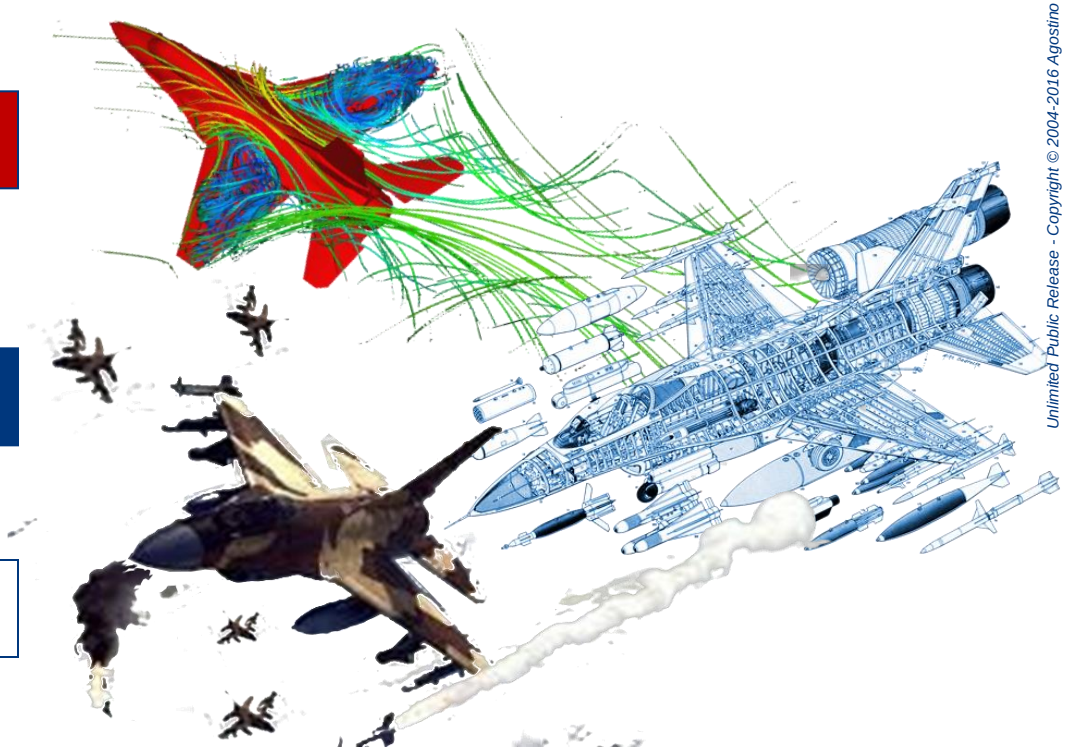
Complexity Concepts in System Engineering

There are different kind of complexity affecting the Products and Systems to be addressed:

Internal Complexity

Integration Complexity

External Complexity

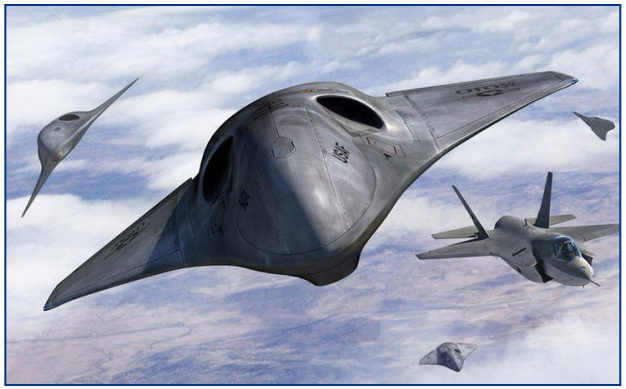


Complex Systems/Products for Aerospace & Defence

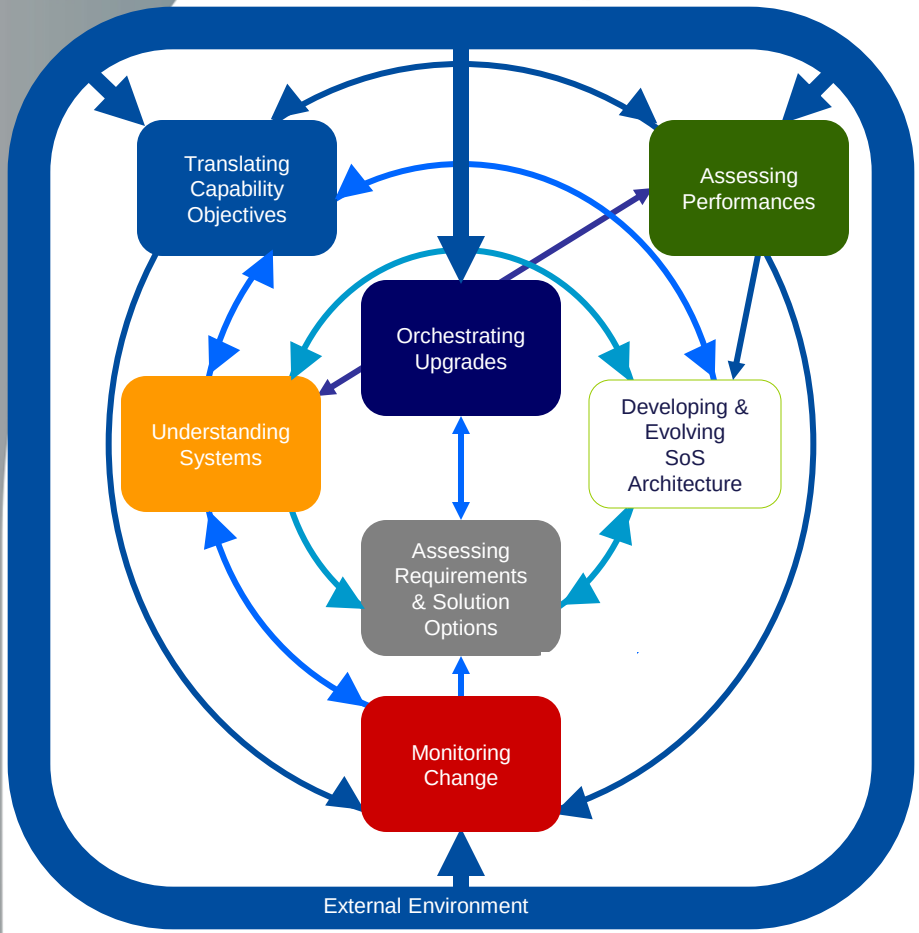
- **Weapon Systems represent examples of Complex Systems often devoted to interoperate among each others**

SoSE & Simulation

- **The increased level of complexity, interoperability and cost effectivness resulted in an increased focus on Models considering the whole System of Systems Engineering**



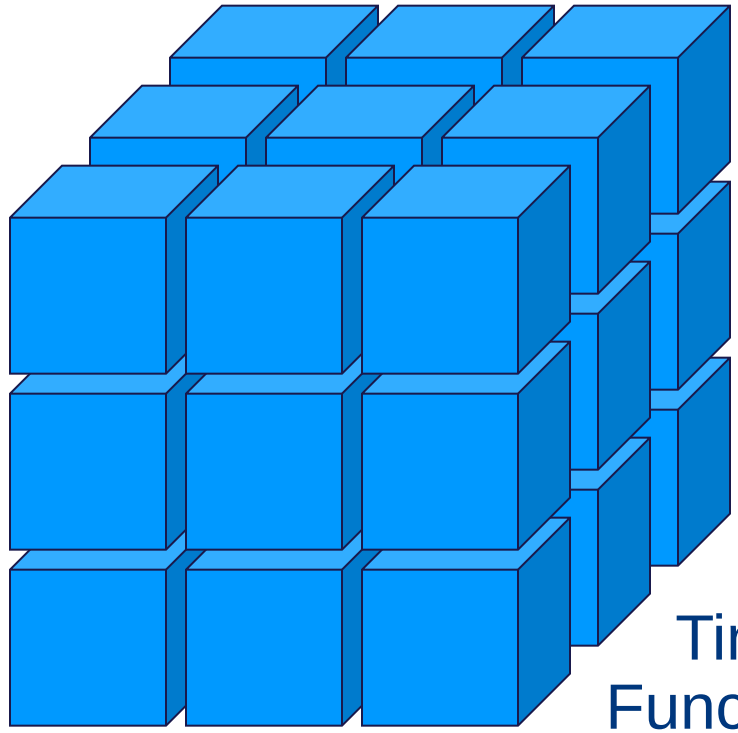
SoS SE as guideline for DoD Acquisitions



Example of an Operational View of an SoS: Naval Integrated Fire Control Counter Air [Source: Navy Chief Engineer's Office]

Engineering in SoS as a Paradigm

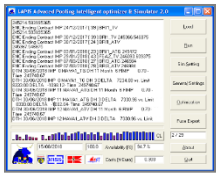
System of System Engineering is an approach able to be applied to SoS created in multidimensional environments

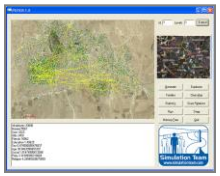


Disciplines & Areas

Time & Functions

Space and Configuration





Strong need to combine Social and Technical Networks

Engineering in SoS as a Paradigm

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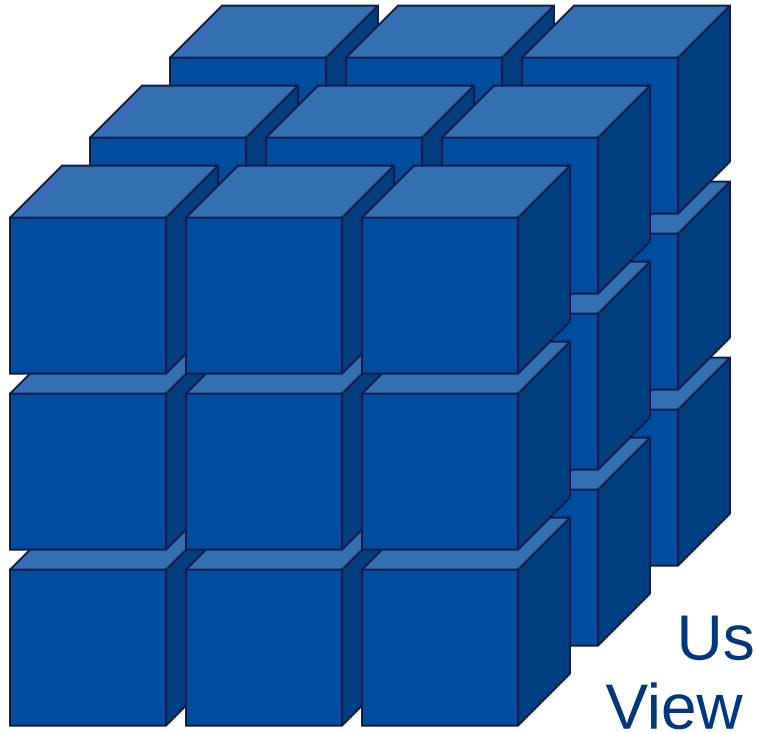
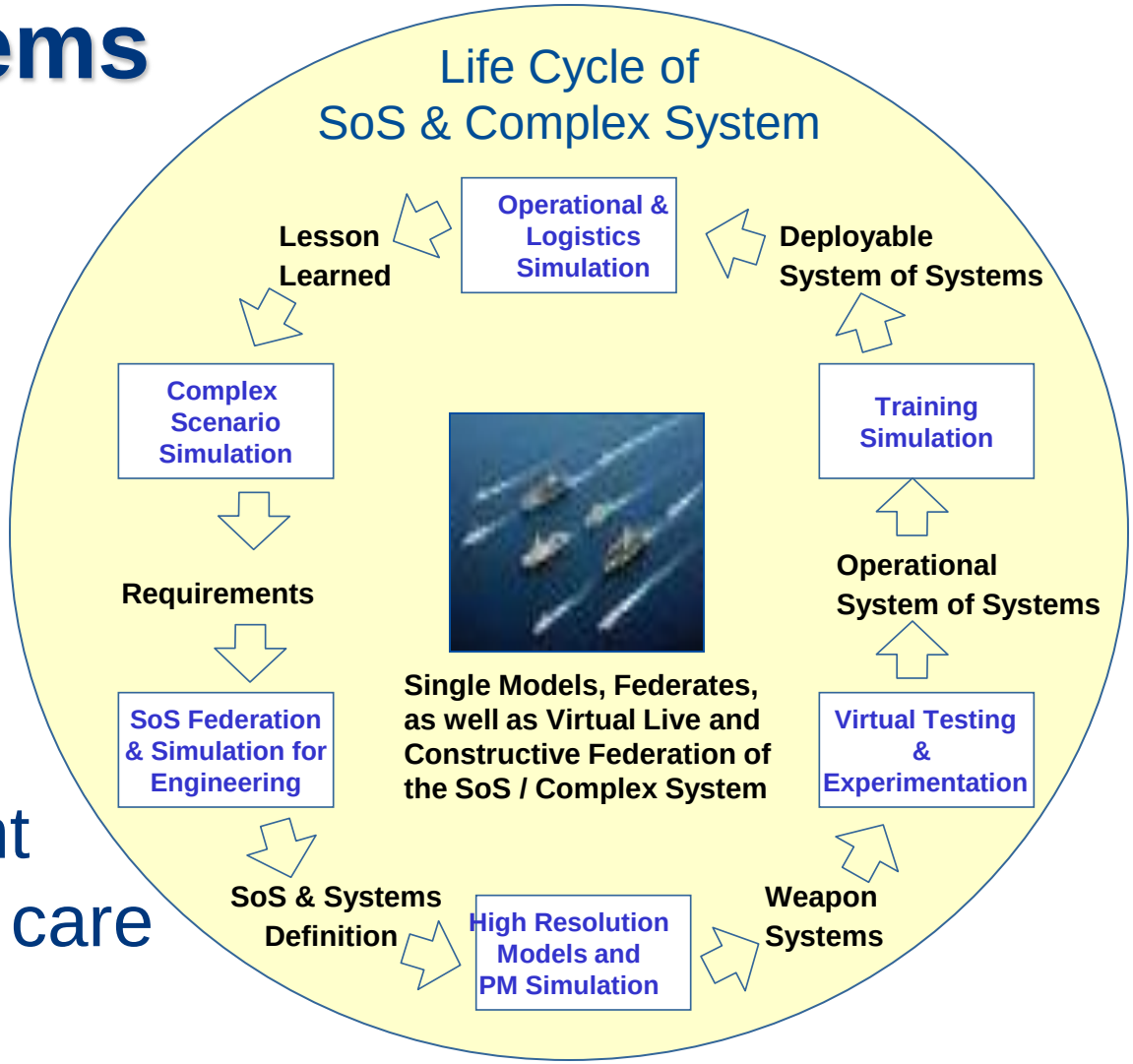


Strong need to combine Social and Technical Networks

Simulation, SoS and Complex Systems

To support the whole Life Cycle of a System of Systems we need simulators able to federate the different aspects and to take care of Humans



2 Worlds / 2 Speeds

The crisis pointed out by Media is very relative in terms of Geographic & Temporal Coordinates for Instance:

- **Automotive Vehicles: +5% in Europe (~12.1 MVehicles), +6% in USA (~16.4 MVehicles), +12% in China (~18.3 Mvehicles) in 2014**
- **Shipbuilding:**
  Europe from 8% of World Market to 3% (-60%) in 10 years
  2011: 200 Ship in Construction just in Shanghai Area

GDP 2013:

China	7.4%	Italy	0.1%	Germany	0.5%
USA	1.6%	Qatar	5.5%	Indonesia	5.3%
Russia	1.3%	Angola	5.6%	Nigeria	6.5%
India	5.7%	Iraq	4.2%		
Brazil	2.5%	Chile	4.9%		
Vietnam	5.3%	Malaysia	4.4%		
World	4.0%				

Commercial Vehicle Production 2008-2012

Rk	Country	Δ Vehicles	[%]
1	USA	1,306,131	27%
2	China	1,186,715	46%
3	Canada	536,629	61%
4	Thailand	532,987	54%
5	India	373,421	77%
6	Mexico	241,481	25%
7	Indonesia	152,851	90%
8	Argentina	69,269	35%
9	Brazil	48,666	7%
10	Iran	30,550	28%
11	South Africa	22,710	9%

Car Production 2008-2012

Rk	Country	Δ Cars	[%]
1	China	8,785,913	130%
2	India	1,439,445	78%
3	South Korea	716,611	21%
4	Mexico	592,549	49%
5	Thailand	556,314	139%
6	Russia	499,360	34%
7	USA	329,212	9%
8	Slovakia	324,224	56%
9	Indonesia	312,078	72%
10	Czech Rep.	237,728	25%
11	Taiwan	139,329	100%
12	Argentina	98,140	25%
13	Romania	95,500	41%
14	Brazil	77,975	3%
15	Others	62,016	17%
16	Malaysia	25,888	5%
17	UK	18,287	1%
18	Serbia	409	4%
19	Austria	-1,836	-1%
20	Finland	-14,619	-83%
21	Portugal	-16,507	-12%
22	Netherlands	-31,223	-53%
23	Egypt	-35,605	-49%
24	Turkey	-44,907	-7%
25	South Africa	-46,251	-14%
26	Uzbekistan	-50,058	-26%
27	Slovenia	-53,397	-30%
28	Sweden	-89,473	-35%
29	Iran	-92,870	-10%
30	Australia	-107,110	-38%
31	Hungary	-126,919	-37%
32	Germany	-143,574	-3%
33	Canada	-155,136	-13%
34	Belgium	-172,927	-25%
35	Italy	-262,404	-40%
36	Poland	-302,000	-36%
37	Ukraine	-331,112	-83%
38	Spain	-403,369	-21%
39	France	-463,121	-22%
40	Japan	-1,373,924	-14%
	Total	**10,343,424**	**20%**

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India	5.6%	Iraq	- 0.5%	S.Leone	8.0%
Brazil	0.3%	Chile	2.0%	S.Sudan	-12.1%
Vietnam	5.5%	Malaysia	5.9%	Ethiopia	8.2%
World	3.4%			Turkmenistan	10.1%
				Congo	8.6%

Università di Genova

Commercial Vehicle Production 2008-2012

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	Total	**10,343,424**	**20%**

Logistics as *Periodic* Source of Risks and Opportunities

The Logistics exploded during the last 20 years due to globalization, therefore due to the market evolution this situation is characterized by periodic behaviors with very challenges oscillations, where M&S could support decision making:

Dry Bulk (Cape Ship) Rates along

~10 kUSD/Day 2006
>100 kUSD/Day 2007
~4 kUSD/Day 2008
5-60 kUSD/Day 2010

Shipping Containers Europe to China

from - 2'000 Euro/TEU
to + 20 USD/TEU

Humans & Globalization

Workers, Employers, Engineers & Managers are people and subjected to the world market evolution; therefore the capability to move and reorganize effectively such realities could get big benefits from modeling & simulation

Plant Engineering Prices

Italy	20-30 Euro/hour
Brazil	15-20 Euro/hour
India	5-10 Euro/hour

Industrial Plant Engineering Sector 2011

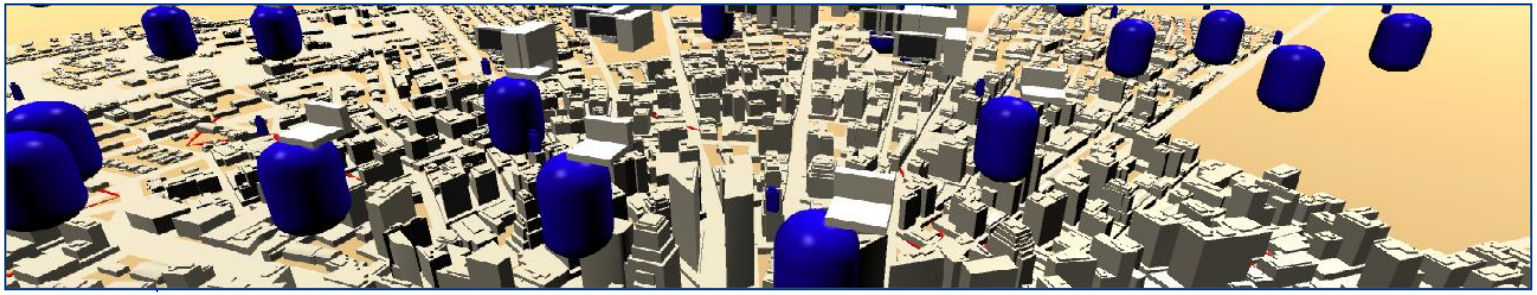
Ship Construction Yard Workers

Italy	2’500 Euro/Month
China	350 USD/Month
Korea	500 USD/Month
Philippines	400 USD/Month

Ship Industry 2011

Trandisciplinary Modeling

The number of complex problems facing engineers has increased, and the technical knowledge required to address and mitigate them continues to evolve rapidly. These problems include not only the design of engineering systems with numerous components and subsystems, but also the design, redesign, and interaction of social, political, managerial, commercial, biological, medical, and other systems. These systems are likely to be dynamic and adaptive in nature. Finding creative solutions to such large-scale, unstructured problems requires activities that cut across traditional disciplinary boundaries.



Multicultural vs. Trans-Disciplinary

Modern Industrial Solution strongly rely on multiple disciplines.

