115th Jubilee of the Zaporozhye National Technical University

20th of November 2015, Zaporozhye, Ukraine

Engineering Education for the Industrial Revolution 4.0

Prof. Dr. Eden MAMUT

"Ovidius" University of Constanta

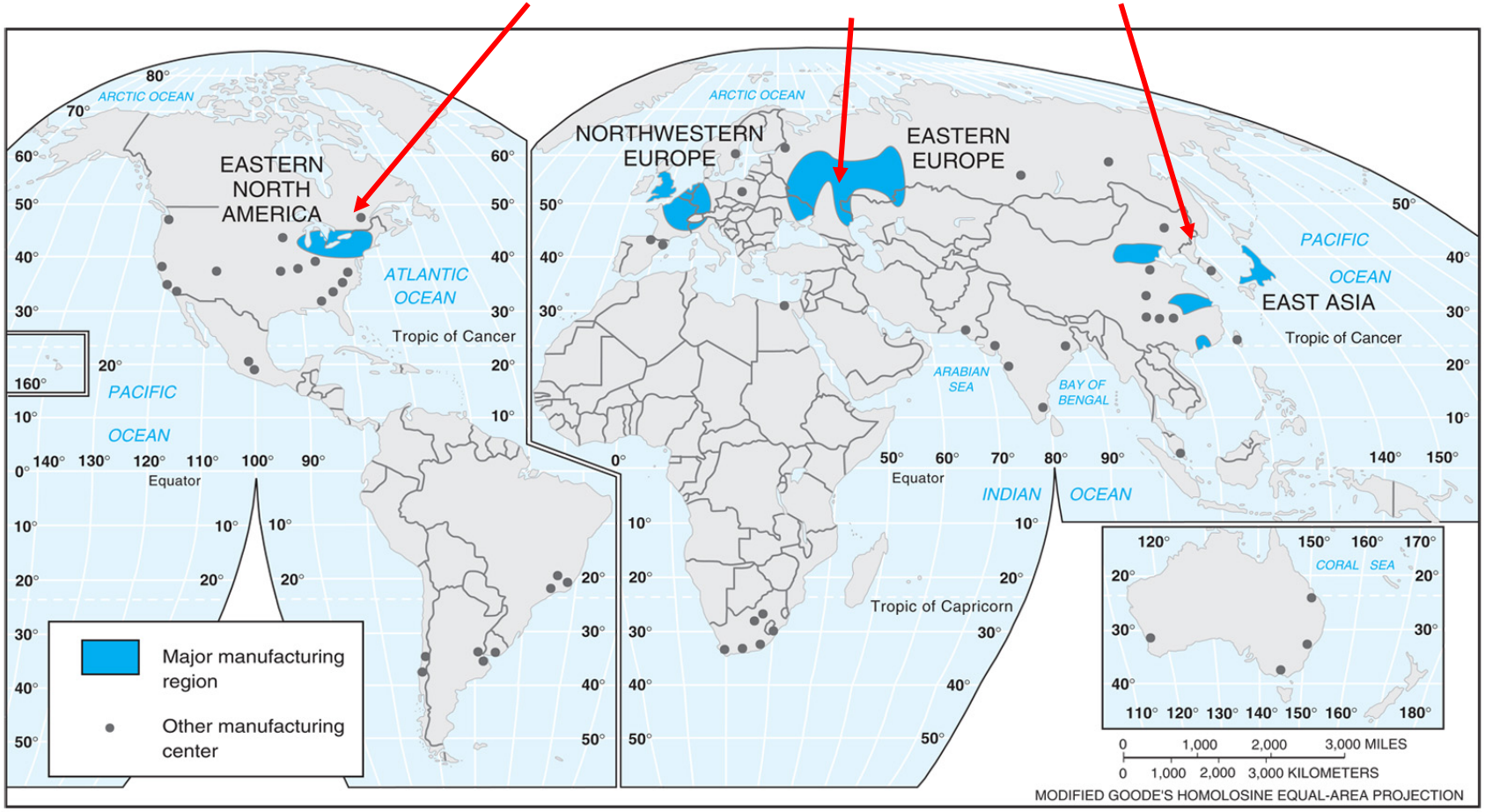
Black Sea Universities Network

Outline

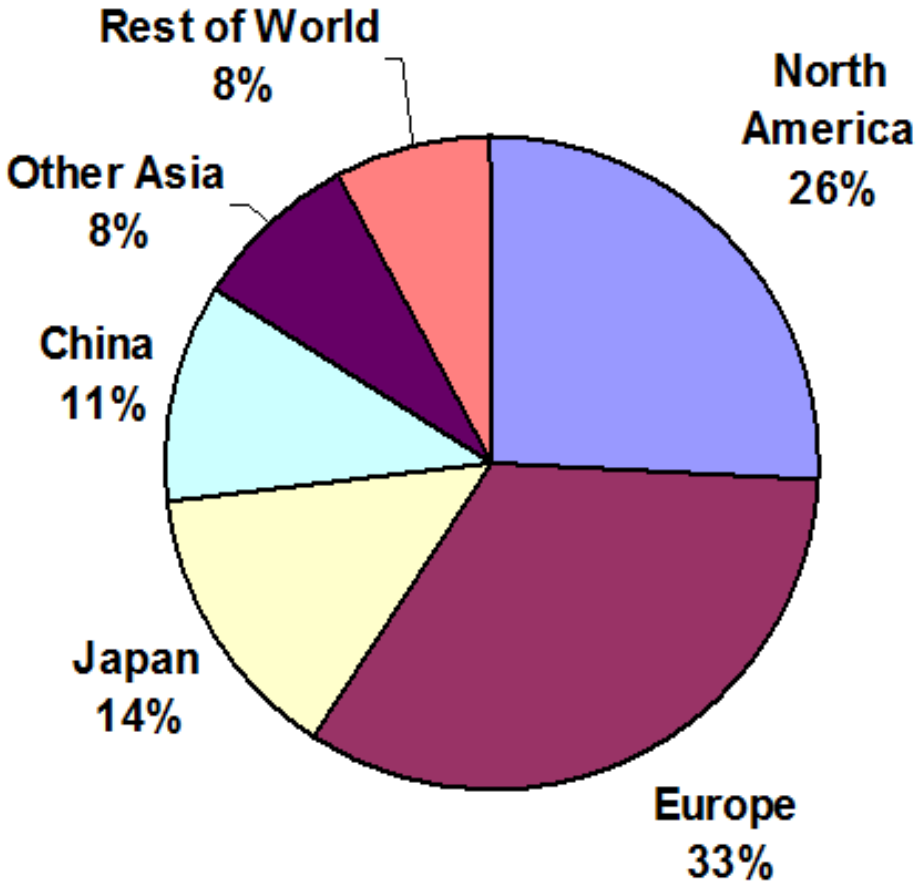
1. **Current trends in the industry**
2. **Challenges**
3. **Pathways to Industrial Revolution 4.0**
4. **Examples**
5. **Opportunities**