Therefore it is critical move *from Mulicultural* teams involving several different backgrounds just talking each other

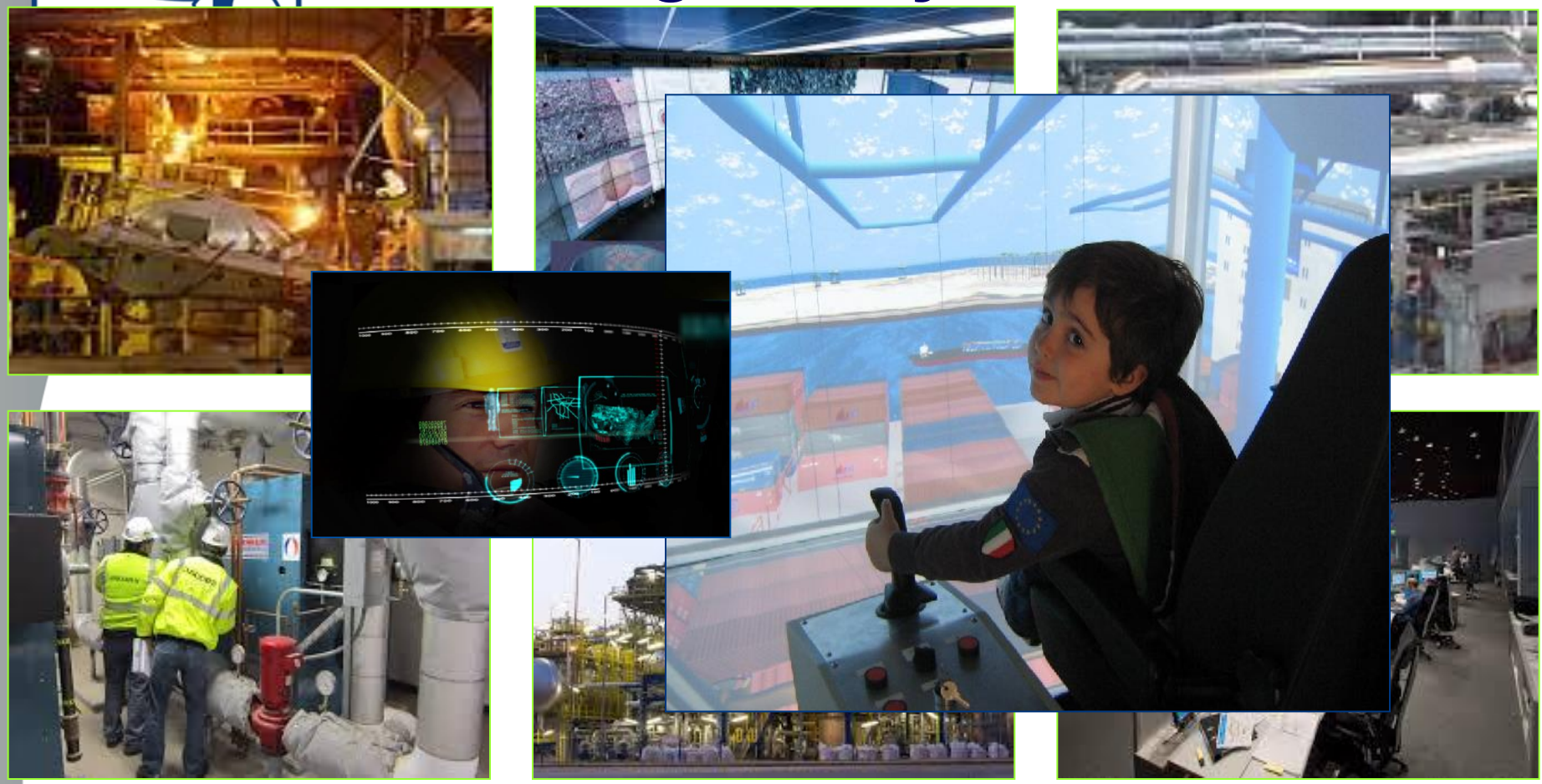
to Tans-disciplinary team having the people and skills *interoperating* effectively

Transdisciplinary vs. Multidisciplinary Approach

Modern projects require to combine different backgrounds from technical to managerial. Therefore it is critical to avoid multidisciplinary teams that are just a mix of different professionists unable to understand each other and to share common concepts.
It is crucial to create transdisciplinary team with common language and capability to to interoperate effectively in the development of new projects over common goals.

Simulation Team

Looking Really for M&S? Yes!



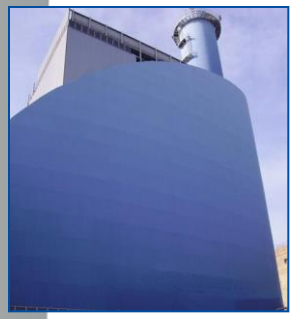
… but you should be… smart… flexible… quick… solid… relying on SME… professional… reliable… etc.

Intellectual Capital for Future of Engineering

Jack Welch (GE CEO 1981-2001 **from $14 billions market value to over $410 billions): Globalization has changed us into a company that searches the world, not just to sell or to source, but to find Intellectual Capital: the World's Best Talents and Greatest Ideas**








Scientists investigate that which already is; Engineers create that which has never been
Albert Einstein, Physics Nobel Price 1921

Human Capital is becoming Even more Important

Engineering is providing an unique opportunity to improve the Capabilities of M&S by Young highly qualified people: Scientists, Researchers, Technicians and Engineers

Complexity evolve along the Life Cycle

A Product, or System, *Life Cycle* is the cycle through which it goes through from its initial introduction to the withdrawal or eventual demis and includes among others:

Requirements Definition ***System Definition***

Development ***Commissioning***

Production ***Deployment***

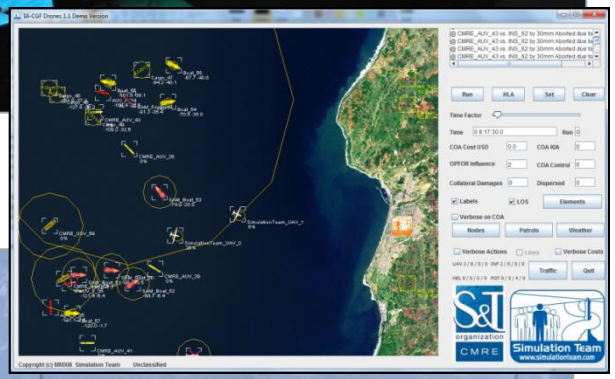
Operation & Service ***Decommissioning***

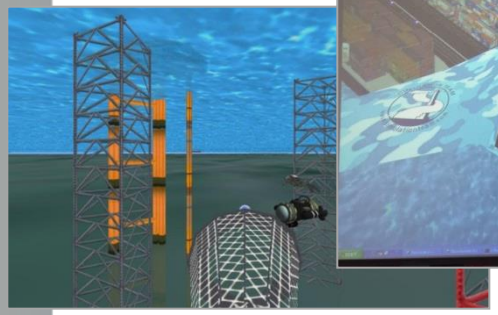
M&S and Experimentation

Simulation allows testing new standardized **components** without committing resources for their acquisition.

M&S explores and compares many options related to different **operating procedures** reducing risk and saving time and costs with respect to experimentation the real world context.

Combining heterogeneous systems and remote human controllers is another important issue due to the implications on aspects such as engineering, use modes and training.

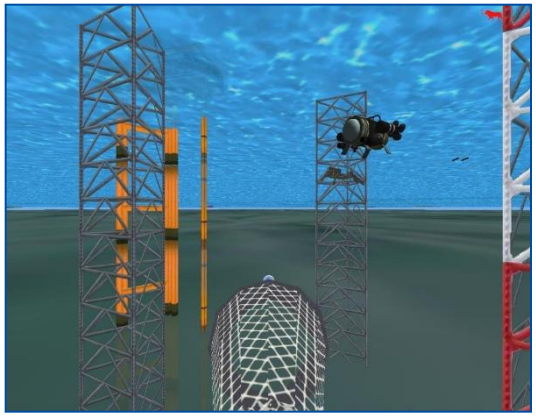


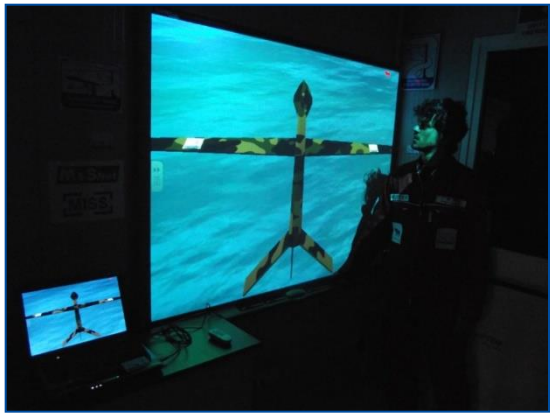


Interoperability to combine Real and Virtual Systems

Many cooperative AxS Solutions are usually based on hypothesis and equipment that are still under development as well as on requirements that are still evolving. Interoperable Simulation allows to anticipating experimentation using Real Systems and Components (e.g. HW/SW) as well as new Virtual Solutions.

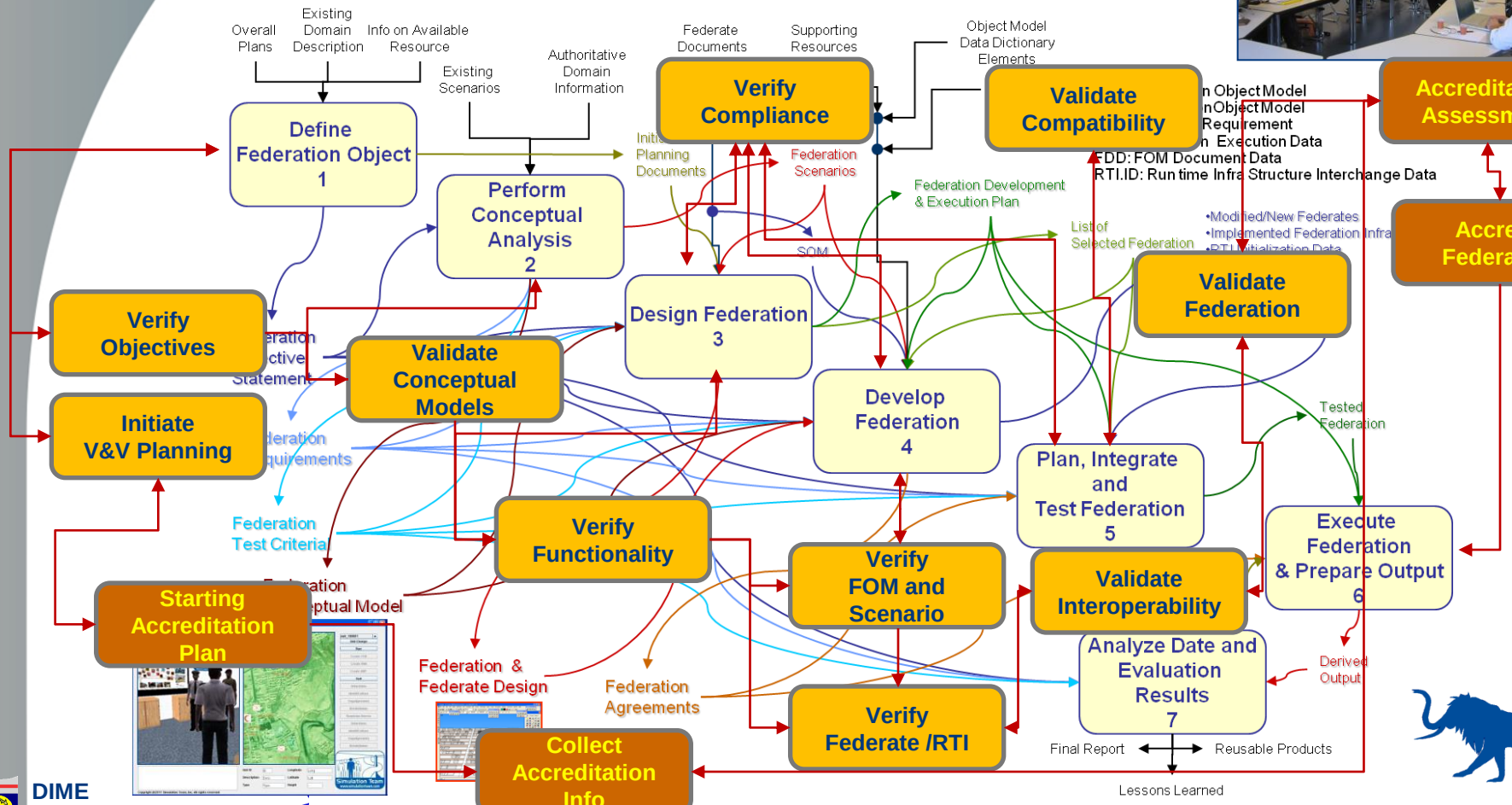
This approach guarantee to identify critical elements within an interactive immersive environments, to check operational limitation of existing real equipment, hardware and software respect new components and solutions available just as models.





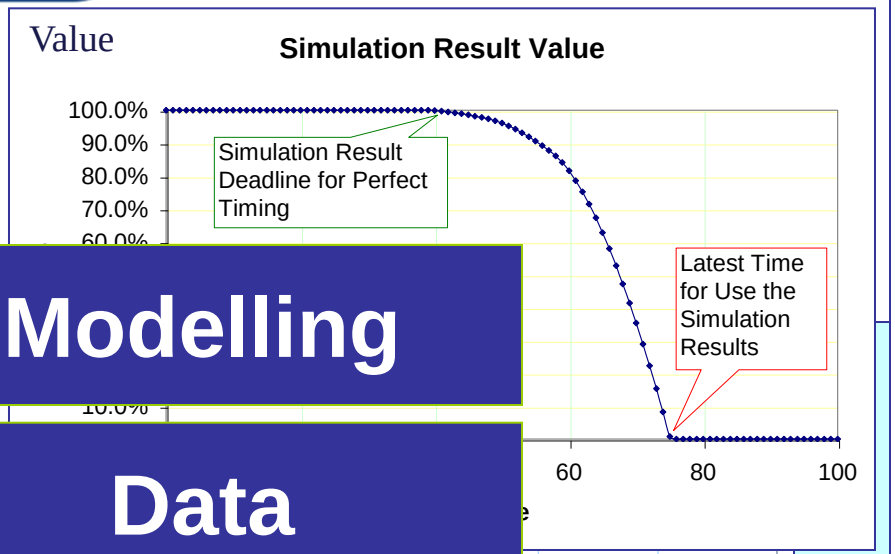
Simulation Team

Simulation Development: VV&A…



Simulation Team

Simulator Development Needs



Modelling

Data

Implementation

Validation

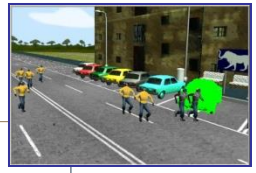
Budget Planning Limitation

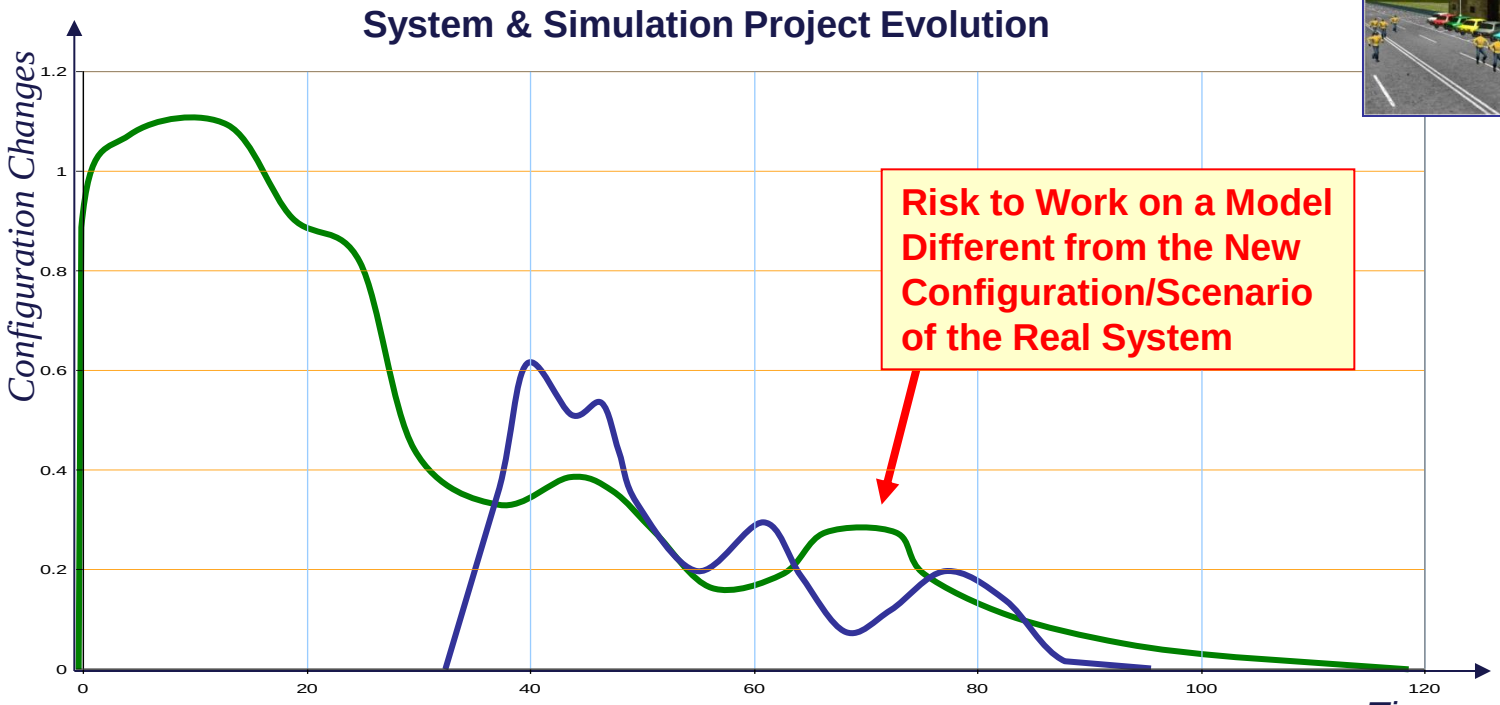
Length of Development Cycle

Communication during Development Cycle

Development Process

System Configuration Dynamics

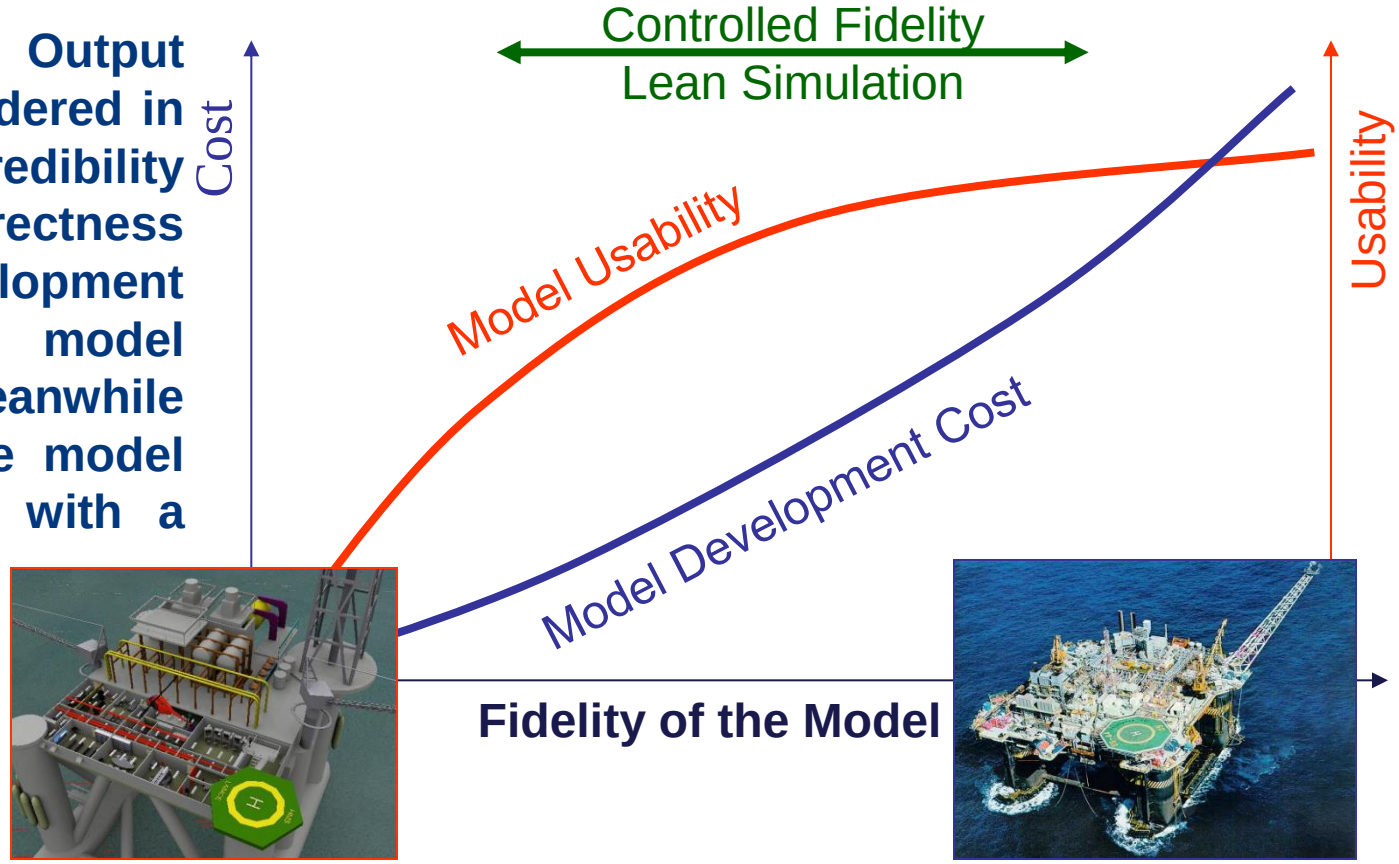




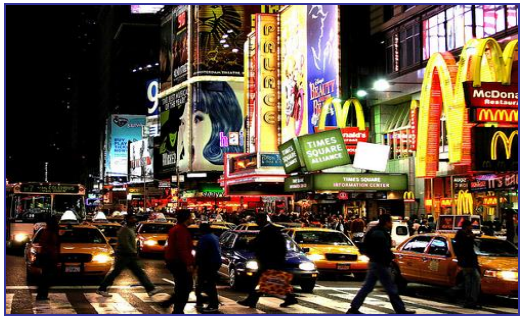
i.e. Human Behavior Analysis introduces Drastic Changes in the Model Infrastructure

Usability vs. Fidelity in M&S

A model Output could be considered in relation to a credibility level. If correctness grows, development cost of the model grows; meanwhile usability of the model increases, but with a non-linear, and usually at decreasing, rate.



Boundaries and Constraints



This new Generation Simulations have to face big challenges

Challenges in Country Modelling & Interoperable Simulation Opportunities

Multi Resolution High Efficiency Simulation

System Size

Large Systems

City/ Country

Simple Systems

Complex Systems

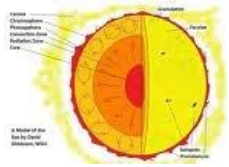
System Complexity

Simulation

Modeling Multiple Interoperable Layers

What are Validation and Verification?

- Validation is the process of determining whether the conceptual model is an accurate representation of the actual system being analyzed. Validation deals with building the right model.
- Verification is the process of determining whether a simulation computer program works as intended (i.e., debugging the computer program). Verification deals with building the model right.



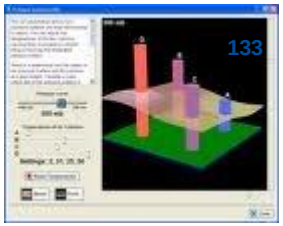
Validation

Conceptual Model

Validation

Simulation Program

Verification



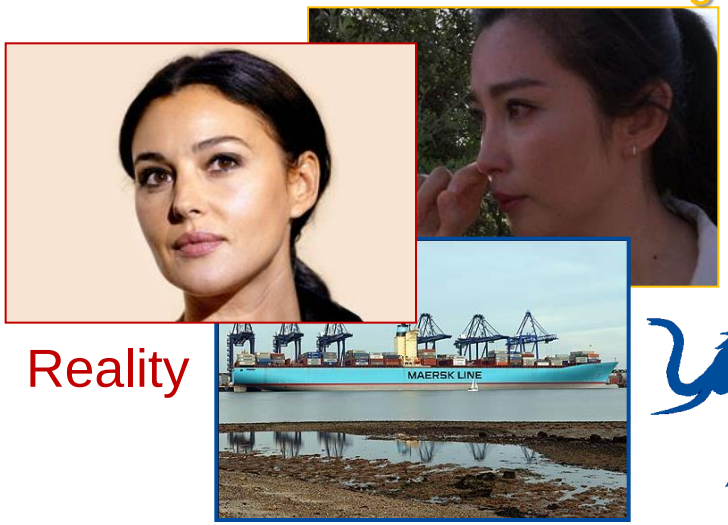
VV&A & HBM Criticality

Respect traditional Software Projects, Simulation requires to create a realistic solution and not just a running program. This requires to conduct multiple Validation and Verification activities and to support the accreditation process

Monica Bellucci

Fan Bingbing

Simulation



Reality

Emma Maersk

Human Modeling Challenges

- RATIONAL DECISION MAKING
  - Intelligent Individual Behavior
  - Organization & Hierarchies
  - Altered Perception
- INSTINCTIVE & EMOTIONAL
  - Emotions & Psychology
  - Socio-Cultural
  - Crowd Behavior

Human Modeling Challenges

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- INSTINCTIVE & EMOTIONAL
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  - Socio-Cultural
  - Crowd Behavior

Simulation Team

Man on the Loop vs. Man in the Loop

Driving Drones

Single Unit Control

Low Level Orders

Acting in Coordinate Mode

De Conflicting Actions

Direct Engagement

Leading Role

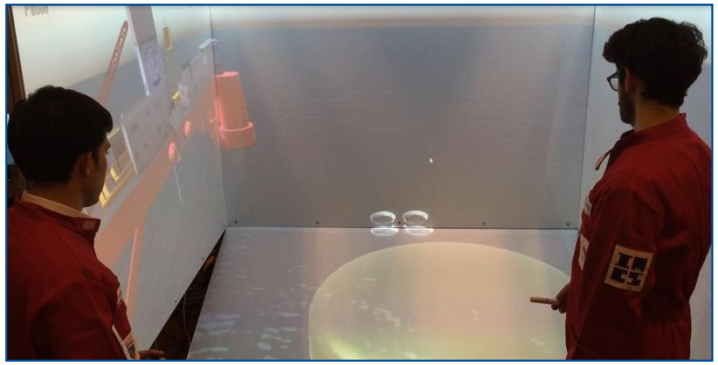
High Level Orders

Responsibilities

Assign Tasks

Assign Goals

Enabling Engagement

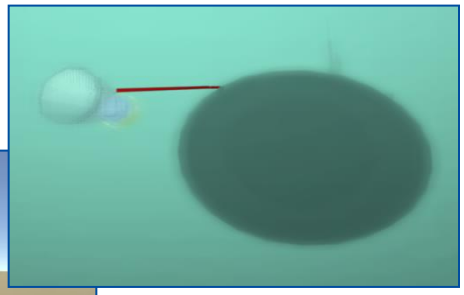


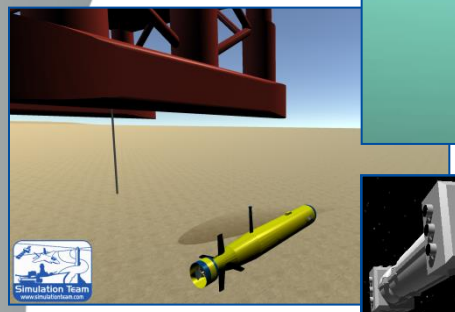
Humans could assign tasks, missions, high level orders and supervise the whole scenario involving AxS collaborative activities. Different solutions need to be to developed with alternative interface solutions (e.g. an immersive interactive cave composed by an interactive whiteboard in a cube solution)

Man-machine interfaces for collaborative work need to be taken into account in order to improve immersive capabilities

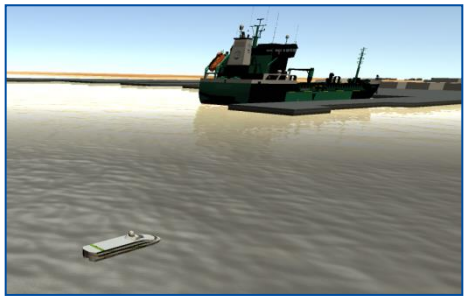
Multi Domain Environments

Underwater

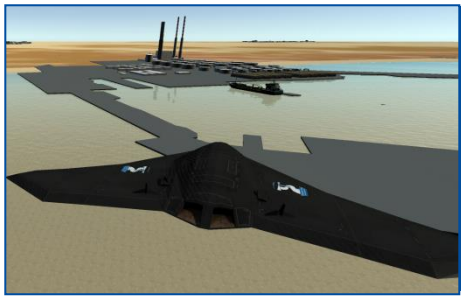




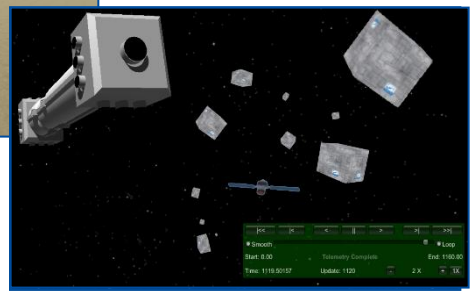
Surface



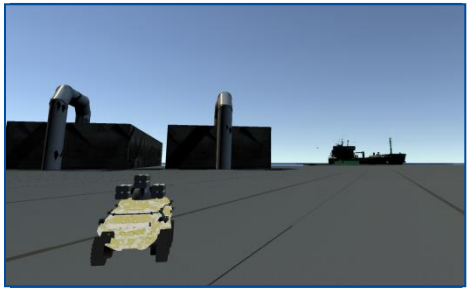
Air



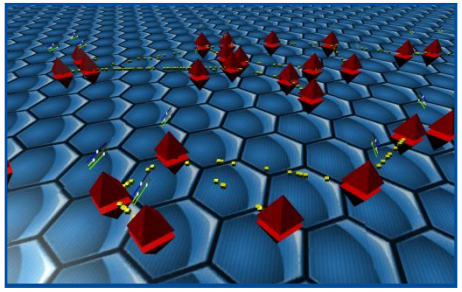
Space



Coast



Cyberspace

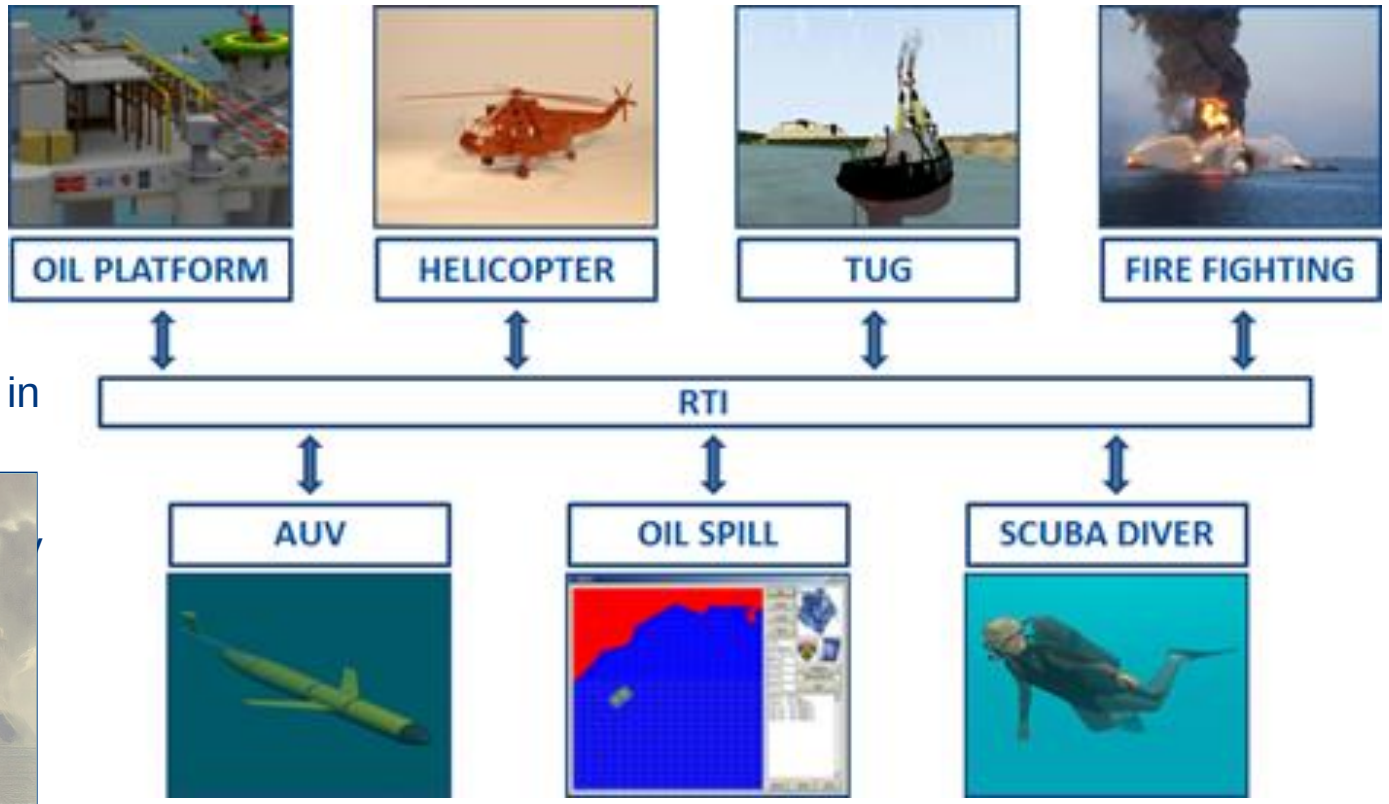


Modeling the different domains is a critical issue to evaluate the impact on the operations and the introduction of Solutions covering the whole Spectrum

Interoperable Simulation to Address Real Challenges

All these Models were available, therefore no joint simulation was existing to address Deep Horizon Crisis in Mexican Gulf

The Criticalities in Safety and Security is related to the Interoperation among Systems!



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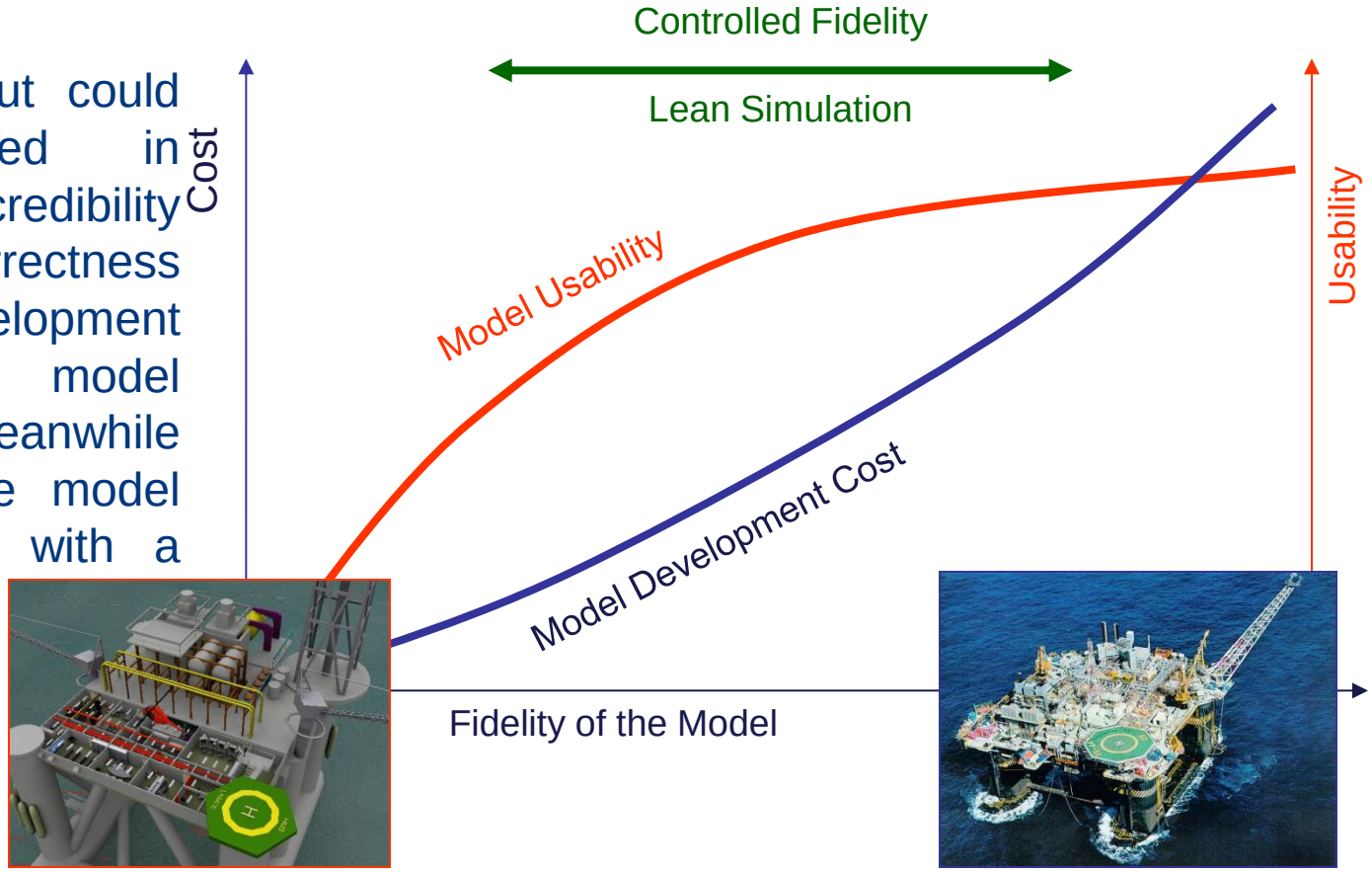


Simulation Team

Why putting Virtual & Augment Reality Everywhere?

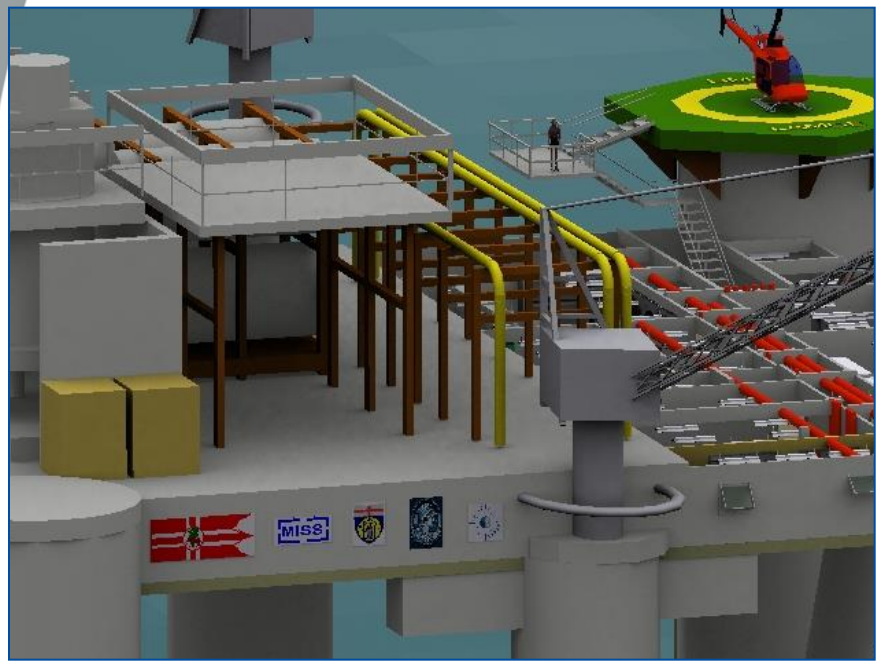
Today technology is available for improving Efficiency through Virtual Environments, Augmented Reality & Phenomena Simulation the decision process so we need to use it for developing :

- **New Operational Supports**
- **New Training Solutions**

Operational Drivers….