Current trends in manufacturing

80% of Global Manufacturing Output in Three Regions



Global Distribution Manufacturing Value Added



Source: Calculated from NationMaster.com

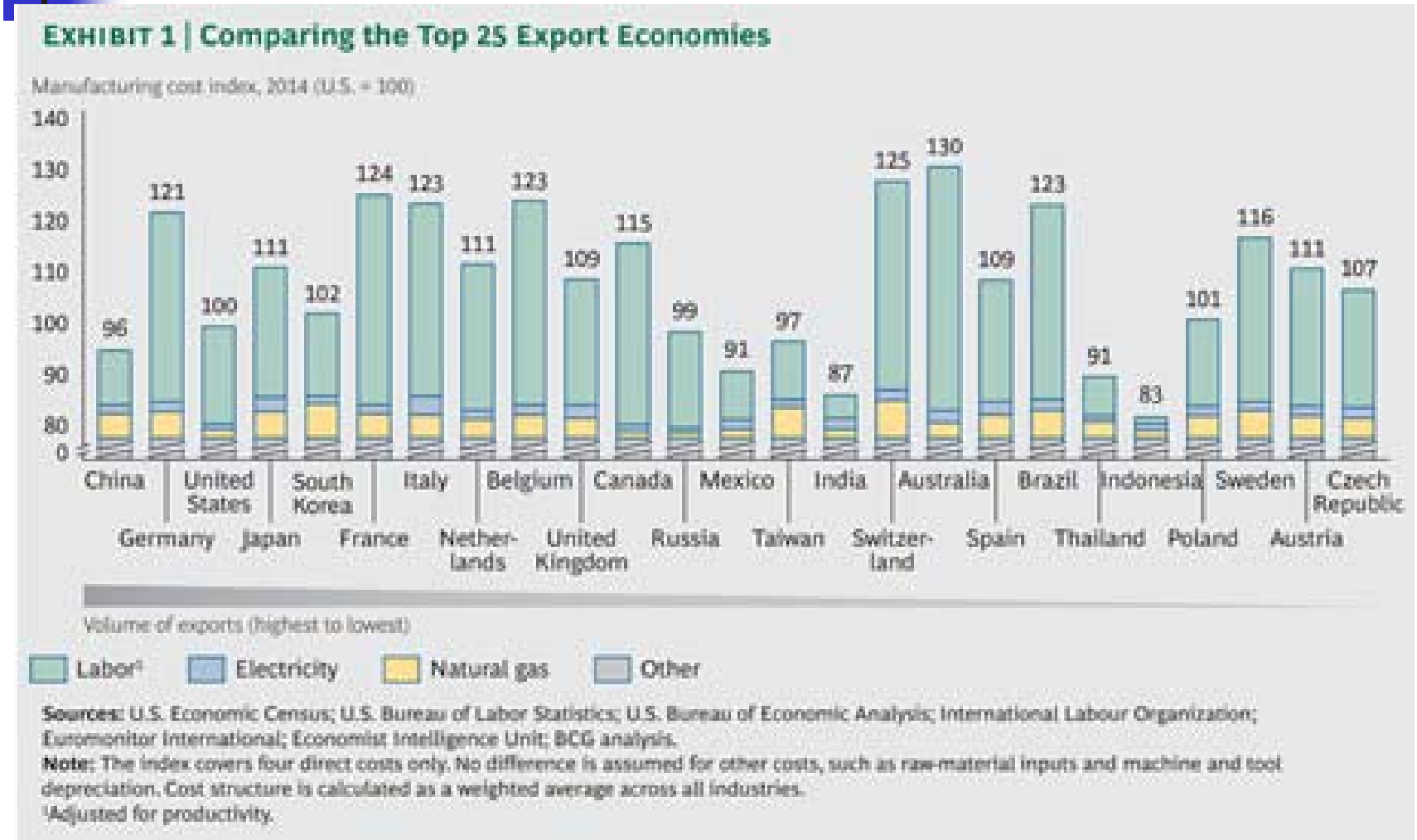
Current trends in manufacturing

Europe's global economic ranking is changing rapidly. By 2050, Europe's share of world GDP is likely to be half of today's 29%.

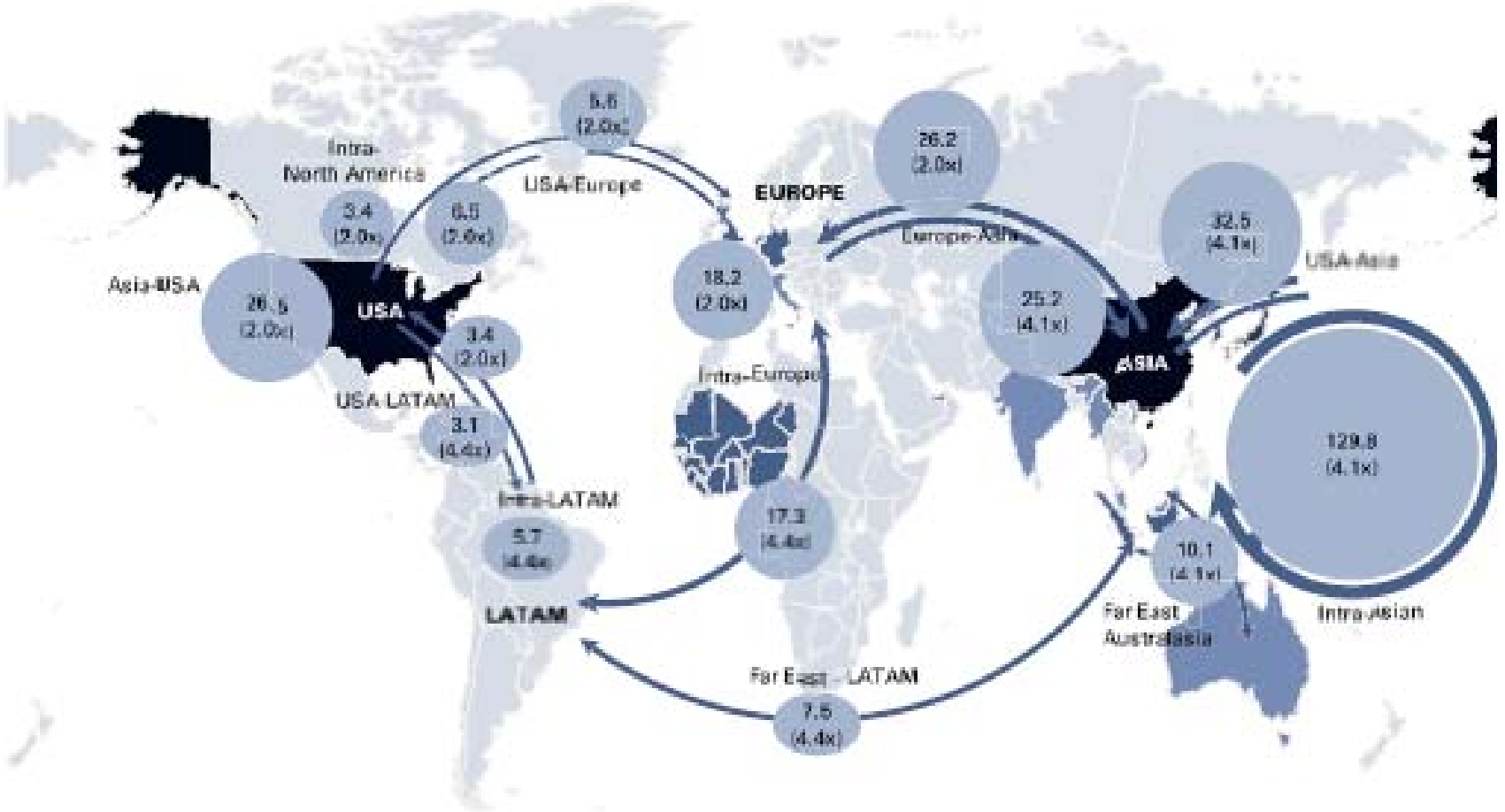
So far, Europe has been able to keep its share of world exports (20%), and in that respect our performance is better than that of other advanced economies.

But China, India and Brazil have started to catch up with the EU by improving their economic performance faster than the EU has, year-on-year, over the last five years.

Global Distribution Manufacturing Value Added



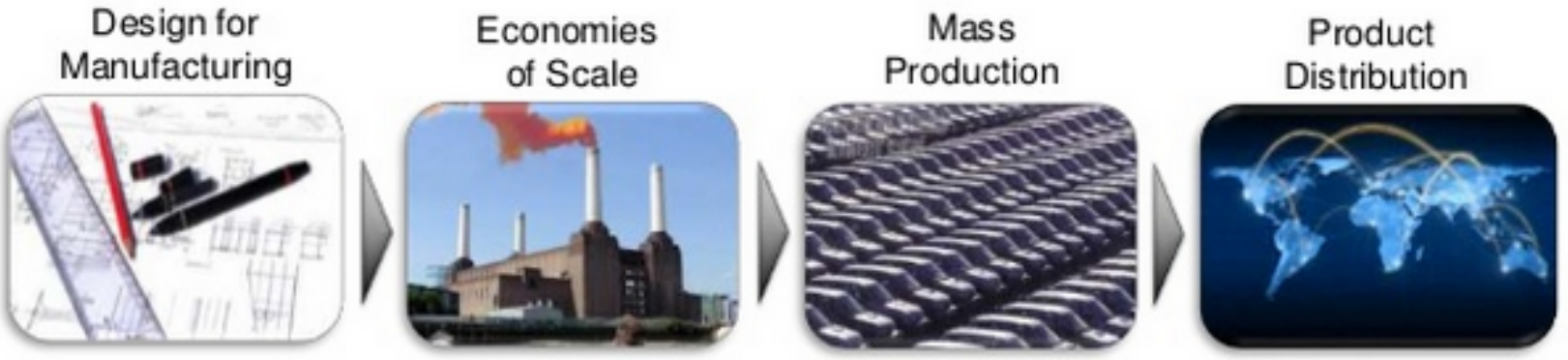
Global container trade flow 2010 vs 2030 (MN TEUs)



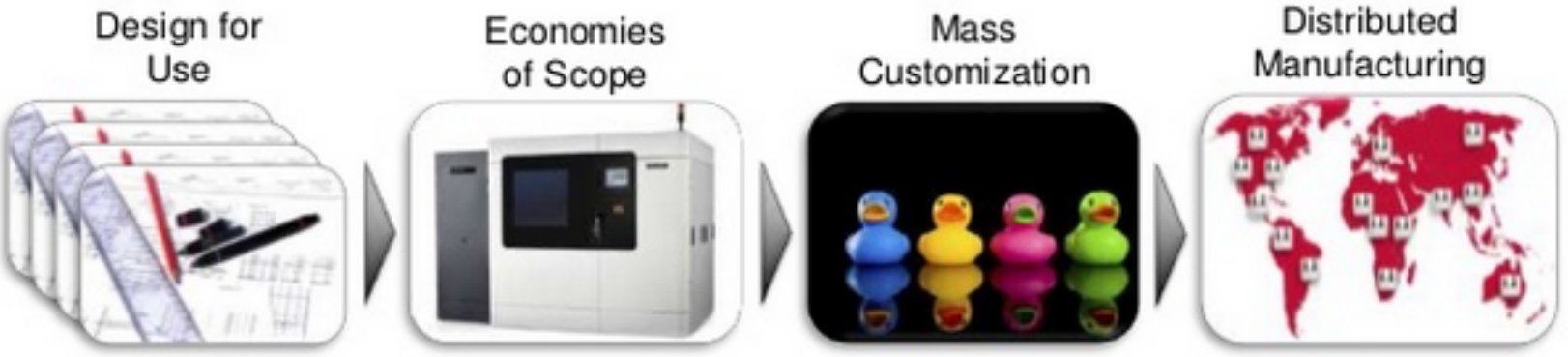
Source: Goldman Sachs Investment Research, 2011.