From Modeling Oil Platforms for Helicopter Landing, Operator Training, Crew Coordination

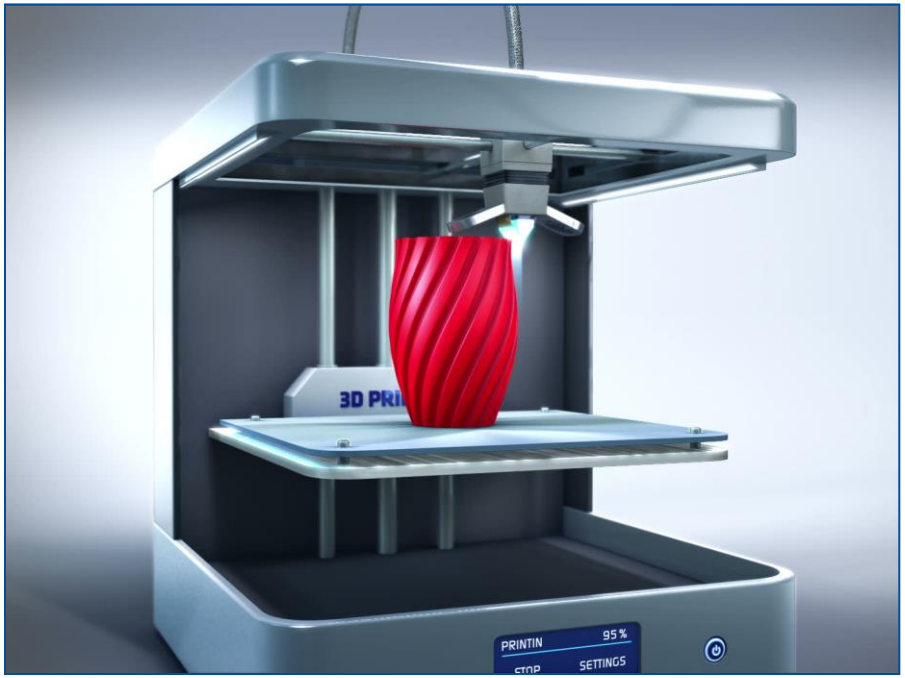
forward to Eco-Mega-Crisis Management



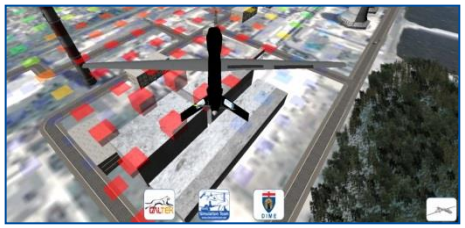
… Technology Enablers

Traditional progressive improvements on systems is sometime going into cul-de-sac

but new approaches arise from new technologies

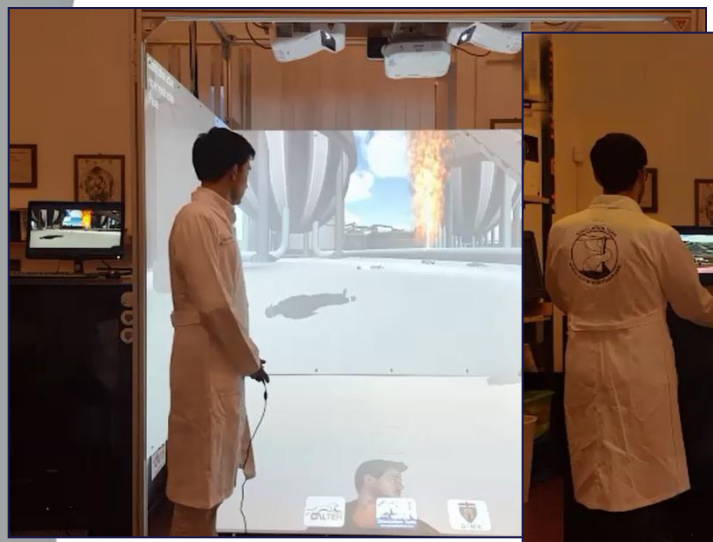


Simulation Team



MS2G and IA-CGF

The innovative concept of MS2G (Modeling, interoperable Simulation and Serious Games) allows to develop interoperable scalable and reusable simulators with benefits of new immersive & engaging solutions. This aspect combined with the use of the IA-CGF (Intelligent Agent Computer Generated Forces) allows to automate many actions and generating complex scenarios (e.g. T-REX)

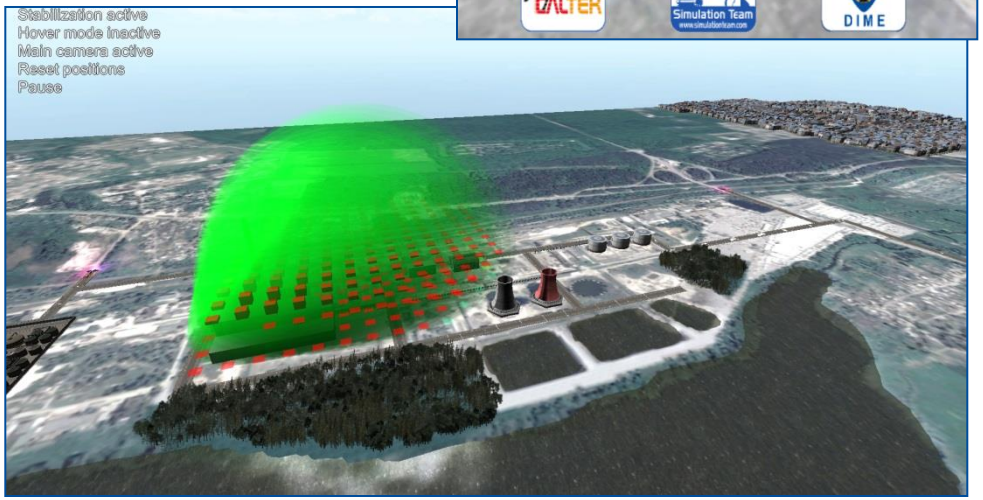


Simulation Team

UAV inside a Contaminated Plant

The proposed scenario focuses on UAV used to access a contaminated area within a Plant by flying outdoor and indoor in order to address several tasks:

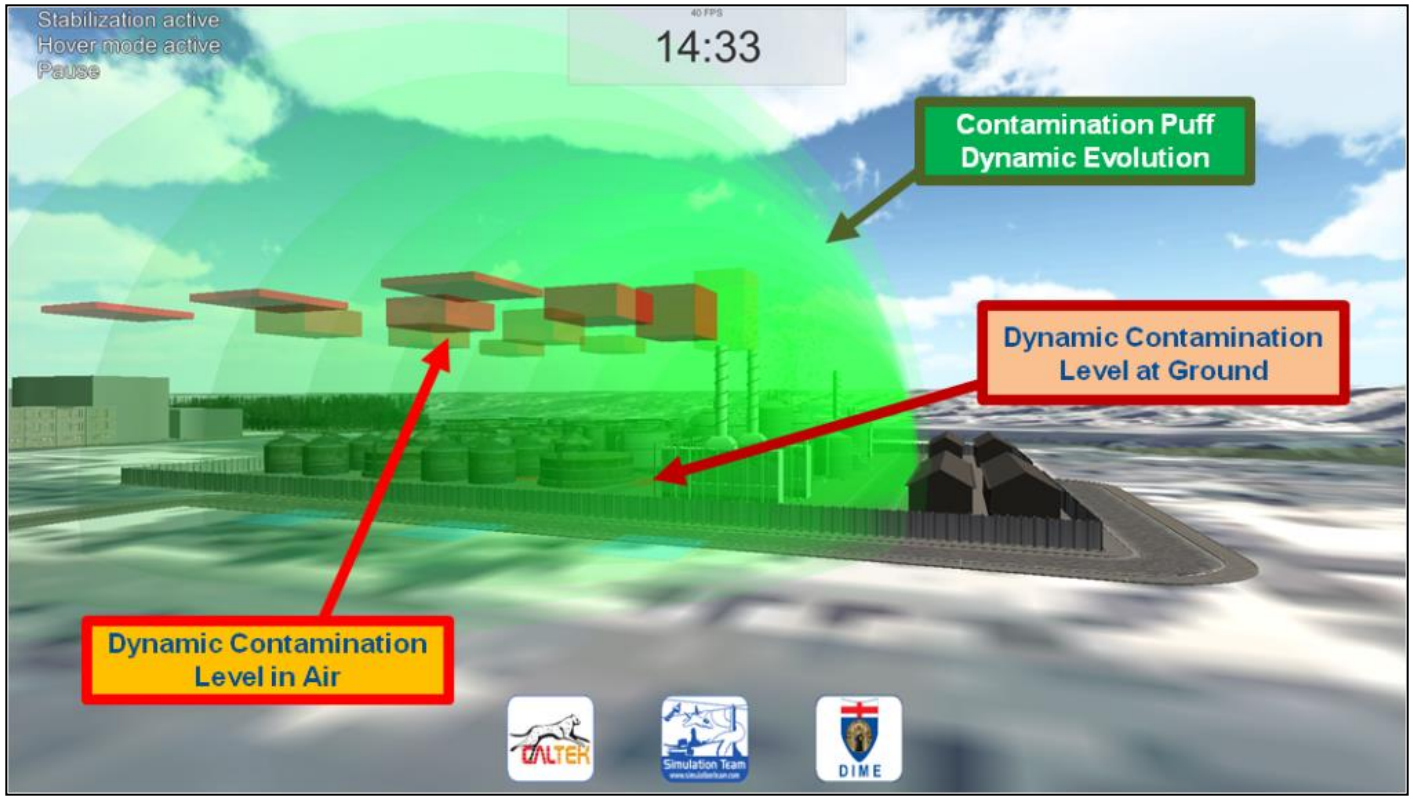
- Situation Assessment and Monitoring of the Plant Acc
  - Continuous Measurements
  - Sample Collections
  - Visual Inspection
- Operations & Supervision Roles:
  - Rescue and Triage Operations
  - Confinement through Limit Areas
  - Securing the Area
  - Clean Up Procedures



IDRASS Presenting the Results

IDRASS includes an augmented dynamic representation of the Situation

This Augmented representation proposed presents the situation by highlighting the contamination levels at air and soil.
This well as to support the trainees during early training phase,
To check consistency of achieved results as well as during Educational sessions



Simulation Team

M&S and E&T

During an emergency situation the capability of the UAV pilots to accomplish the task quickly and effectively is a primary key; this implies forr instance an high attention on the quality of the training for the pilot

In addition, the Pilots need to be coordinated with other operators and first responders and to act in strict synergy.

<u>It is evident the necessity to develop effective E&T Programs and Solutions</u>

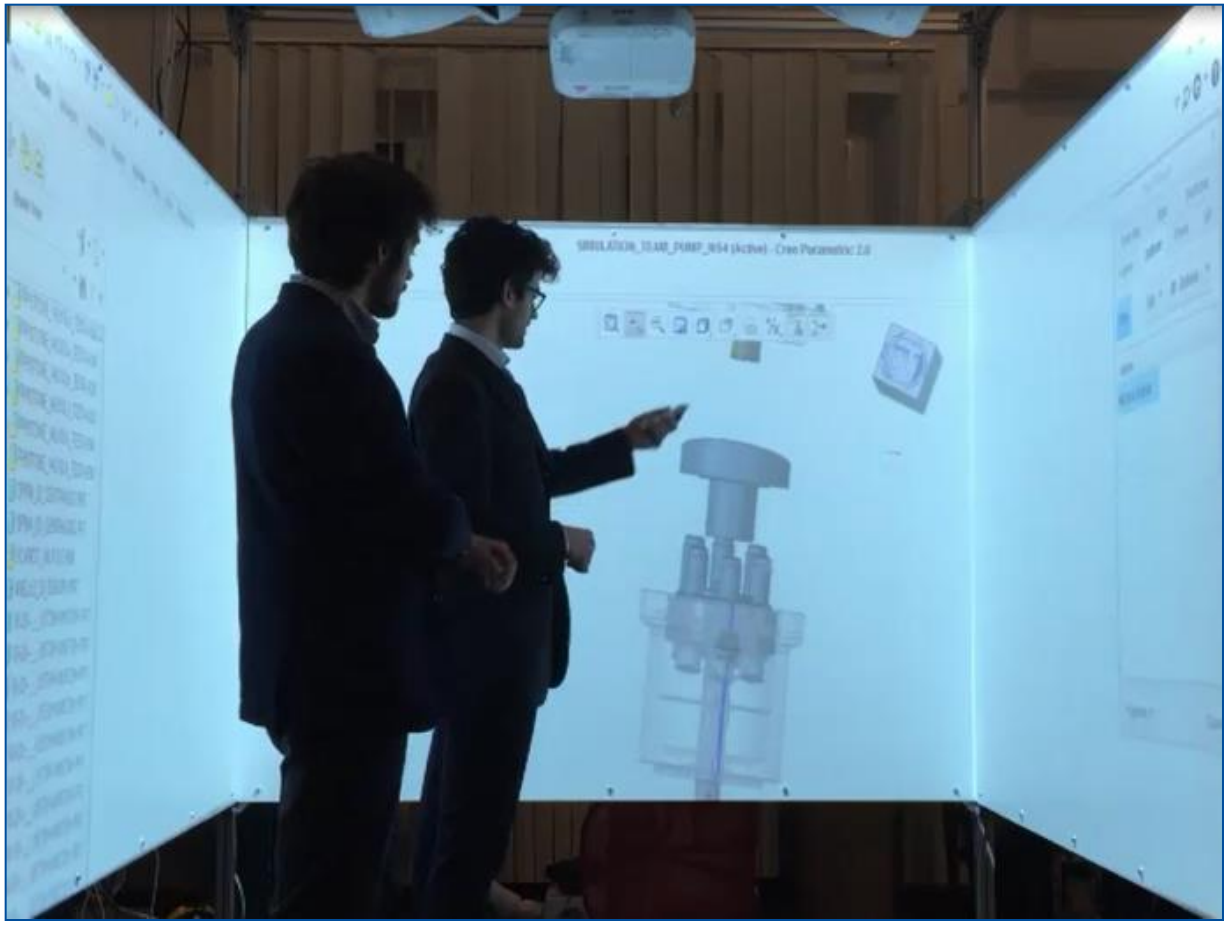
The proposed scenario involve an Industrial Plant where a Disaster is newly occurred. The ability of the pilot is measured by the system and several variables and constraints are implemented (such as small spaces and barriers to overcome, battery durations, risk of damages due to high temperatures zones, wind, etc.) to provide a realistic training scenario

Testing & Experimentation

- IDRASS is able to run with different drone configurations as well as versus different kind of accidents and by combining in the Federation detailed models as well simplified meta models
- This flexible approach enabling use of different models supports the possibility to analyze, verify and validate different hypotheses and also to present different solutions and operational modes
- The use of the scenario by SME is used to support the VV&A during its dynamic phase

Collaborative Remote Supervision & Service

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



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

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.

Previous Project Examples: 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 two interoperable demonstrators:

- LOCARS: Logistics Crane Simulator
- FEBO: Federation of Boats

Future Use and Innovative Interface

The architecture is designed to incorporate future technologies for continuous development.

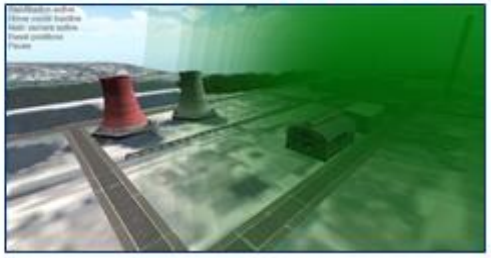
This R&D addresses especially:

- Monitoring & Tracking
- Remote Test & Troubleshooting
- Supervision
- Remote Service Support
- Mobile Service Support
- Availability Improvements
- Reduction or Losses Robberies and Misuse

Simulation Team

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.

Simulation Team

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.

Simulation Team

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.

Simulation Team

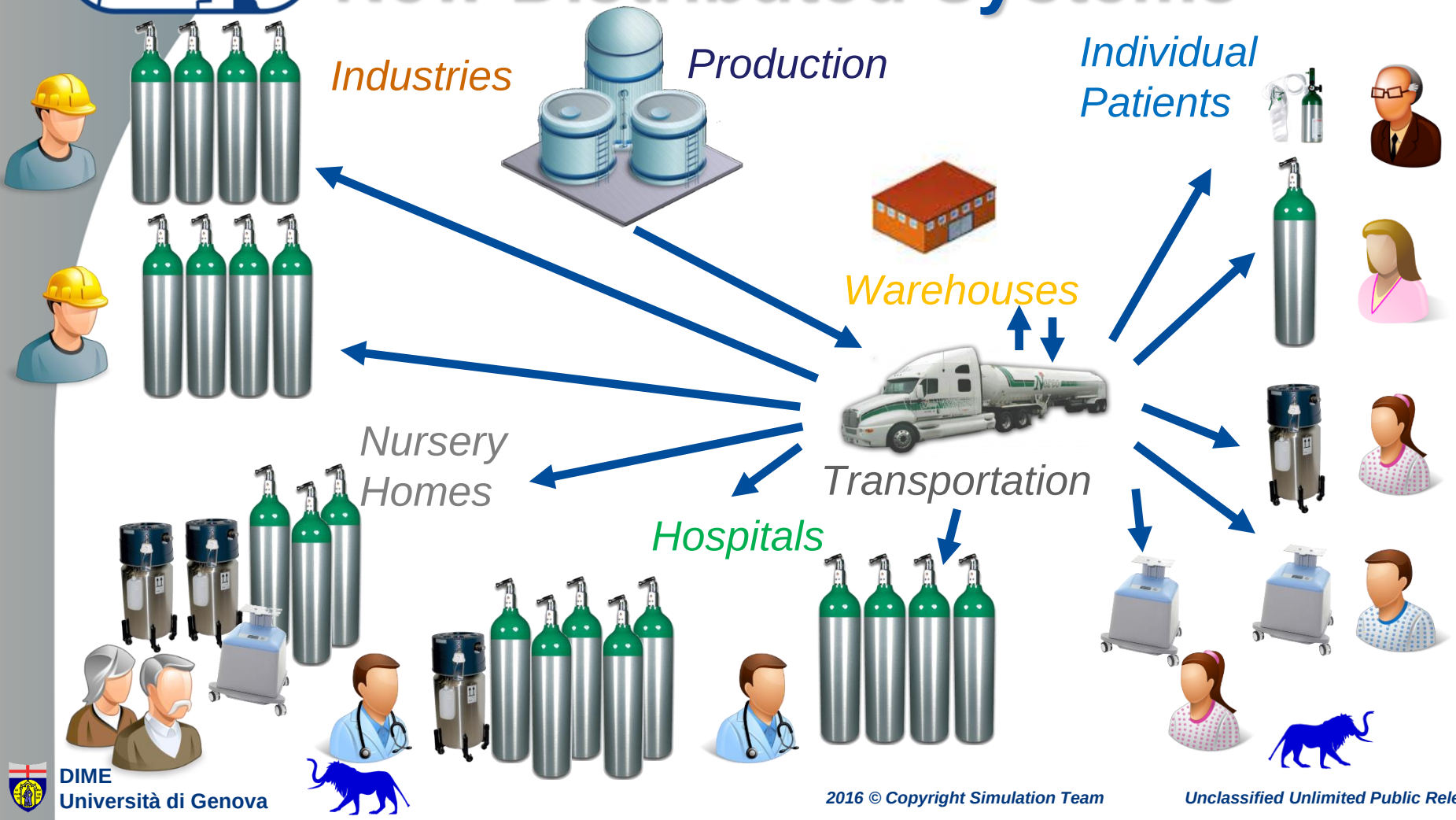
AR & VR for Autonomous System Maintenance