Trends in manufacturing

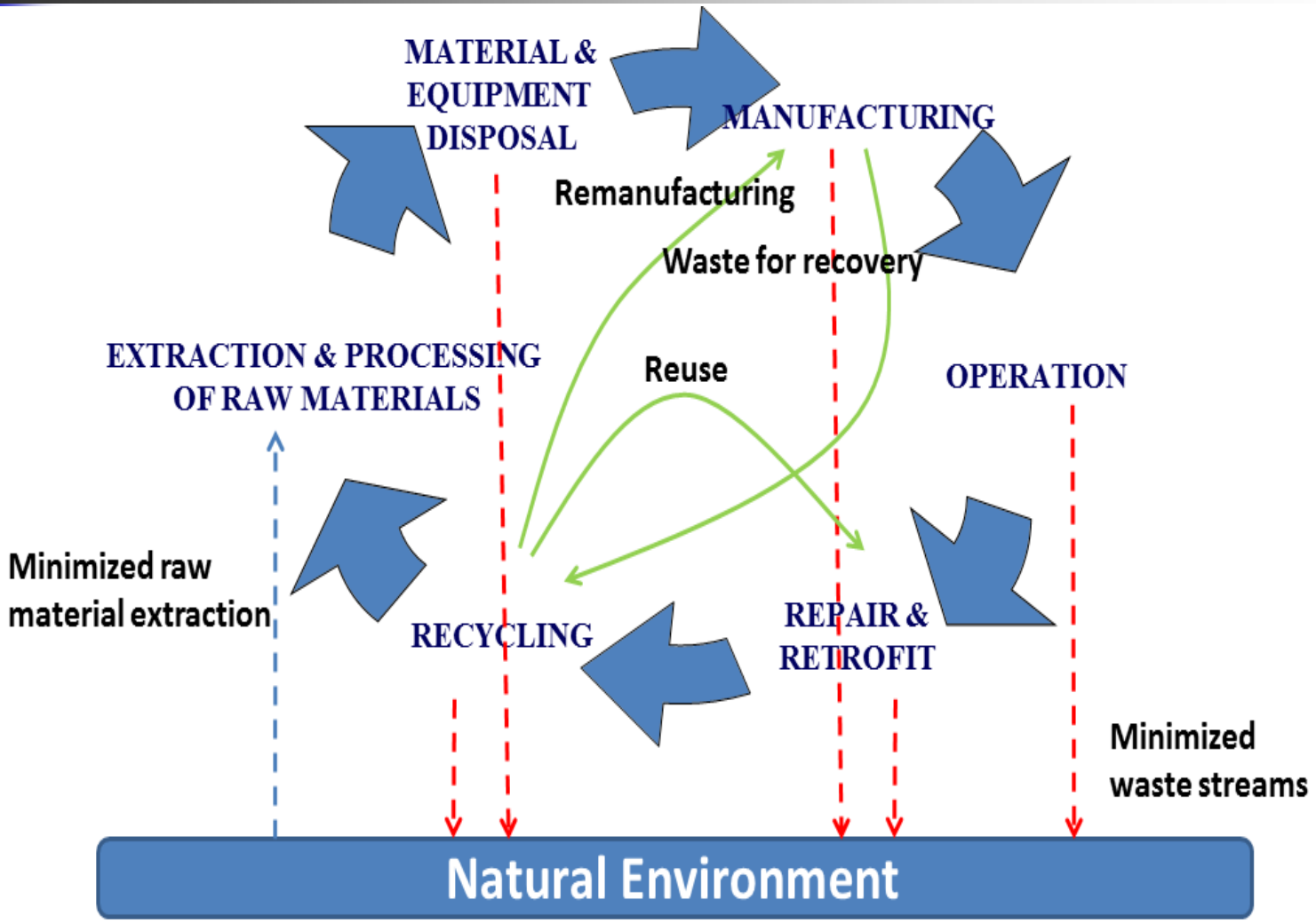
Current State :: Mass Production



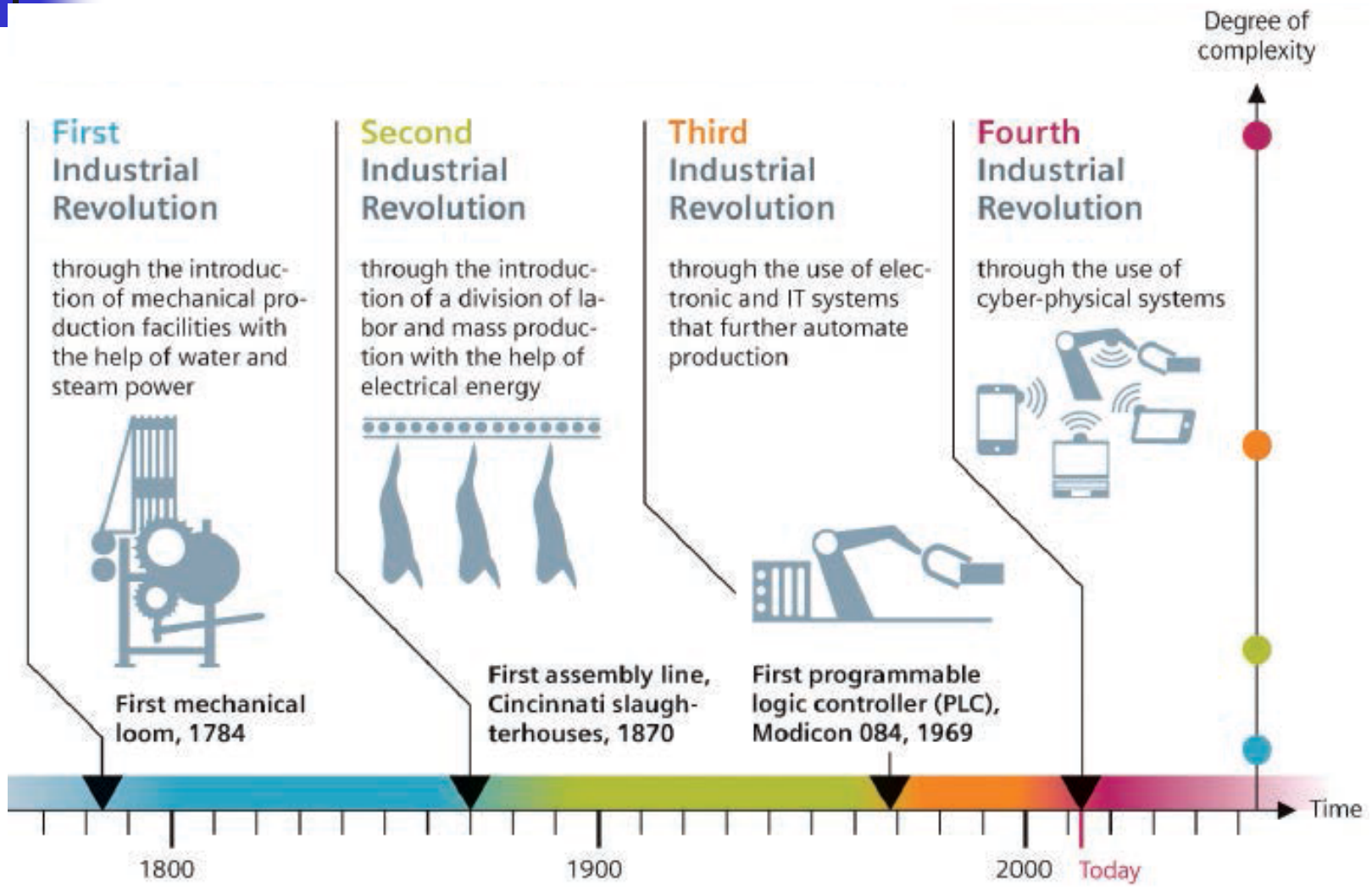
Emerging State :: Mass Customization



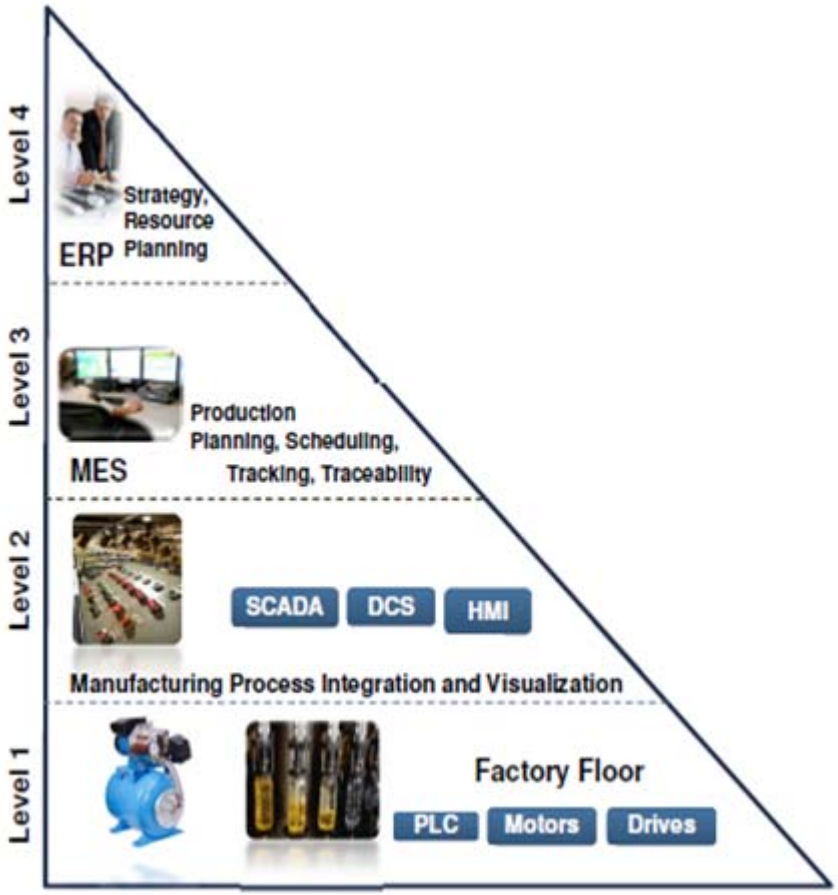
Closed loop manufacturing



The 4th industrial revolution

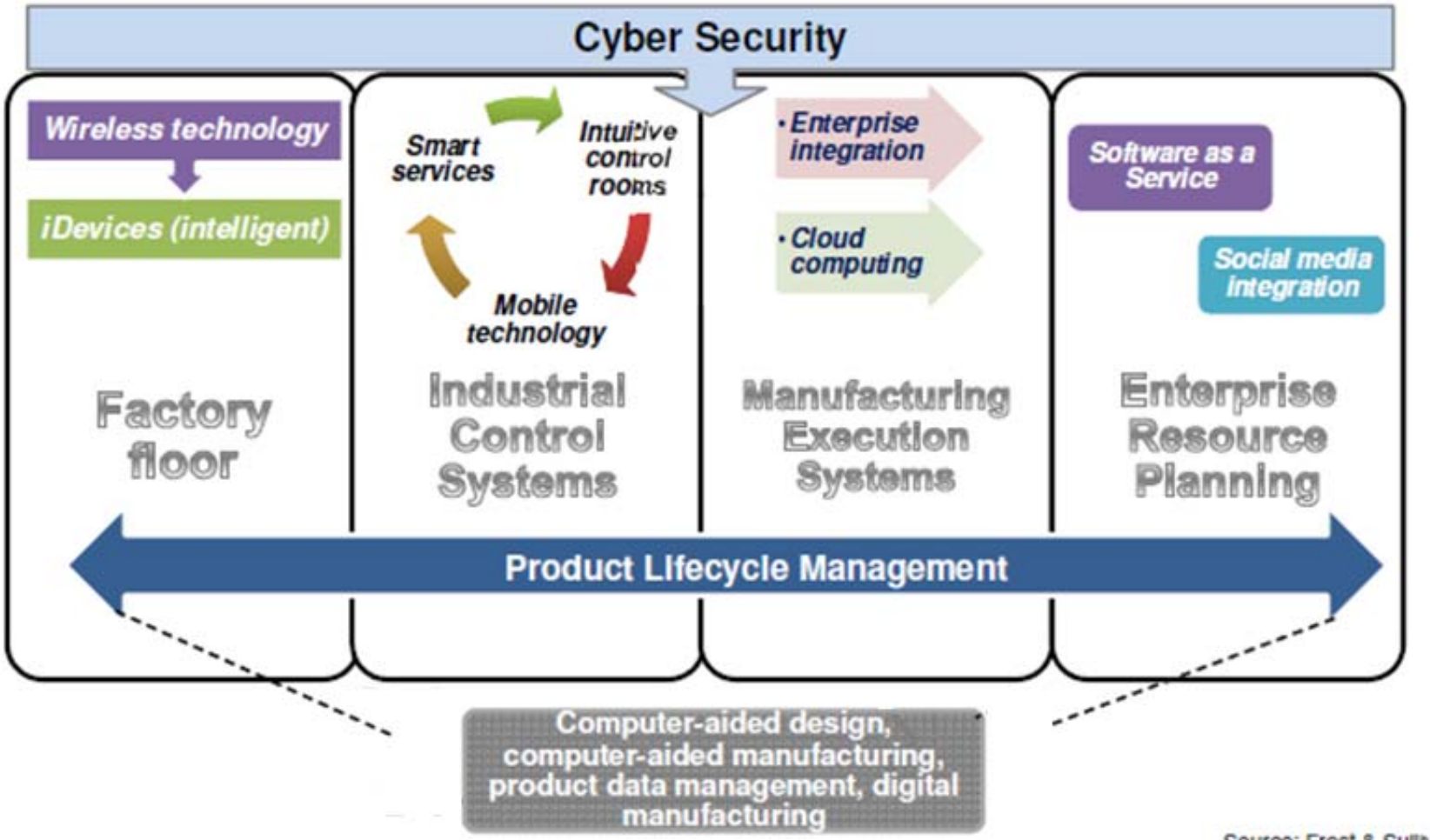


The Enterprise Pyramid



- The Enterprise Pyramid is a comprehensive representation of different operational layers at their respective positions.