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*

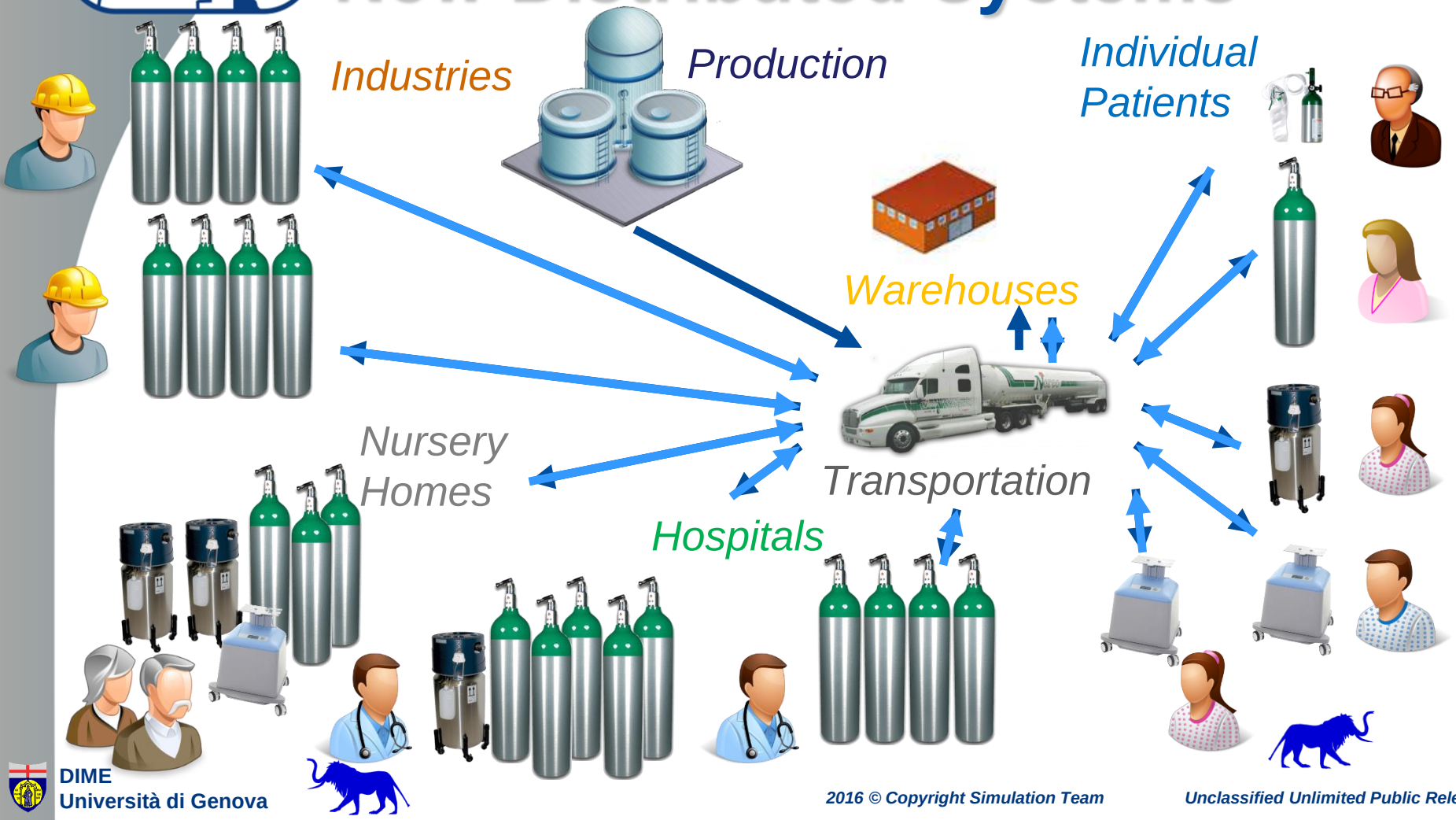
Simulation Team

Distributed Assets & IoT: New Distributed Systems



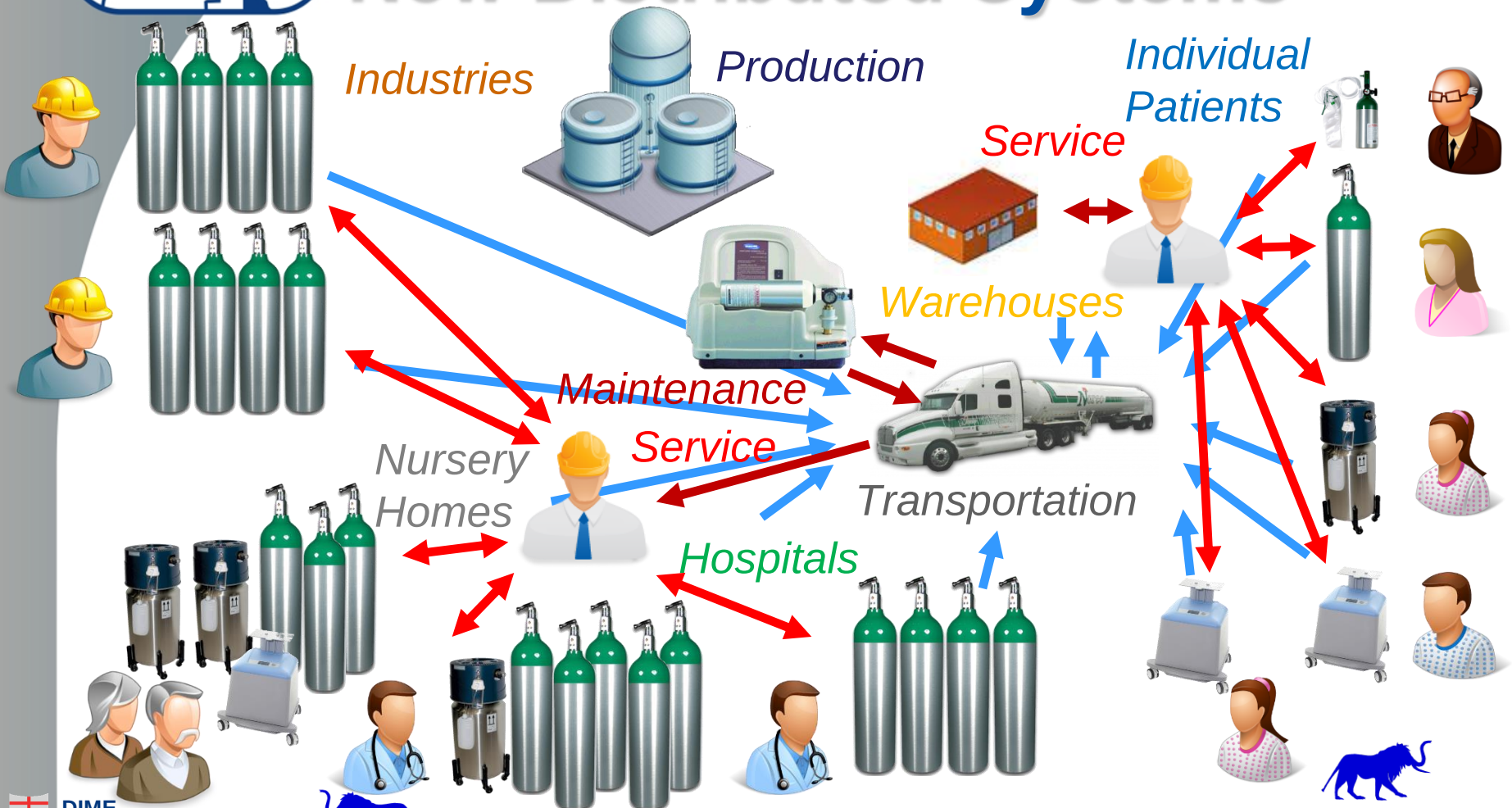
Simulation Team

Distributed Assets & IoT: New Distributed Systems



Simulation Team

Distributed Assets & IoT: New Distributed Systems



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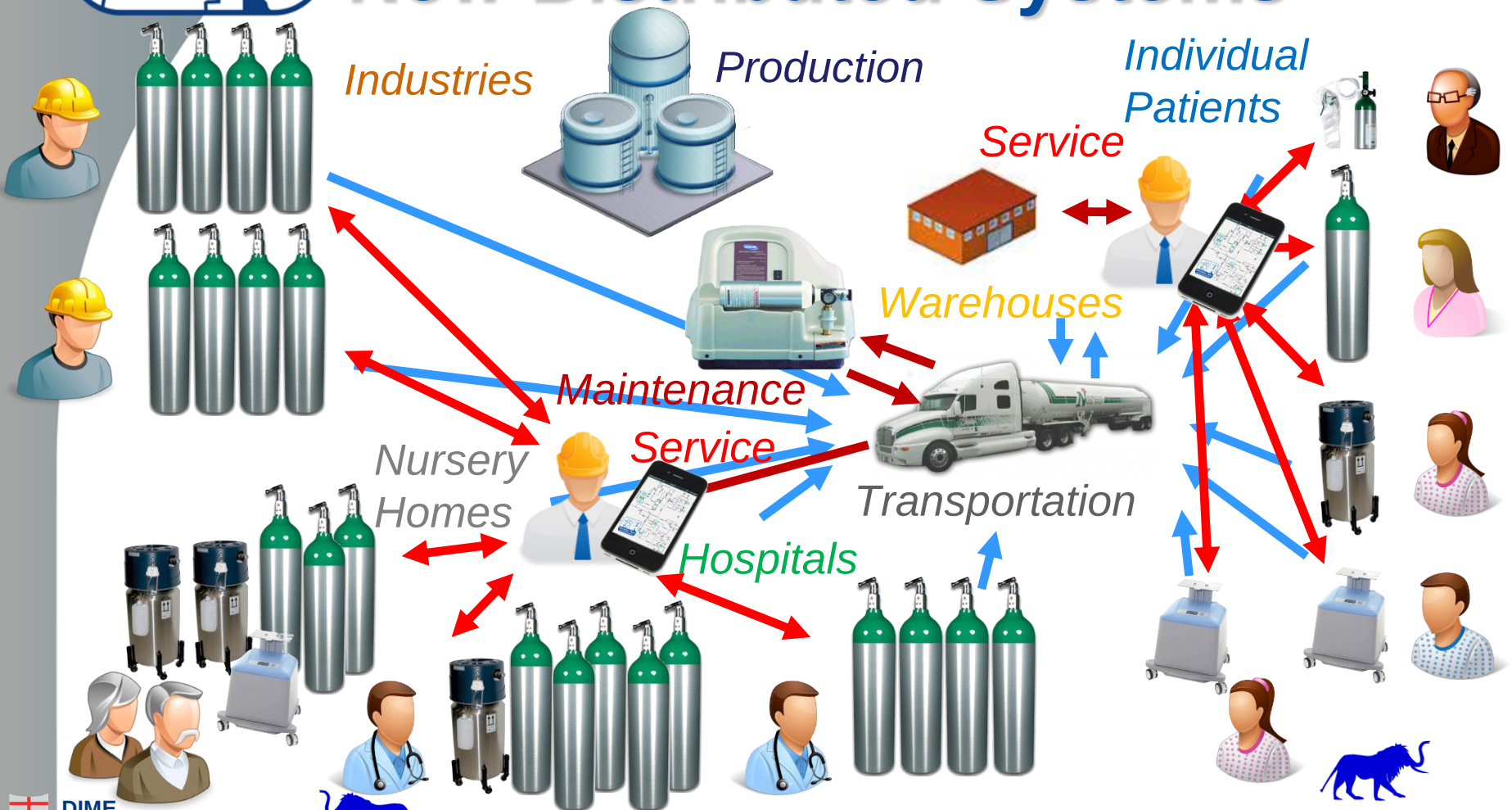

Simulation Team

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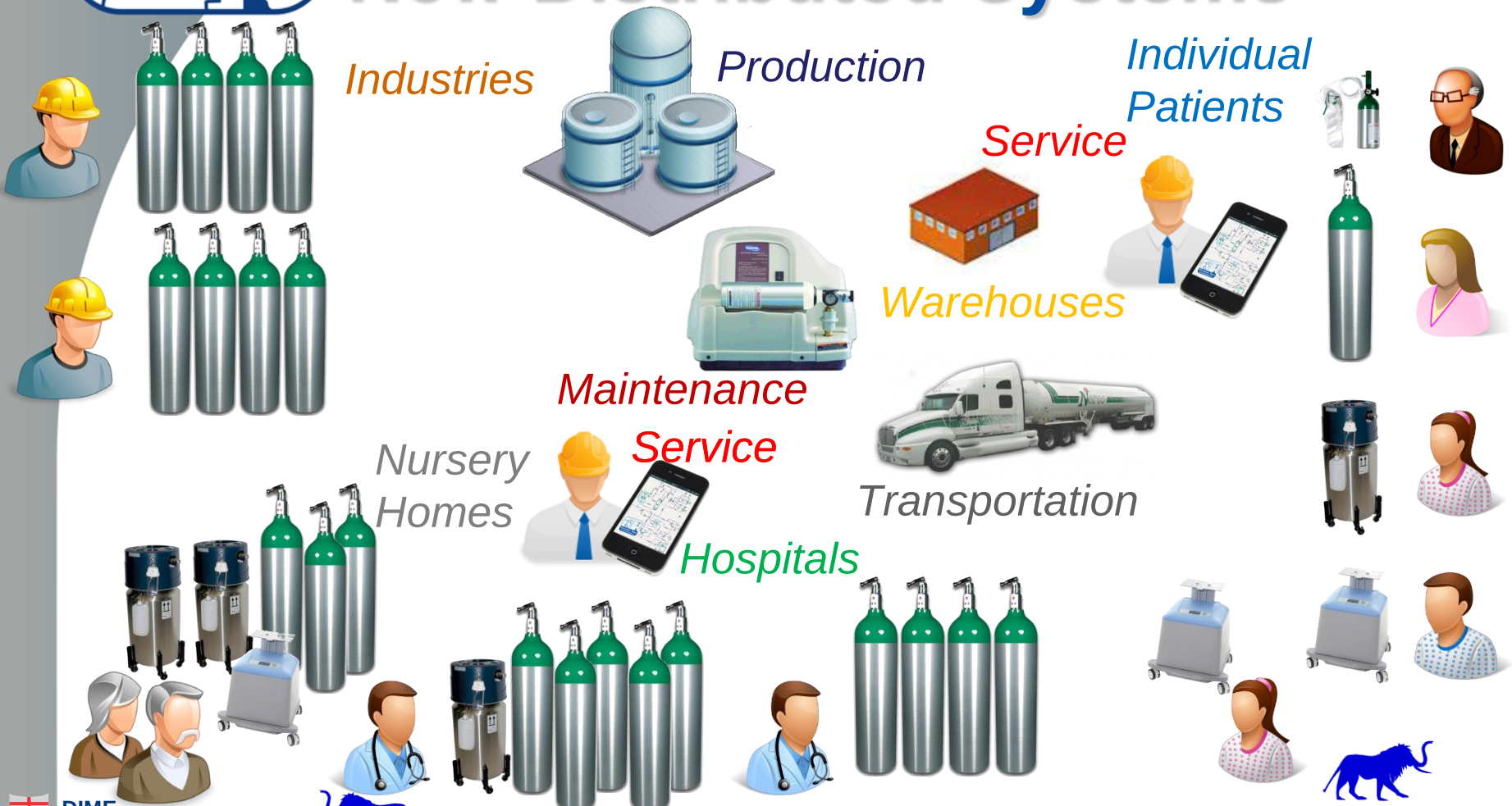
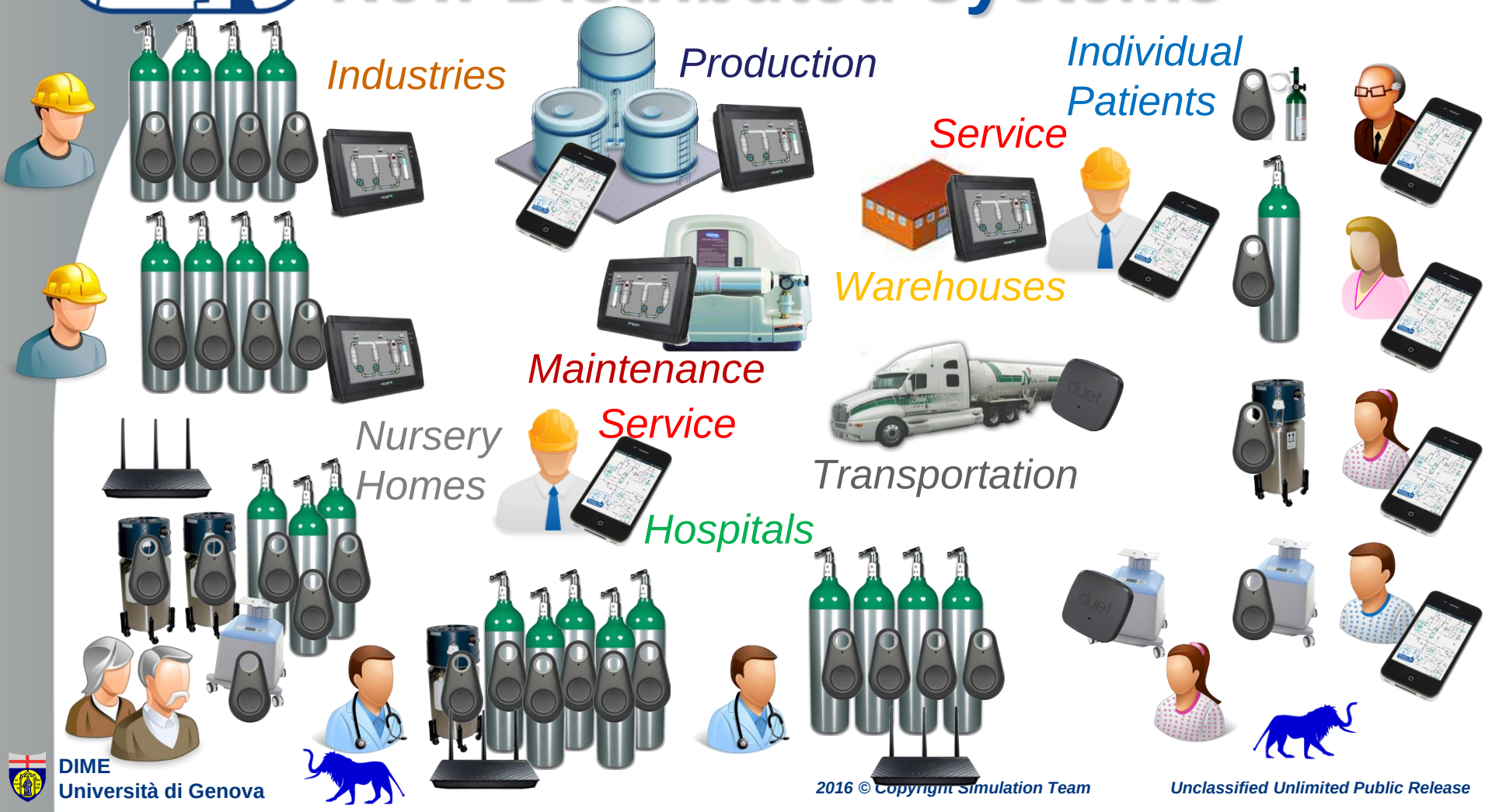
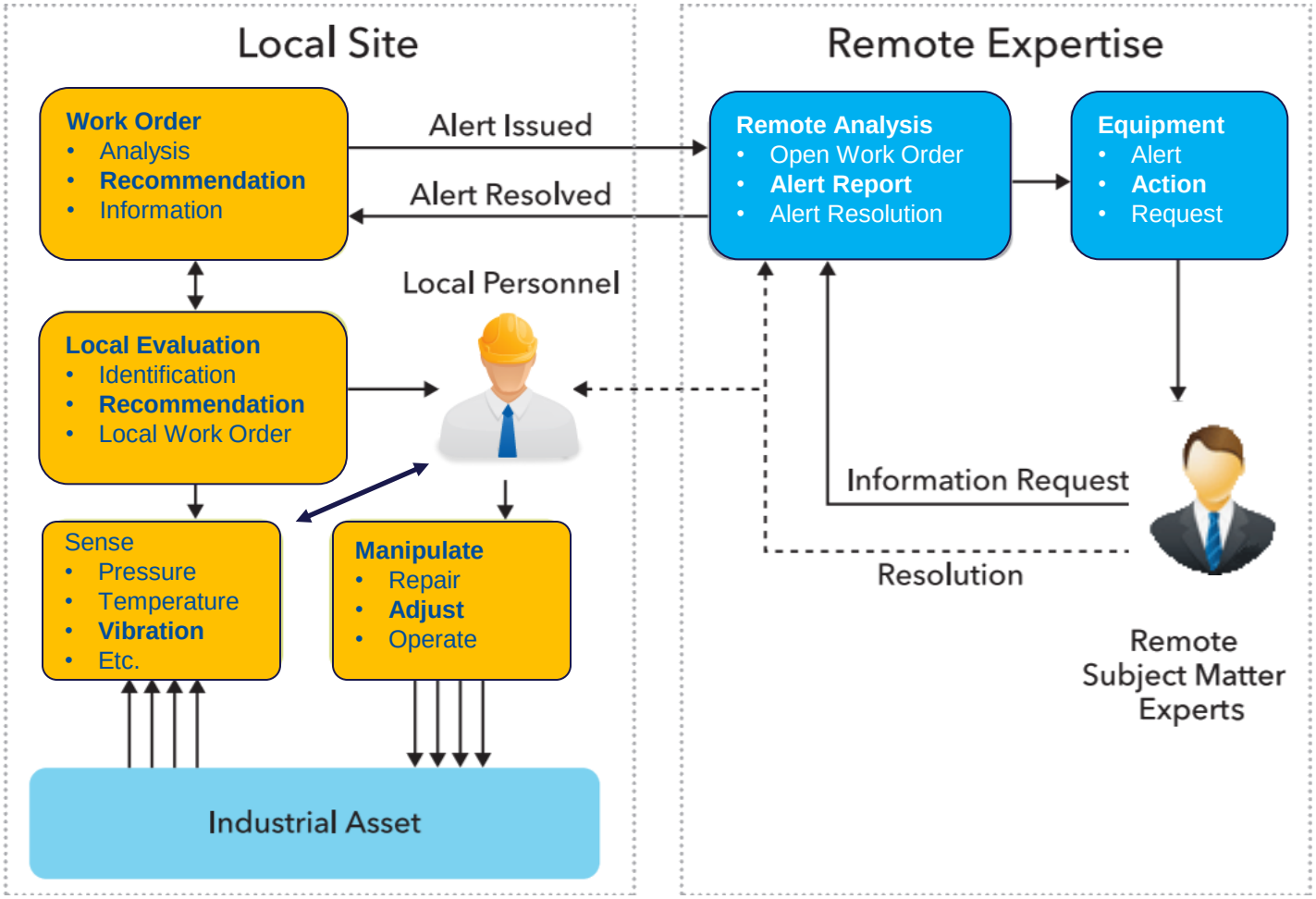


Simulation Team

Distributed Assets & IoT: New Distributed Systems



Example of Architecture



Simulation Team

Example of Architecture

Local Site

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

Alert Issued

Alert Resolved

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

Local Personnel

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

Manipulate
- Repair
- **Adjust**
- Operate

Industrial Asset

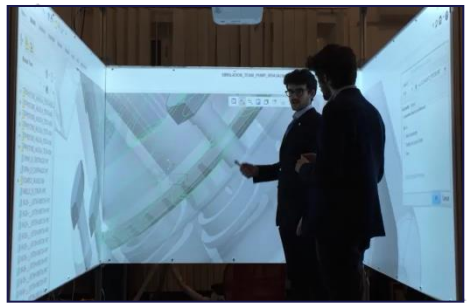
Remote Expertise

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

Equipment
- Alert
- **Action**
- Request

Information Request

Resolution

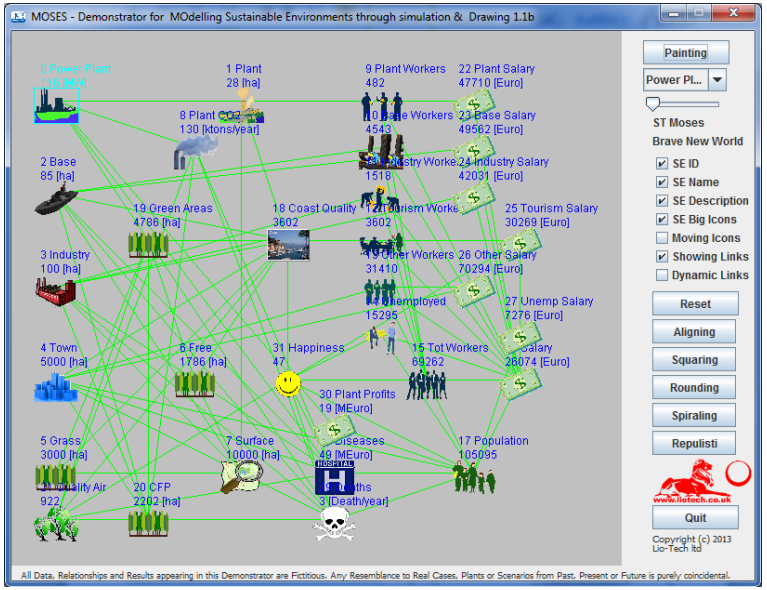


Remote Subject Matter Experts

Simulation Team

MOSES

MOdelling Sustainable Environment through Simulation



MOSES is a sustainability model based on dynamic simulator which has been used as a tool in a game based experience.