- This includes factory floor at Level 1, followed by controls and automation in Level 2, MES at Level 3, and ERP at Level 4.
- In a new development, product life cycle management is expected to be included in the future of enterprise hierarchy, between Levels 3 and 4.

Integrated Enterprise Ecosystem

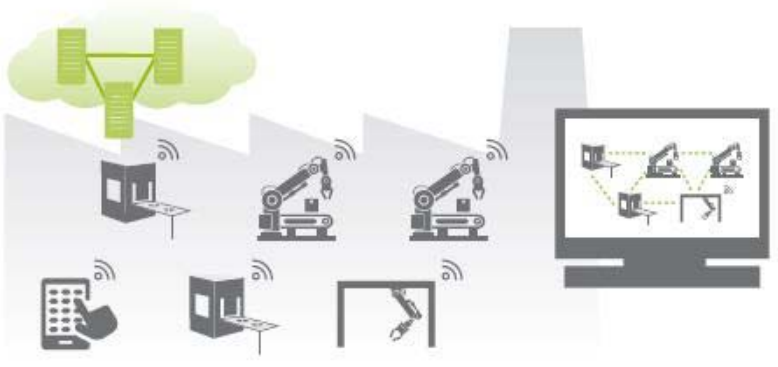


Source: Frost & Sullivan Analysis.

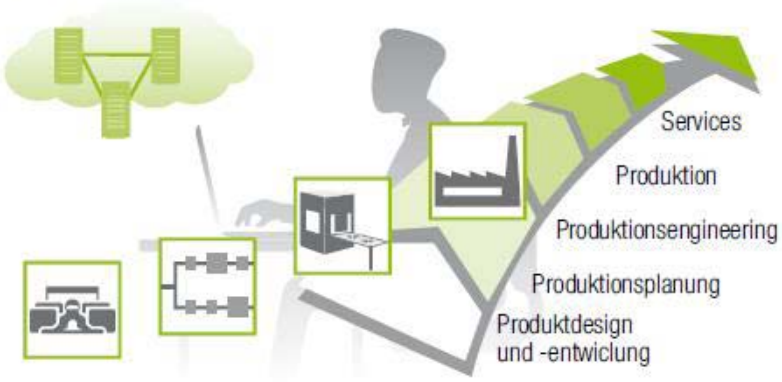
Main Characteristics

Horizontal integration across value networks

Vertical integration & networked production systems



Digital consistency of the engineering across value chain



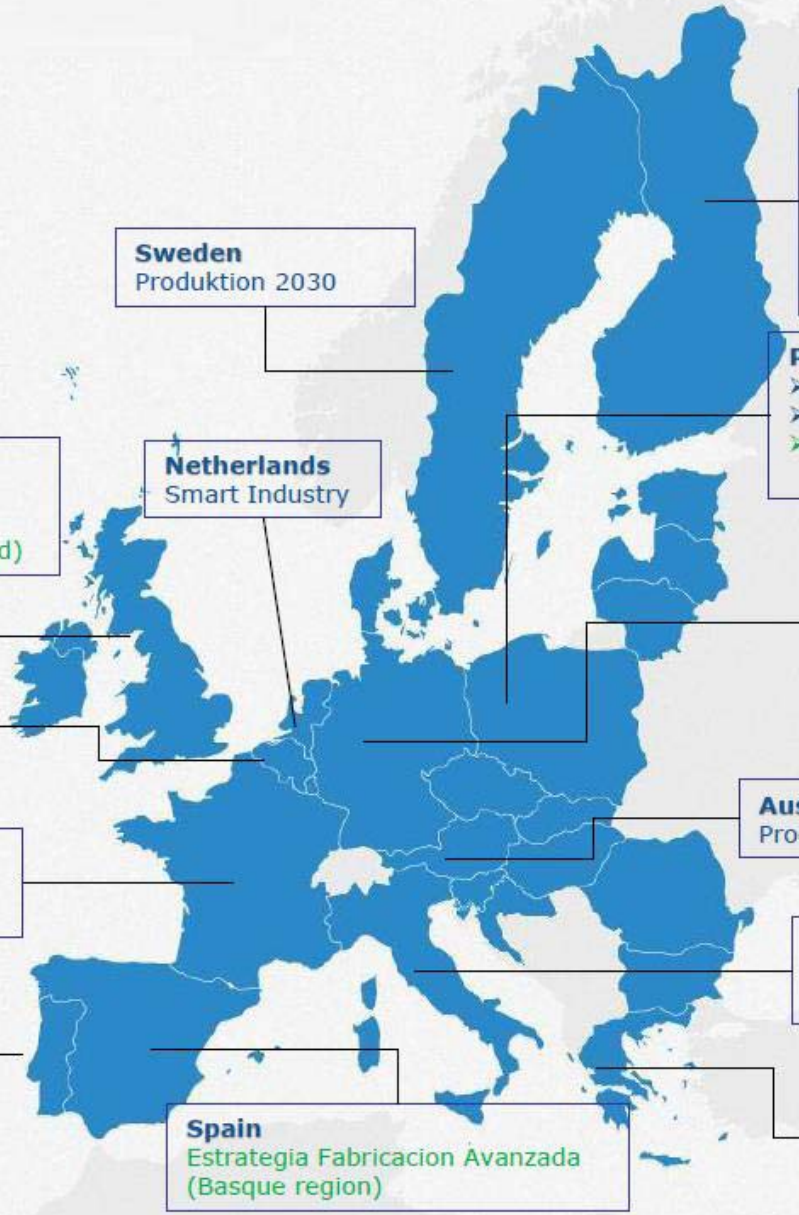
Man as a conductor of the value

Overview of Digital Manufacturing Initiatives across Europe

European Commission

EU-level Initiatives
- Application PPPs: FoF, SPIRE
- I4MS
- Smart Anything Everywhere
- ICT PPPs