The goals of MOSES project are:

- **To analyze business alternatives in building a coal power plant in a port area**
- **To propose a quantitative method for modelling and integrating well-known sustainability issues**
- **To conduct a role play game experience through the use of a sustainability model implemented in a simulator**

The model has been tailored on a city populated by about 95k inhabitants, facing the Tyrrhenian sea and with one commercial and military port hosting the arsenal of the Navy. The urban area extends over 52 km^2 and includes a power-plant .

DIME
Università di Genova

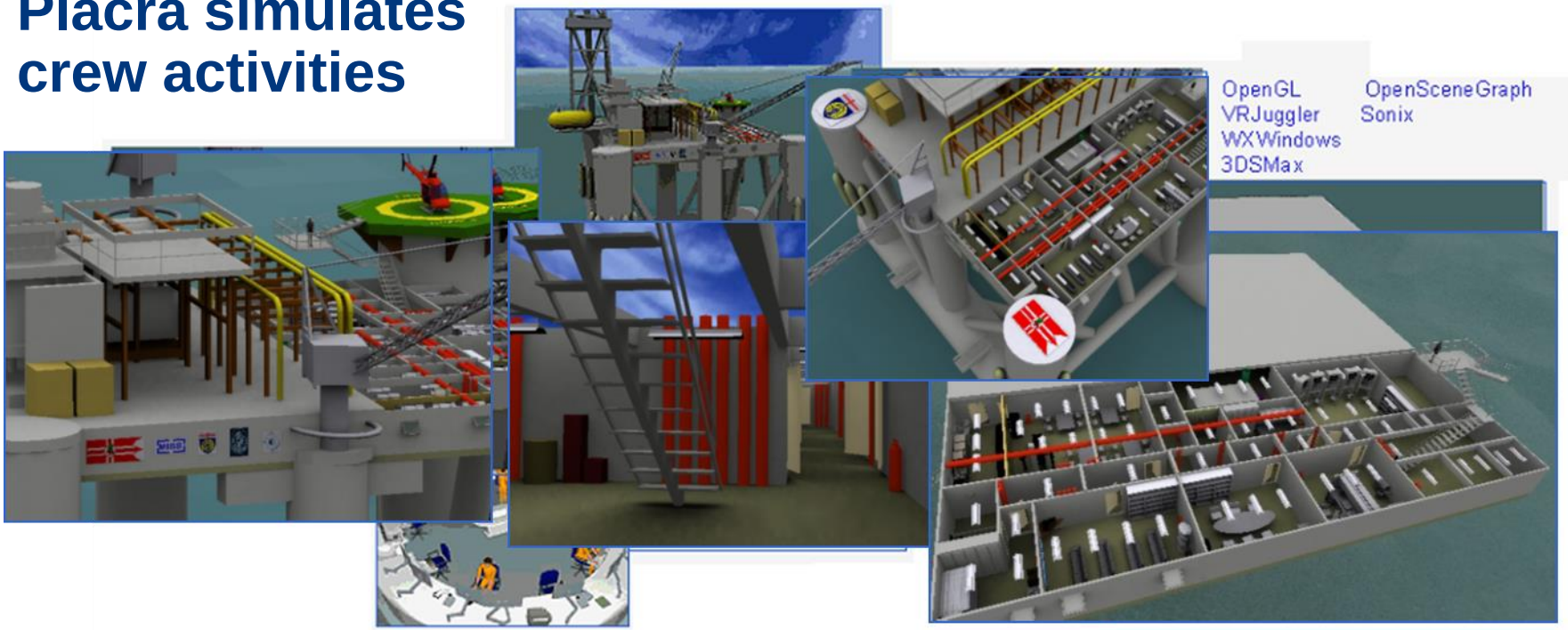
www.liotech.co.uk

Simulation Team

Placra

Platform Crew Analyser

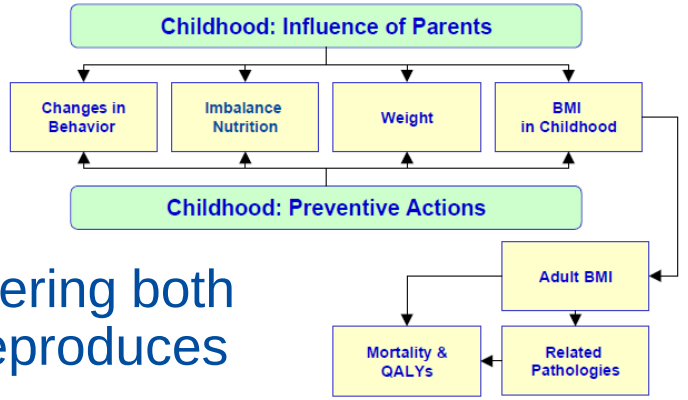
The Placra model was developed in order to reproduce the crew activities on Oil Platforms. Placra simulates crew activities



Simulation Team

BACCUS

Behavioral Advanced Characters & Complex Systems Unified Simulator

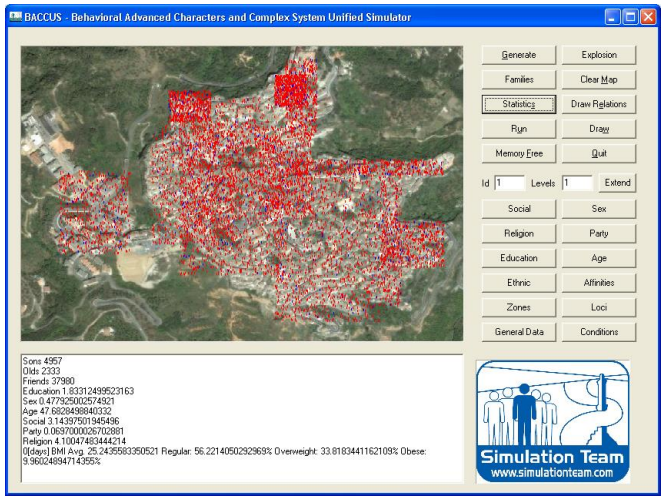


Basic Model of Obesity in Childhood

The BACCUS simulator is intended to be used to study the Obesity Epidemics considering both physiological and social aspects; the model reproduces the population dynamics, estimating correlation among different factors:

- *BMI*
- *Infarct*
- *Cancer*
- *Sport Profile*
- *Atrial Fibrillation*
- *Hyperlipidemia*
- *Stroke*
- *Diabetes*
- *Alcohol Profile*
- *Hypertension*

BACCUS simulates social networks such as Family and Friends to assess the population evolution and the mutual interaction with diffusion of pathologies



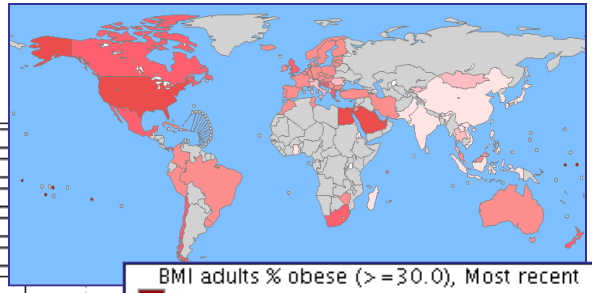
Beth Israel Deaconess Medical Center

A TEACHING HOSPITAL OF HARVARD MEDICAL SCHOOL

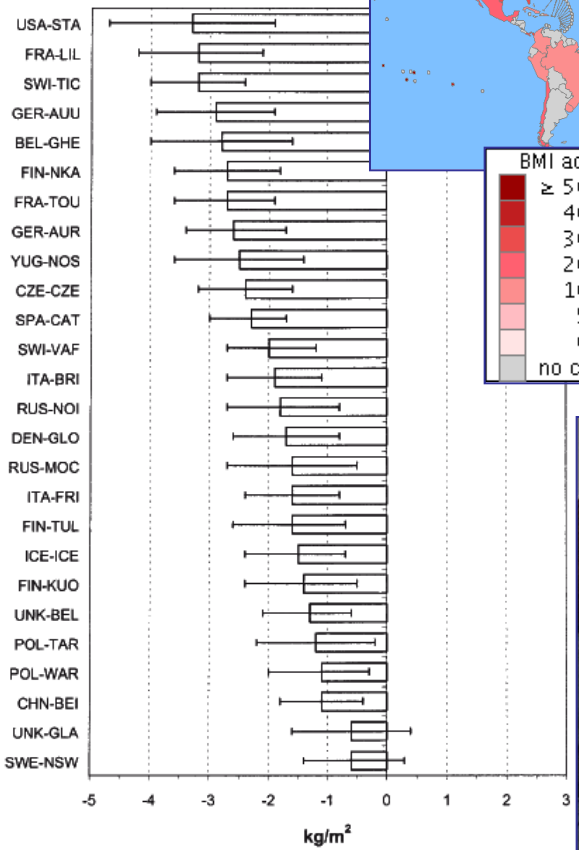
Obesity as a Social Epidemics

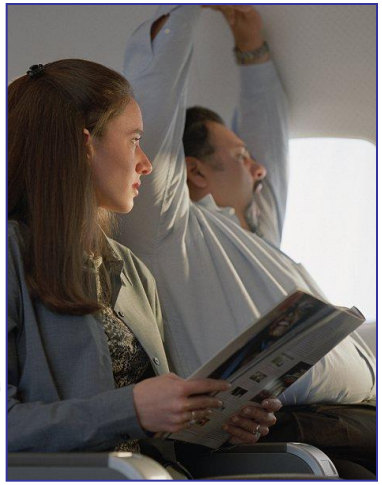
- To Analyze existing models and for analyzing the Impact of phenomena related
  to the evolution of the population such as obesity in terms of demand for infrastructure, facilities, services
- To develop a model that takes into account the different phenomena that affect the development of obesity in the population in different scenarios (i.e. Italy and the United States)
- To Study the evolution of the obesity epidemics and its effects by using intelligent agents

Obesity Epidemics as Global Evolving Problem



The study led to a characterization of the phenomenon of obesity in different areas and along its temporal evolution





Intelligent Agents and Simulation

Agent: Any entity capable of perceiving its environment and act upon it through actuators

Intelligent Agent: the agent who acts in the right way, that is, with actions that bring the greatest success

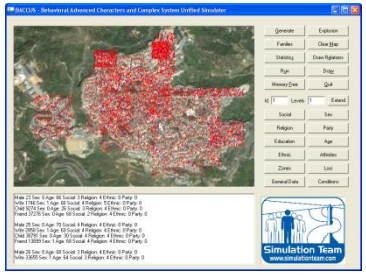
PAGE Paradigm

- ***Percepts***
- ***Actions***
- ***Goals***
- ***Environment***

Agent in use are based on IA-CGF and include Human behavior modifiers such as : *Stress, Fatigue, Fear, Aggressiveness*

$$SL_j(t_{i+1}) = SL_j(t) + Dsc\left(SOP_j(t), zone_j(t_i)\right) \times Hs\left(SL_j(t_i), Dsc\left(SOP_j(t_i), zone_j(t_i)\right), FL_j(t_i)\right)(t_{i+1} - t_i)$$ where :

$$Hs\left(SL_j(t_i), y, FL_j(t_i)\right) = \begin{cases} y \le 0 & Gsf_j \times ksf_1 \times \sqrt{\frac{SL_j(t_i)}{bsl_1}} + 1 \times IFfa\left(FL_j(t_i)\right) \\ y > 0 & Gsf_j \times ksf_2 \times \frac{\sqrt{\frac{SL_j(t_i)}{bsl_2}} + 1}{SL_j(t_i) + 1} \times IFfa\left(FL_j(t_i)\right) \end{cases}$$



$SL_j(t_i)$ is the Stress Level of th e j- th Action Object at i- th event time

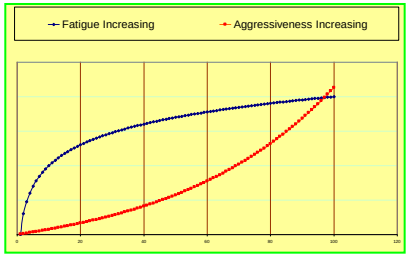
$SOP_j(t_i)$ Status of Operation of the j- th Action Object in i- th event time

$zone_j(t_i)$ Zone location of the j- th Action Object in i- th event time

$Dsc(x,y)$ Unitary Continuous Change in Stress Level due to Status x in Environment y, this variable is usually zero or negative

Gsf_j Stress Factor Characteristics of j- th Action Object

$Hs(x,y)$ Function for reproducing Hysteresis and Saturation on Stress depending on current status as well as current increase



ksf_1, ksf_2 Factors for tuning Hs Function Impact

bs_1,bs_2 Factors for tuning Hs Function Period

$IFfa(z)$ Impact Modifier due to current status of j- th Action Object in term of Fatigue

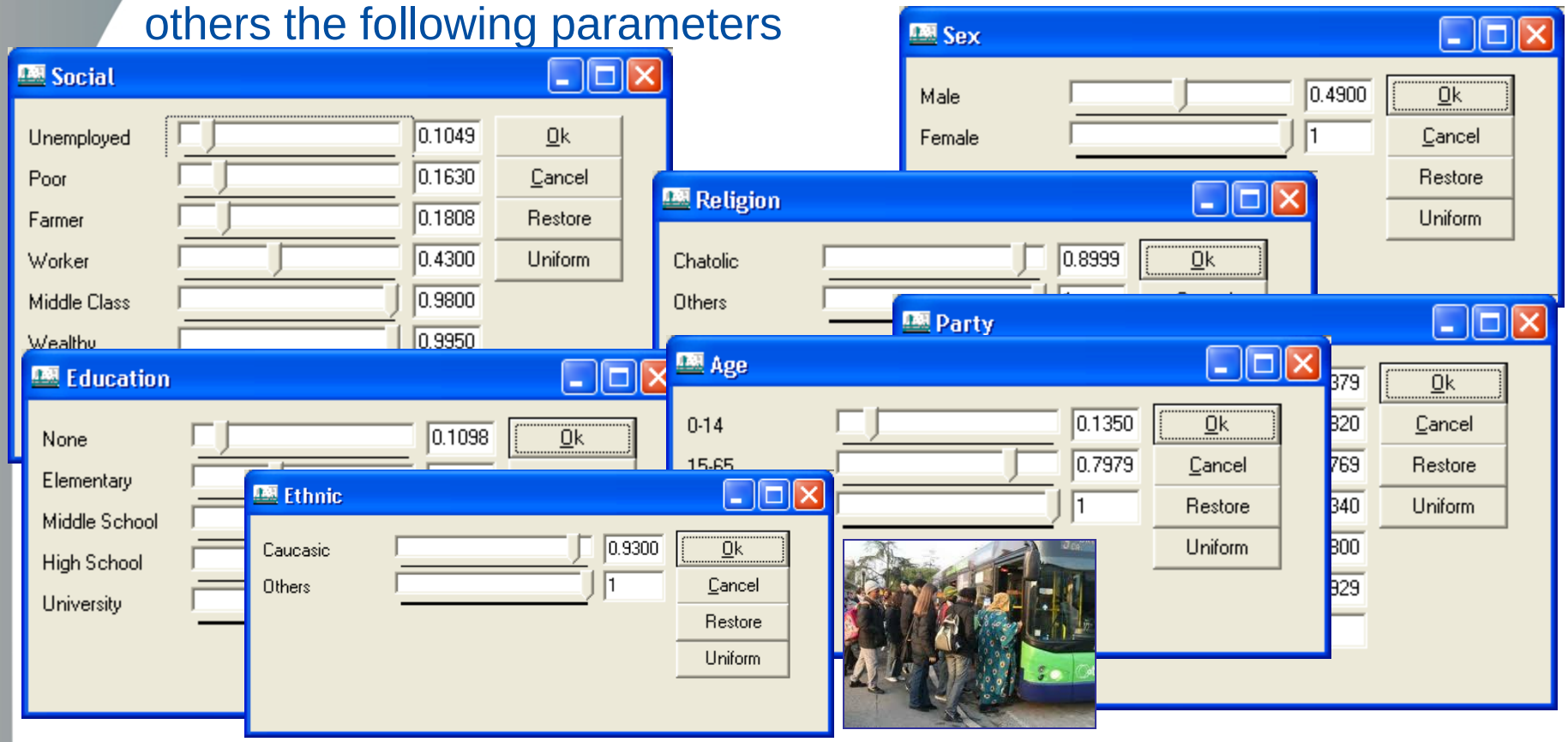
$SL_j(t_i) = SL_j(t_i) + Dse\left(E_i\right) \times Hs\left(SL_j(t_i), Dse\left(E_i\right)\right)$ E_i Event affecting the j- th Object at i- th event time

$Dse(x,y)$ Event Discrete Change in Stress Level due to Status x in Environment y

Dsc as Dse can assume both positive and negative values representing activities and phenomena increasing as well as decreasing the stress level.

Population Characteristics

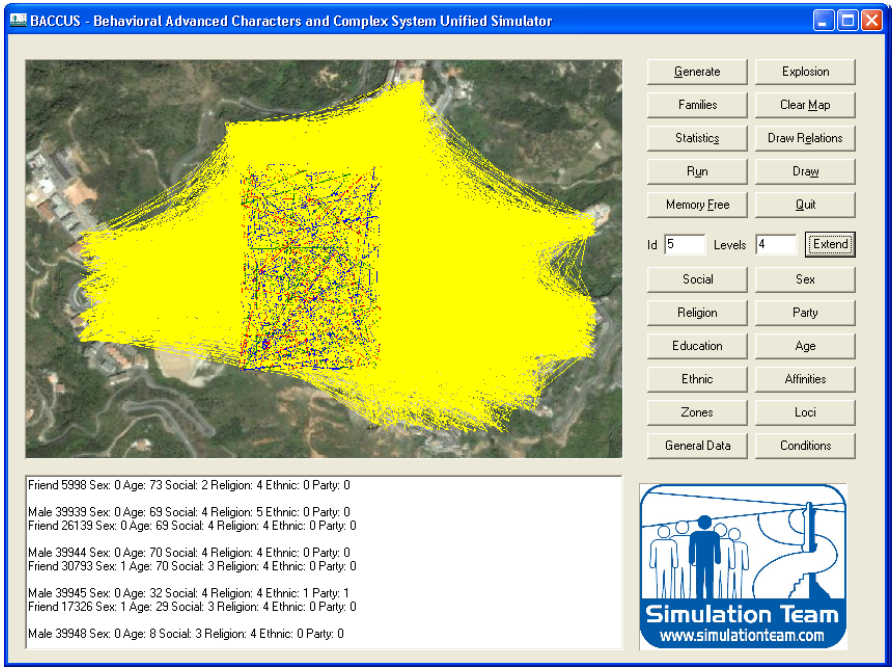
The Agents reproducing the population include among the others the following parameters



BACCUS Simulator

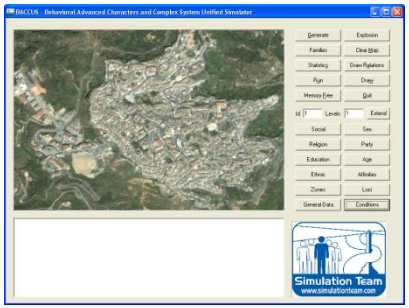
The simulator BACCUS (Advanced Behavioral Characters and Complex Systems Unified Simulator) is intended to be used to study the phenomenon and led to the addition of a set of parameters

- ***BMI***
- ***Sport Profile***
- ***Alcohol Profile***
- ***Stroke***
- ***Infarct***
- ***Diabetes***
- ***Cancer***
- ***Hypertension***
- ***Atrial Fibrillation***
- ***Hyperlipidemia***

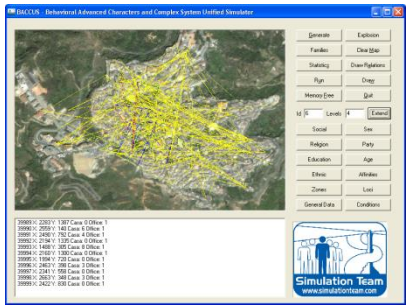


BACCUS uses also the information related to social networks such as Ffamily (spouses, children, parents) and Friends to assess the impact on obesity epidemics

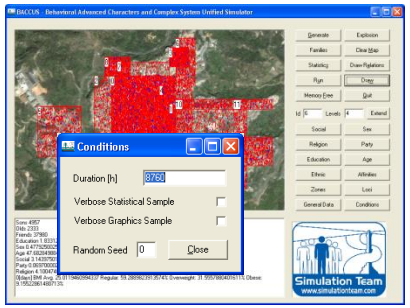
Scenario Simulation



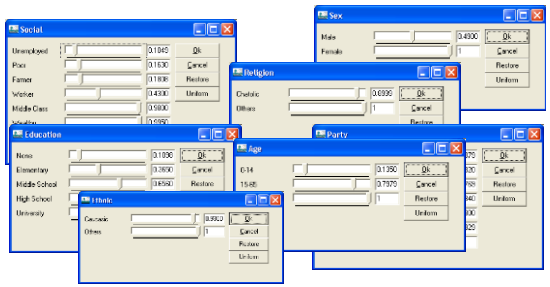
Town/Region Scenario



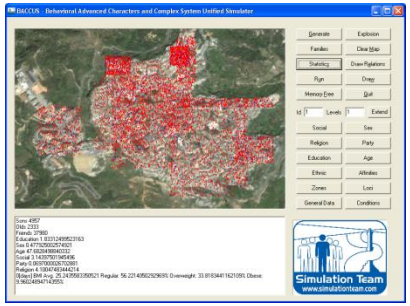
Generate Social Networks



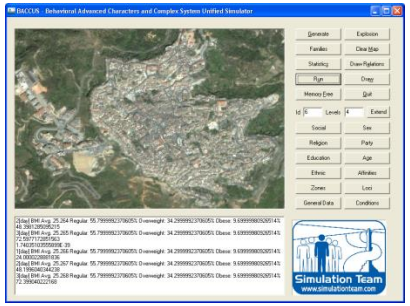
Define Paramters



Population & Social Network Configuration



Generate Population



Simulation Run

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LOTECAS

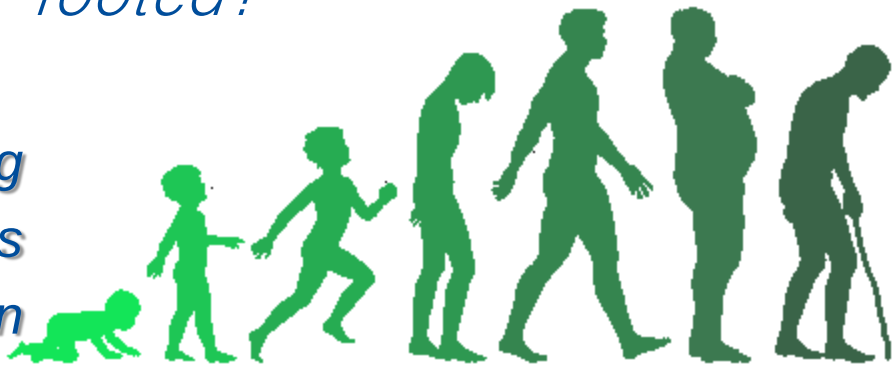
Long Term Care Simulation

LOTECAS Simulator addresses the incumbent problem of Population Aging and it is devoted to support development of Long Term initiatives based on Modeling, interoperable Simulation and Serious Games to improve Effectiveness and Efficiency in Nursery Home and in Long Term Health Care Services

Riddle of the Sphinx.. …Nowadays

What is it that has one voice and yet becomes four-footed and two-footed and three-footed?

Developing Countries 6.3 billion



Developed Countries 1.1 billion

World Wide Population

7,349,742,000 *2015*

7,419,603,000 *2016*

9,725,000,000 *2050*

People over 65

Egypt 5%

Myanmar 5%

Ecuador 7%

People over 65

USA 15%

UK 18%

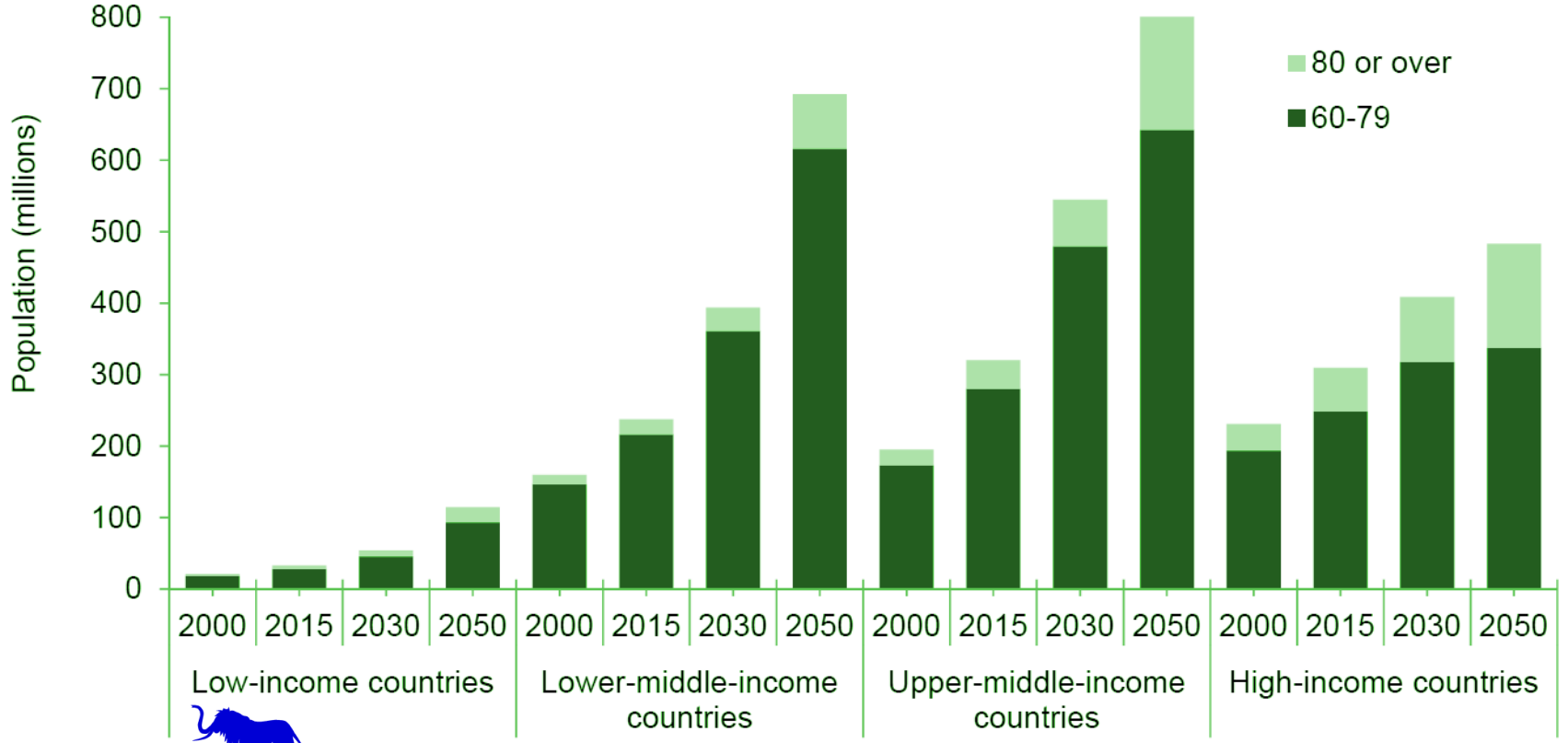
Italy 22%

UN, Wiki

Not Only Developed Countries

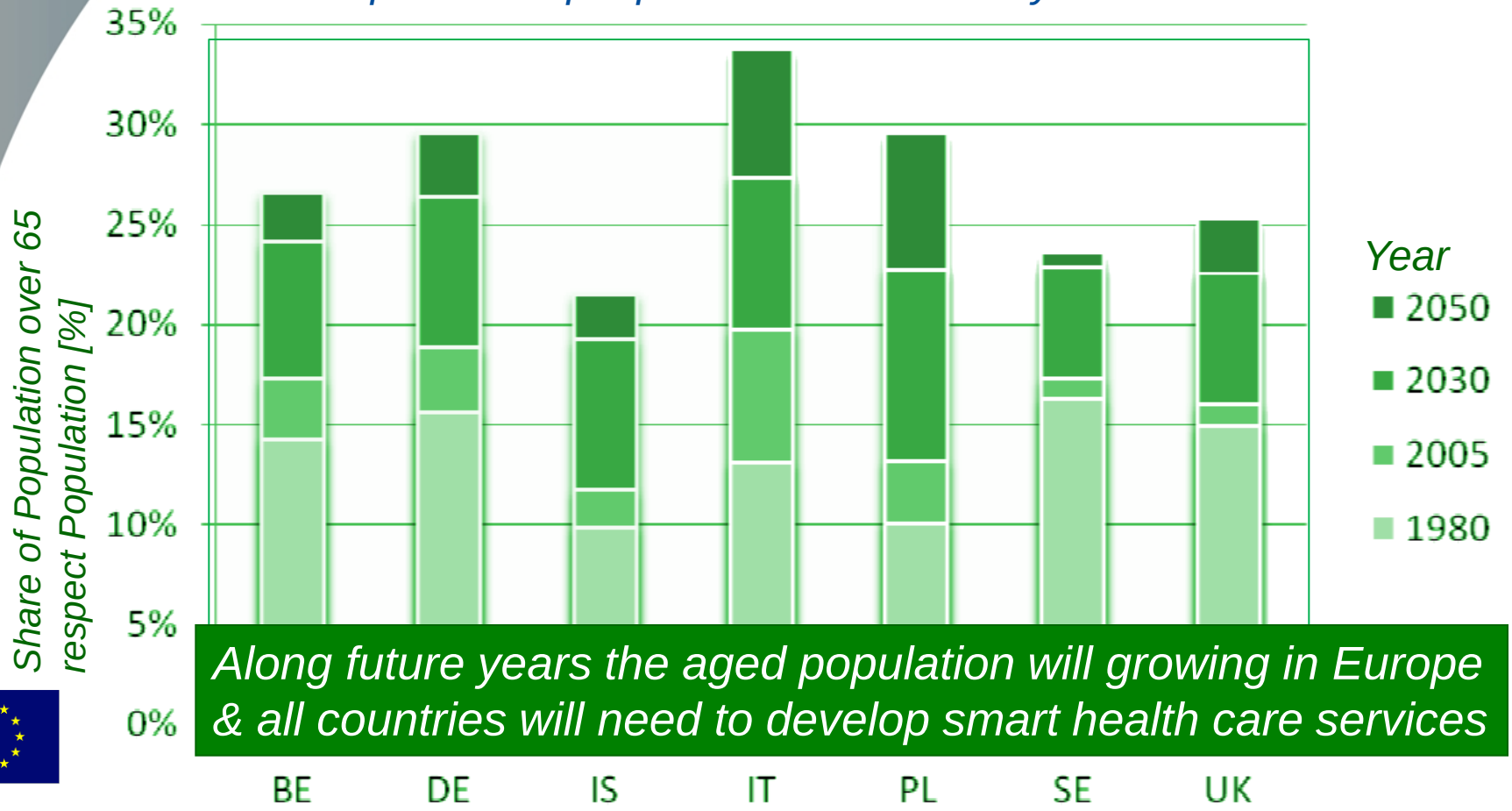
Also Emerging Countries are increasing their Life Expectation: so this problem is expected to arise soon also there and even more intensively

Population aged 60-79 years and aged 80 years or over by income group, 2000, 2015, 2030 and 2050



Future Trends in Europe: 65+

We expect older people Mental &/OR Body Disabled



Along future years the aged population will growing in Europe & all countries will need to develop smart health care services

Eurostat 2007

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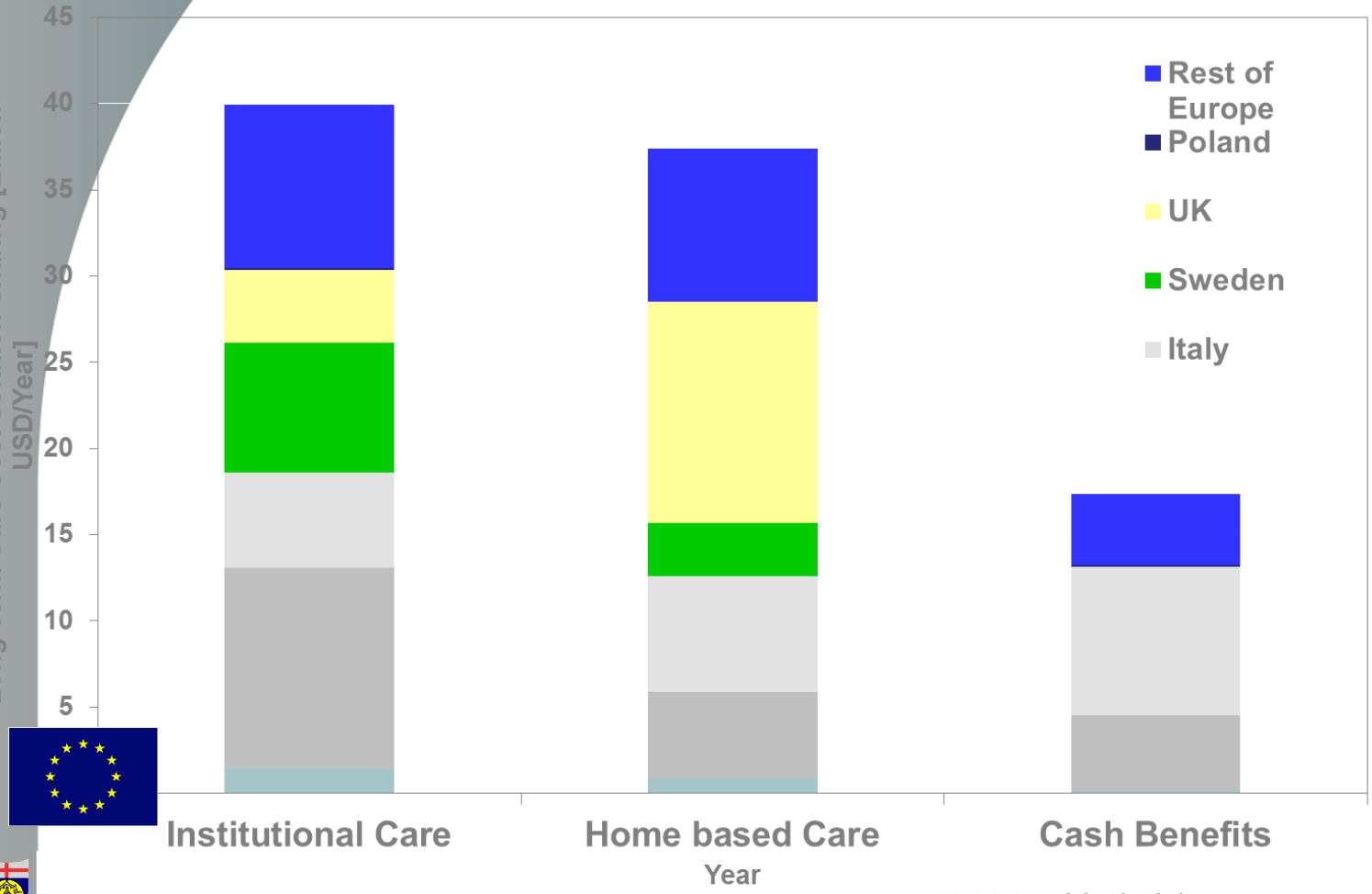
Solution Sharing on Long Term Health Care Efforts in Europe



Cost of Long Term Care is valuable in Euro billions per year even today and could strongly benefit of Modeling and Simulation to Improve Performance in terms of Costs and Quality

A Very Basic Example

A very basic benefit from Use of Simulation and Serious Game on a Research (Journal of Geriatric Physical Therapy 2009)

Clinical Use of Nintendo Wii™ Bowling Simulation to Decrease Fall Risk in an Elderly Resident of a Nursing Home: A Case Report

Clark & Klamer

Saving on 1.7 million USA Residents in Nursing Homes with 850'000 Falls/Year and over 93'000 Injuries

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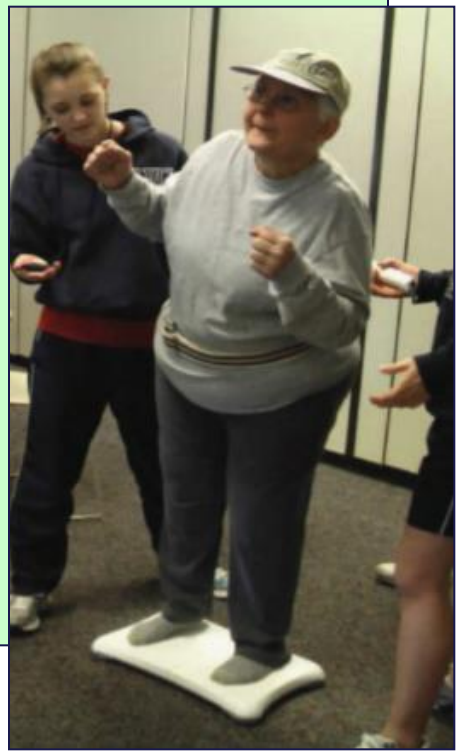
What if a WII… save from Falls?

Do you remember the basic case mentioned: using of WII for help Elderly Residents of Nursery Homes?

It was extended to several experimentation….

…Let's consider the USA: 1.7 million Residents in Nursing Homes with:

850'000 Falls/Year,
93'000 Injuries/year,
30'000 USD/fall with Injury average cost



Bainbridge, Bevans, Keeley, & Oriel, "The Effects of the Nintendo Wii Fit on Community-Dwelling Older Adults with Perceived Balance Deficits: A Pilot Study", Physical & Occupational Therapy in Geriatrics, 29(2):126–135, 2011
US Journal of Safety Research

Let's consider a Simple Case….

A **scientific experimentation conducted in 2011 on a small group of people (6) by** 30min sessions on WII Soccer/Ski/Table Tilt Games, 2 times/week for 6 weeks plus 5 minutes yoga before and after…

The results evaluated an improvement on **Berg Balance Scale (BBS) for Individuals corresponding to a reduction in 50% of the people of the risk to falls to around 12%.**
Despite the very limited generalization value of the research, considering an improvement of 6% as measured on the tests….

Bainbridge, Bevans, Keeley, & Oriel, "The Effects of the Nintendo Wii Fit on Community-Dwelling Older Adults with Perceived Balance Deficits: A Pilot Study", Physical & Occupational Therapy in Geriatrics, 29(2):126–135, 2011
US Journal of Safety Research

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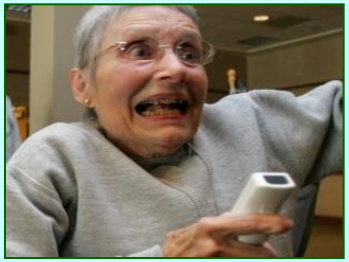
A Great Result requires a Great Serious Game!

This will correspond, in USA, to a Save of 166 MUSD/year vs. an operating cost of 74 MUSD/year (power ~16, service ~16, depreciation !42). This will avoid 5'500 injuries due to falls each year. Summarizing: New Serious Game need to be scientifically designed:

- A specific Serious Game for WII able to reduce *10%* the falls guarantees Net Saving of 200 MUSD/year and Reduction of 10'000 injuries

- **A WII Treatment that is performing** operationally just half of this test **(*2.65%*) will just pair the costs!**



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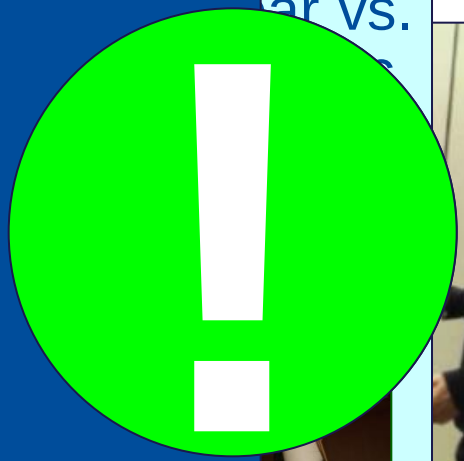
Now what if … sig… A New Ser… me…

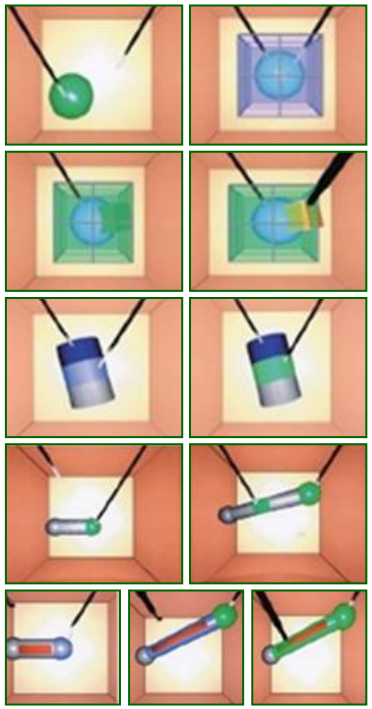
… able to…

… Create Empathy with Elderly Resident…
… **Create Engagement of Elderly Resident …**
… **Improve their Mental and Physical Conditions…**
… Create Networking among Residents…
… **Create Networking with Young Generations…**
… Mentor in Social Values the new Generations…
… Support Experience and Knowledge Transfer…



- The potential for such new Serious Game, just in Europe, is addressing a market of many Million People and provides opportunities to reduce Injuries and Provide a Service to the Society that is almost Incommensurable

M&S impact on Medicine



"Hospitals that have already been funded under a US DoD Medical Simulation Trial Program saw their clinical error rate decrease from 30% to almost 4%, which, when applied across the USA, could reduce medical error costs by up to $17 billion"

J.R. Forbes, 2009

Congressman & Promoter of M&S in Caucus

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Rethinking Health Care

New Technologies and New Solutions *Provide t*oday many opportunities to rethink the Health Care as well as the Long Term Care

It is evident that Simulation is Fundamental to investigate the new Possibilities and to design innovative Solutions for the Future

New Opportunities for M&S

Very interesting Opportunities are provide by new area in Particular:

- Internet of Things & Mobile Solution
- Virtual and Augmented Reality
- Remote Operations & Controls
- New Equipment
- Networking & Engagement
- New Health Services
- Pooling with Existing Ones
- Demand Modeling by Agents

What if a New Stochastic Discrete Simulation…

…Integrates all Processes, and Systems of a Nursery Home and is able to…

… Interact with Human Resource Management…

… Optimize Flexible Schedule…

… Optimize Plant Use to reduce Consumptions…

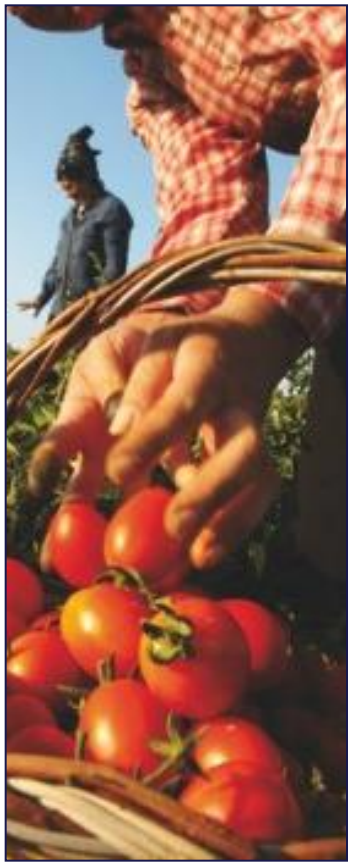
… Share the Resources among different Facilities…

… Interoperate with Public Health Care Systems…

- The potential for such Constructive Simulation, just in Europe, addresses opportunities for Quality Improvement, Health Care and Energy Savings over a Budget that overpass largely 100 billion Euro and is growing quickly

Slow Food & World Market

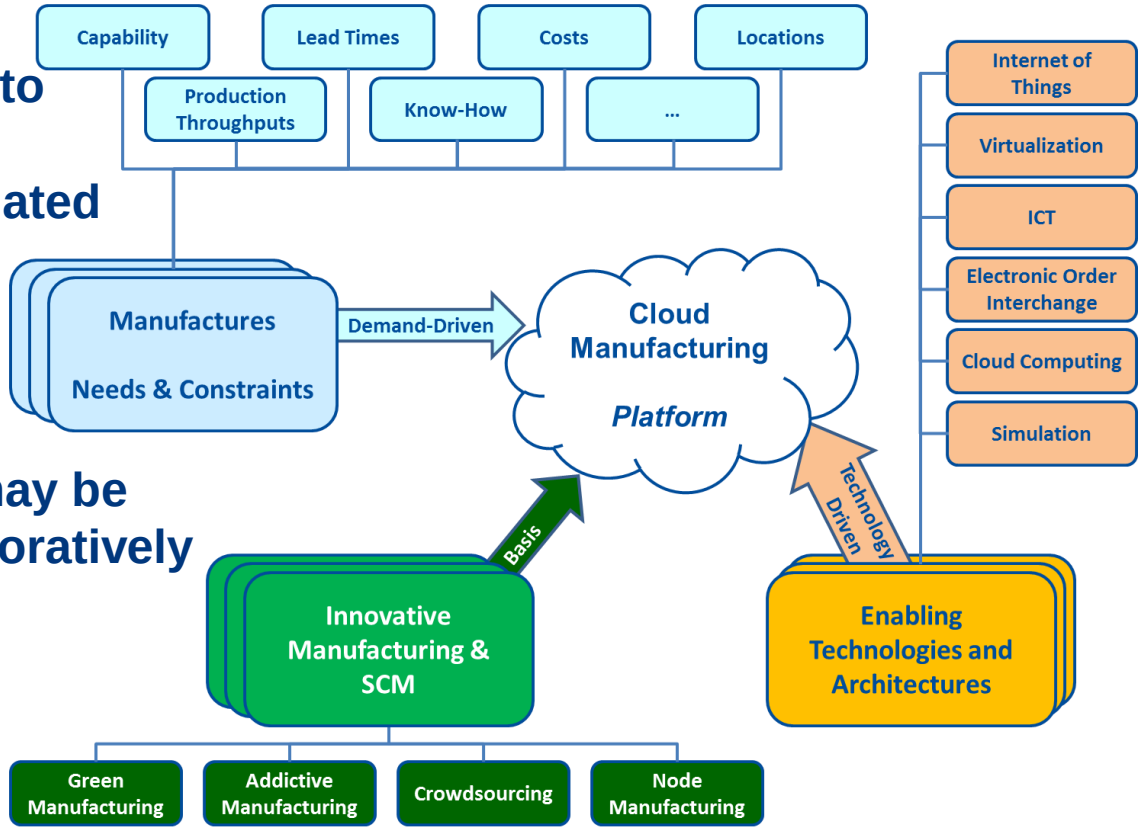
- Slow Food is a Concept spread worldwide that promotes an alternative to fast food based on preservation of Traditional and Regional Cuisine and promotion of Plants, Seeds and Livestock Farming that are specific of Local Ecosystems.
- Its final goal is Sustainable Foods and Promotion of Local Small Businesses in opposition to Globalization of Agricultural Products



CM: Cloud Mmanufacturing

CM applied to Slow Food
Cloud Central Services

The Cloud Manufacturing (CM) is a new paradigm based on Networks within the Cloud that are devoted to improve flexibility and responsiveness by a coordinated approach able to react dynamically to the demand A CM system is based on sharing of resources and capability production which may be used and exchanged in collaboratively to meet specific requirements



Slow Food Service within the Cloud

Cloud Computing is a innovative service based on internet in which large amounts of remote servers are linked together in a network able to guarantee an unique virtual location of the Data as well as online access to services and shared resources

Cloud Computing could be based on :

- **Public Solution**
- **Private Solution**
- **Hybrid Solution**

Virtualization

The virtualization technology allows to abstract physical resources (e.g., computing hardware) to make them available for software programs as a virtual resource.

The main advantages are the rationalization and optimization of the resources and the uniqueness of the control services, supervision and security.

Key element is the virtual machine monitor (VMM) that connects applications and virtual machines with the underlying hardware. Through the VMM the computing resources can be encapsulated in a collection of virtual machines.

Grid Computing

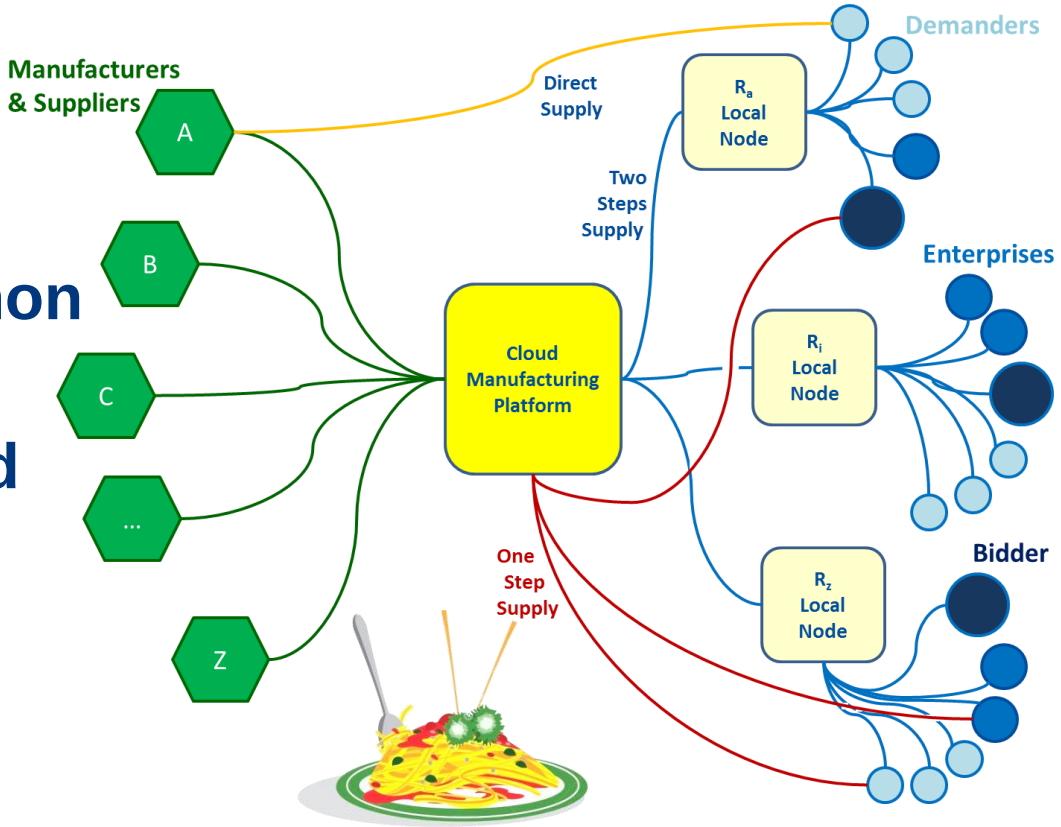
Grid computing is the network infrastructure and it includes all processing resources located in multiple locations intended to be used for achieve a common goal. The grid can be thought of as a distributed system to which is assigned the work load in order to optimize the use than computationally expensive problems.

Unlike the Cloud Computing, Grids are a form of distributed computing that is a virtual supercomputer composed of many almost freely coupled server and connected in a network

CM Platform Management

Major Management Problems in using the platform

- Dynamic Resource Allocation
- Acquisition of Common Resources
- Selection of Required Services
- Creation of Specific management model



Resource Allocation

Due to the virtualization layer across the types of resources within the platform and high heterogeneity and distribution of resources, it is necessary to develop intelligent allocation system.

Several optimization algorithms are under study and development by Principal Active Centers in this field as Beihang, Genoa, Tsiengtuo & Universities

Collecting the Resources

The models adopted by this approach are based on the following methodology devoted to collect the resources:

- **Interface Definition**
- **Encapsulation of the Resource**
- **Dynamic Supply Process**

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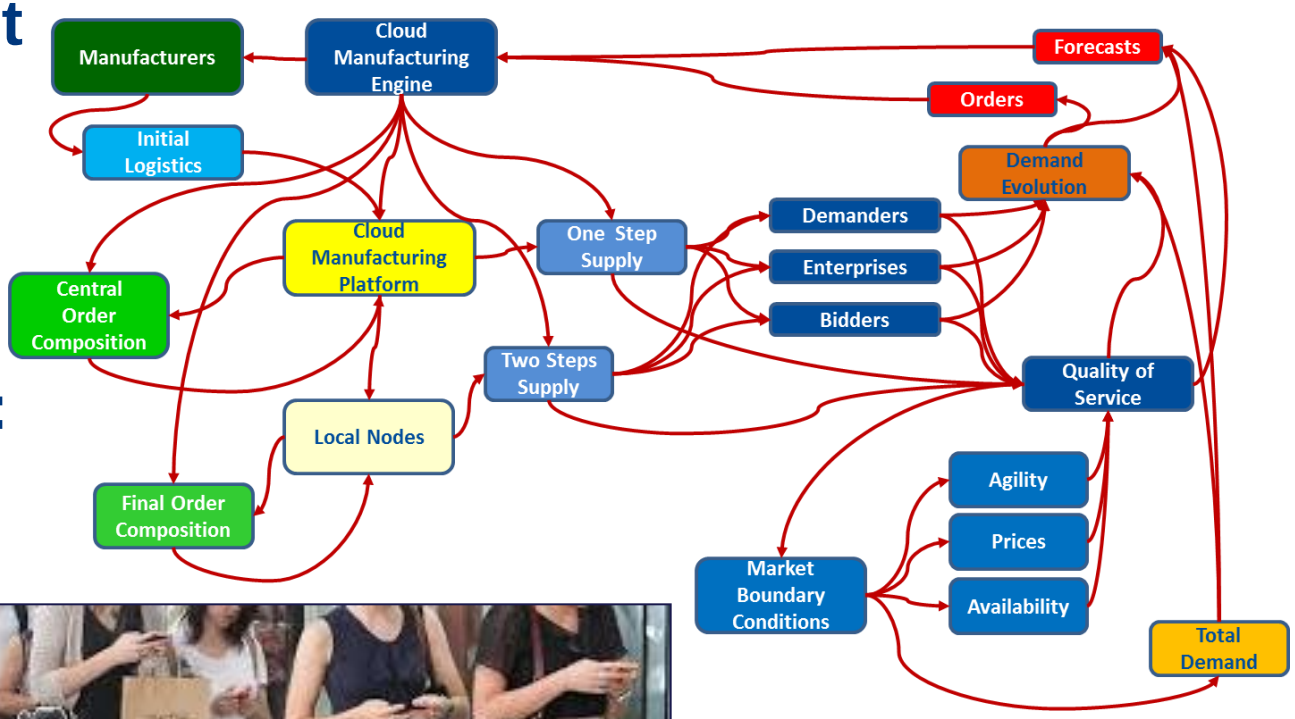
Megacity Model

A Megacity is commonly defined as a City with over 10 million people and it is usually affected by management and development problems similar to a small States. Megacity Model Allow to check how CM address:

- **Environment**
- **Energy**
- **Transport**
- **Security**



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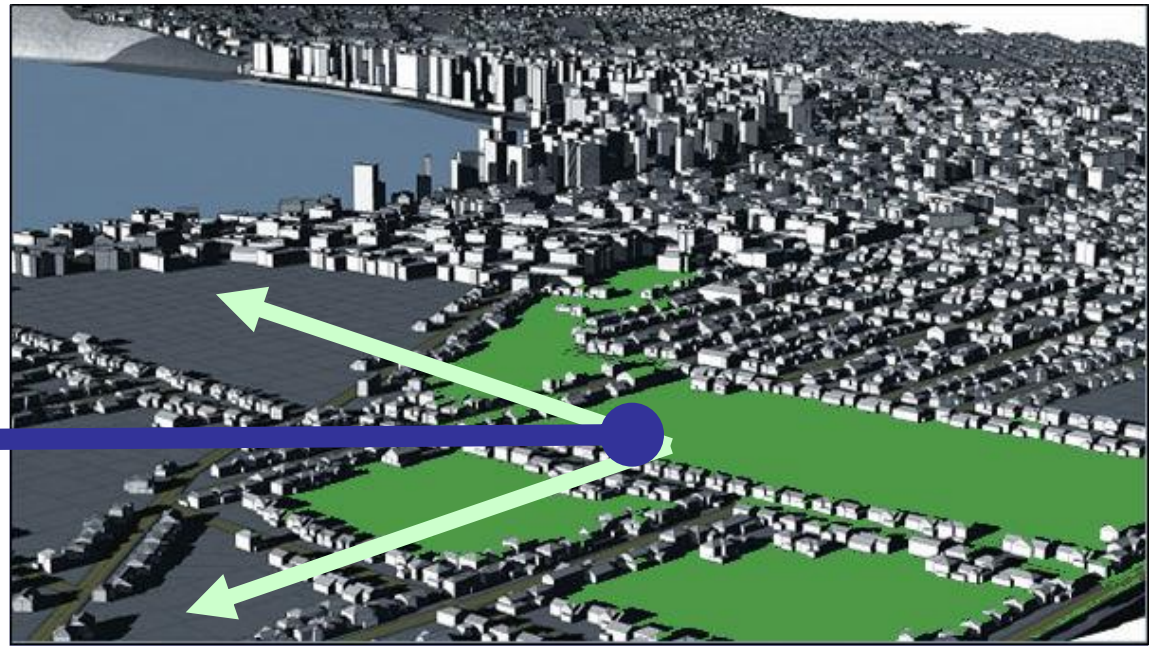
Virtual Support Model

The creation of a Virtual Model of a Megacity allowed to visualize & to Quantify dynamically The Dynamics of Town Demand

User | Scenario | Power | Boundaries | Levels



Run

Review

Results

DBase

Quit

Area Required by Local Node Warehouse to support CM based on dynamic demand

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Algorithm to Quantify the Service Efficiency KPI

This Algorithm is devoted to provide a support to improve platform service quality:

$$\min\left(\sum_{j=0}^{M} C_{uncm}^{j} + C_{lncm}^{j} + C_{tncm}^{j} - \sum_{i=0}^{N} C_{ucm}^{i} + C_{lcm}^{i} + C_{tcm}^{i} + C_{fcm}\right)$$

Scenario without CM

C_{uncm}= Resource Unit Cost

C_{lncm}= Costs of Logistics

C_{tncm}= Costs due to the Service Lead Times

Scenario with CM

C_{ucm}= Resource Unit Cost

C_{lcm}= Costs of Logistics

C_{tcm}= Costs due to Service Lead Times

C_{fcm}= CM Platform Registration Cost

$C_{tcm}^{i} = C_t * \gamma_i$ Contribution to the Costs due to Service Time of the i-th platform provider

$C_{tncm}^{j} = C_t * \gamma_j$ Contribution to the Costs due to Service Time of the j-th external provider

$C_{fcm} = C_f\, X_t(n)\beta_t$ Fees of the t-users

γ = Readiness Index

n = Resource Number

$X(n)$ = Participation Rate in using the Platform

β = Platform Use Frequency

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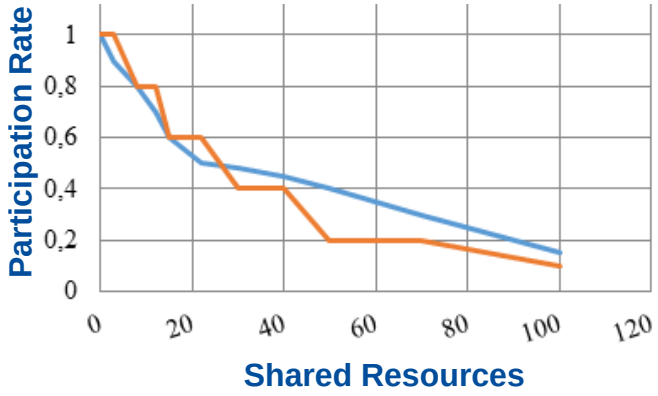
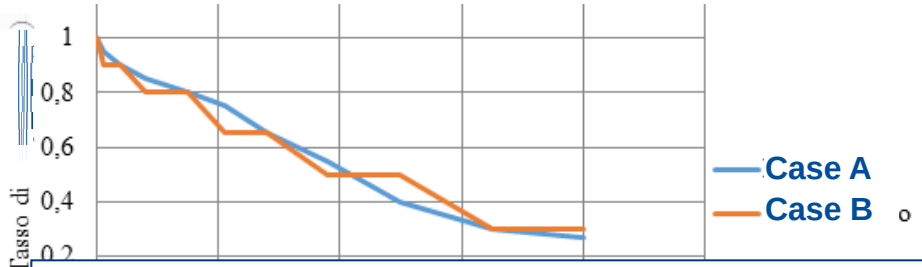
Experimental Synthesis

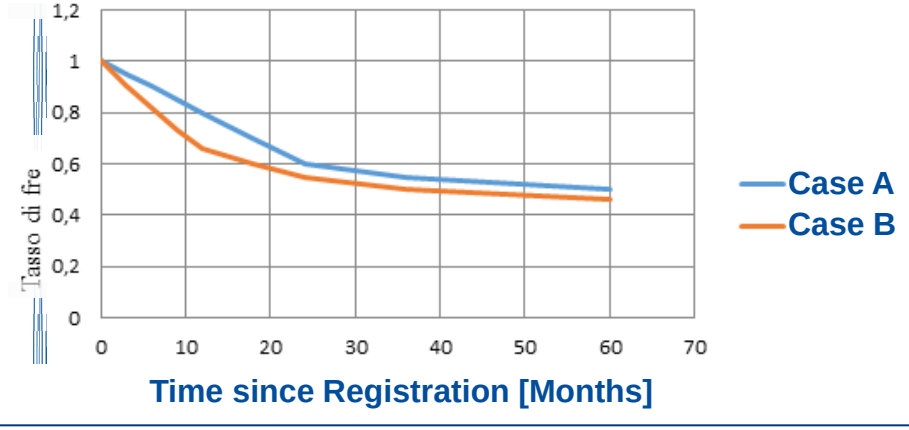
Evaluation Method Comparison on Participation Rate respect Shared Reso



Evaluation Method Comparison on Frequency Rate respect on Task Numbers



Evaluation Method Comparison on Frequency Rate respect Original Registration Time



- ***Case A***: Conservative Approach on hhe Costs of people using CM Platform first Time
- ***Case B***: Dynamic Approach with initial reduction of Cost to attract customers

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The International Activity of Liophant Simulation

Conclusions

Modeling and Simulation are Strategic Sciences to address the modern Industrial Challenges

Using them in Industry Provides a Competitive Advantage for Industries Dominating New Technologies and Evolving Markets requires extensive use of Modeling and Simulation

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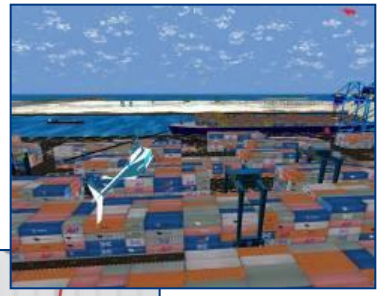
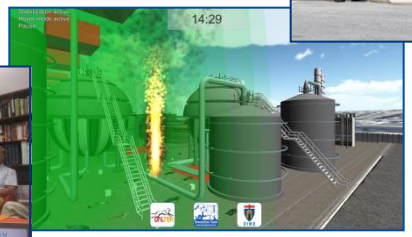
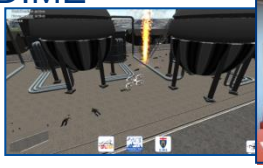
References







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