Multi-region Initiatives
- Vanguard



Finland
- FIMECC PPP Programmes (MANU, S-STEP, SIMP, S4FLeet)
- Industrial Internet Business Revolution
- IoT pilot Factory (IoT PFF)

Sweden
Produktion 2030

Poland
- INNOMOTO
- INNOLOT
- Digital manufacturing for the SME (Mazovia)

United Kingdom
- High Value Manufacturing
- Innovate UK
- Action Plan for Manufacturing (Scotland)

Netherlands
Smart Industry

Germany
- Industrie 4,0
- Smart Service World
- Autonomik fur Industrie 4.0
- It's OWL (Ostwestfalen-Lippe)
- Allianz Industrie 4.0 (Baden-Württemberg)

Belgium
- Made Different
- Flanders Make/iMinds (Flanders)

Austria
Produktion der Zukunft

France
- Usine du Futur
- FoF Ile-de-France

Italy
- Fabbrica Intelligente
- Ass. Fabbr. Intell. Lombardia

Portugal
Produtech

Spain
Estrategia Fabricacion Avanzada (Basque region)

Greece
Operational Programme in Region Western Greece

European initiatives are in red
National initiatives are in blue
Regional initiatives are in green

European Commission
DG CONNECT, Unit A3, ML

Project & Initiatives

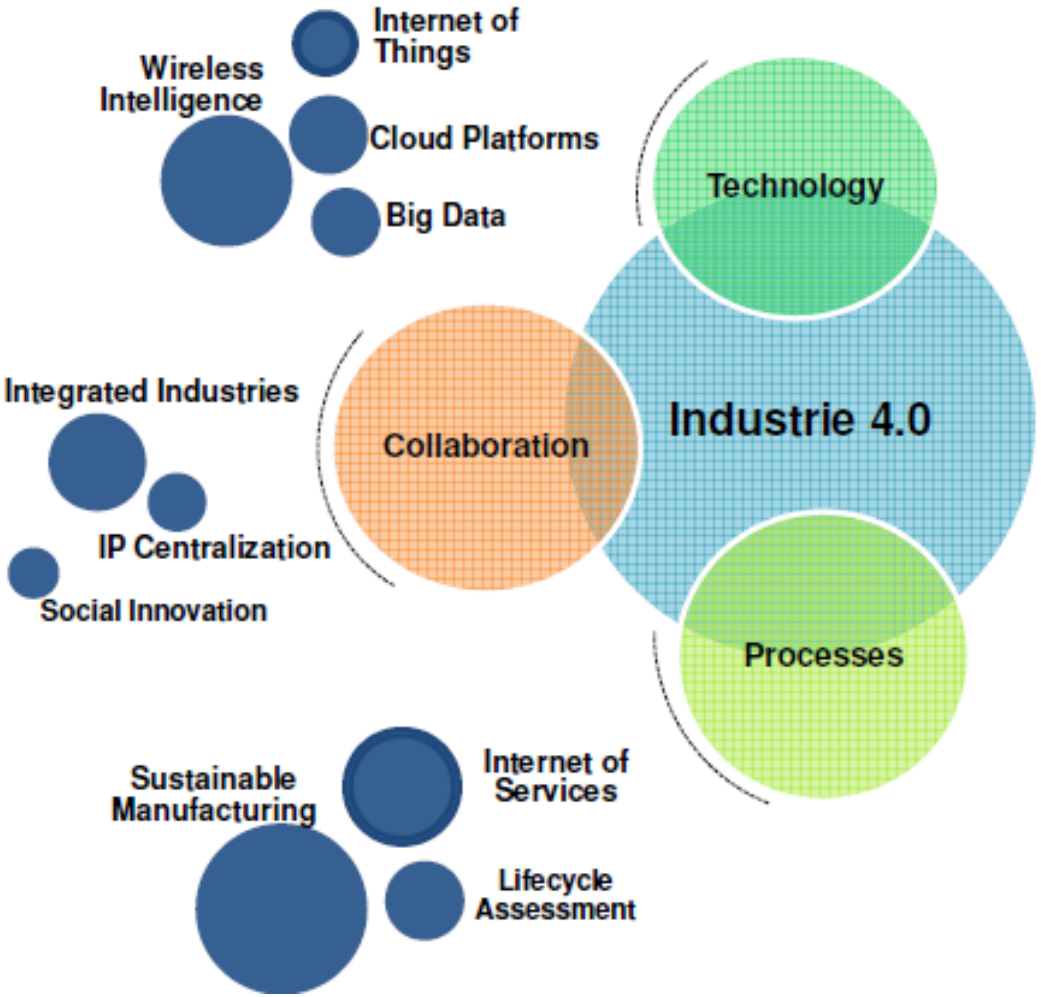
Consequences and implications

Strategic trends

-Convergence of applications will form conditions of new advancements

-Energy efficiency and sustainability to gain greater business focus

-Greater presence of mobility and web-based information systems



Critical factors

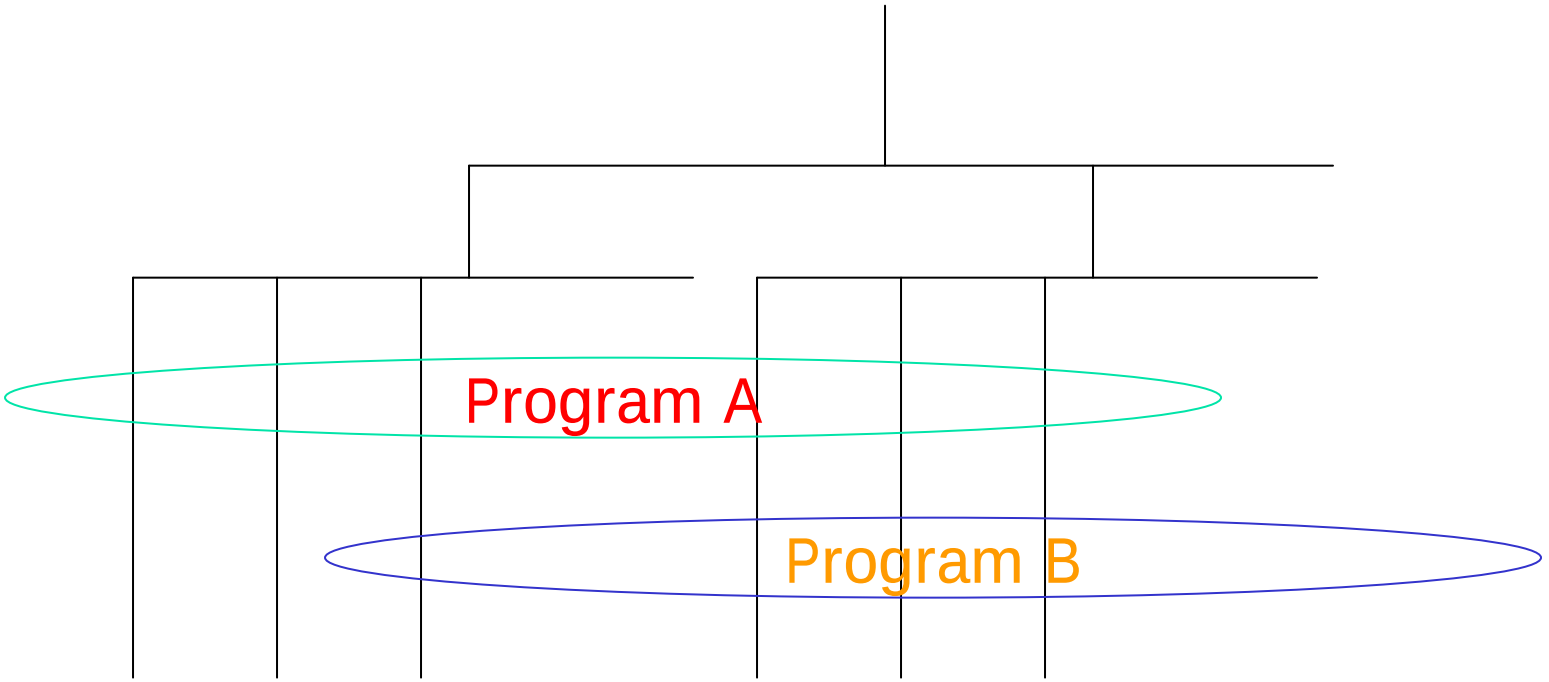
- Expert knowledge, flexibility, creativity and innovation;
- Convergence of production and interaction, work and communication are increasingly interdisciplinary competencies for staying economically competitive.
- For companies and businesses, however, these competencies do not just appear out of nowhere.

Our way of behaving

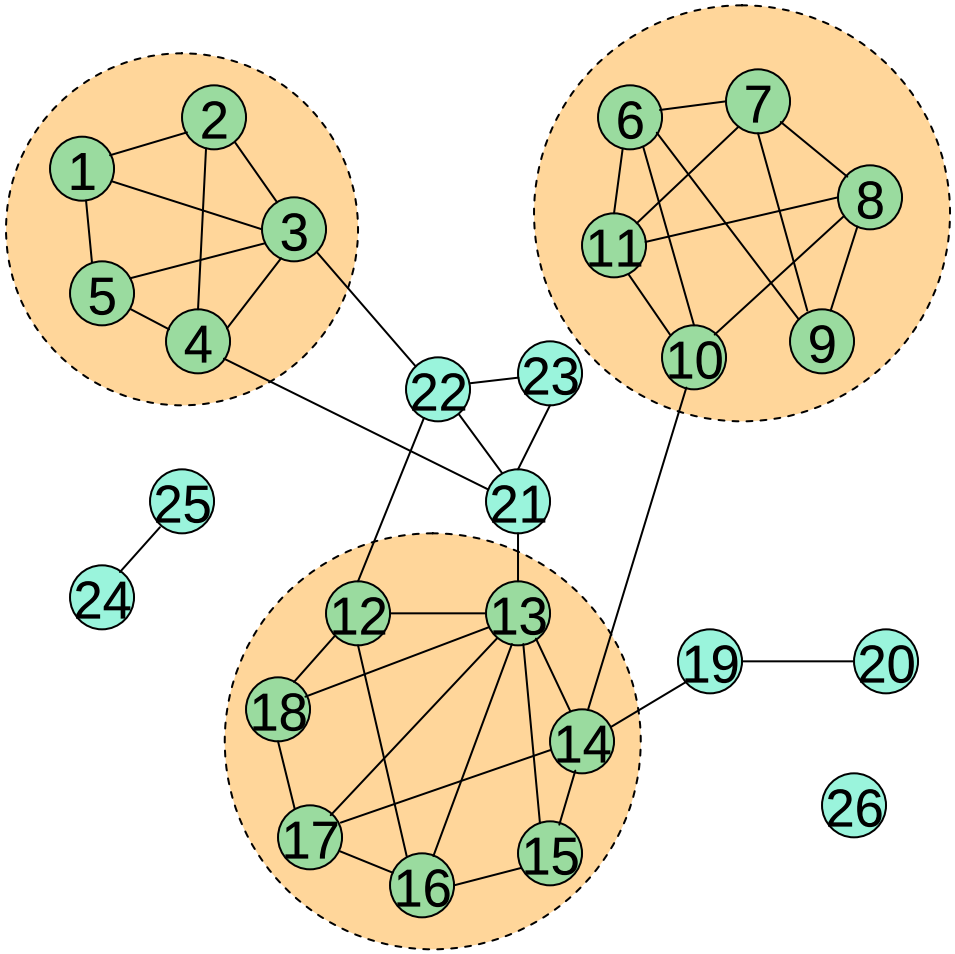
Intellectual Social Responsibility

- Multivalent logic
- Synthetic thinking
- Integrative learning
- Focus on results
- Generate Synergies
- Team work
- Active involvement

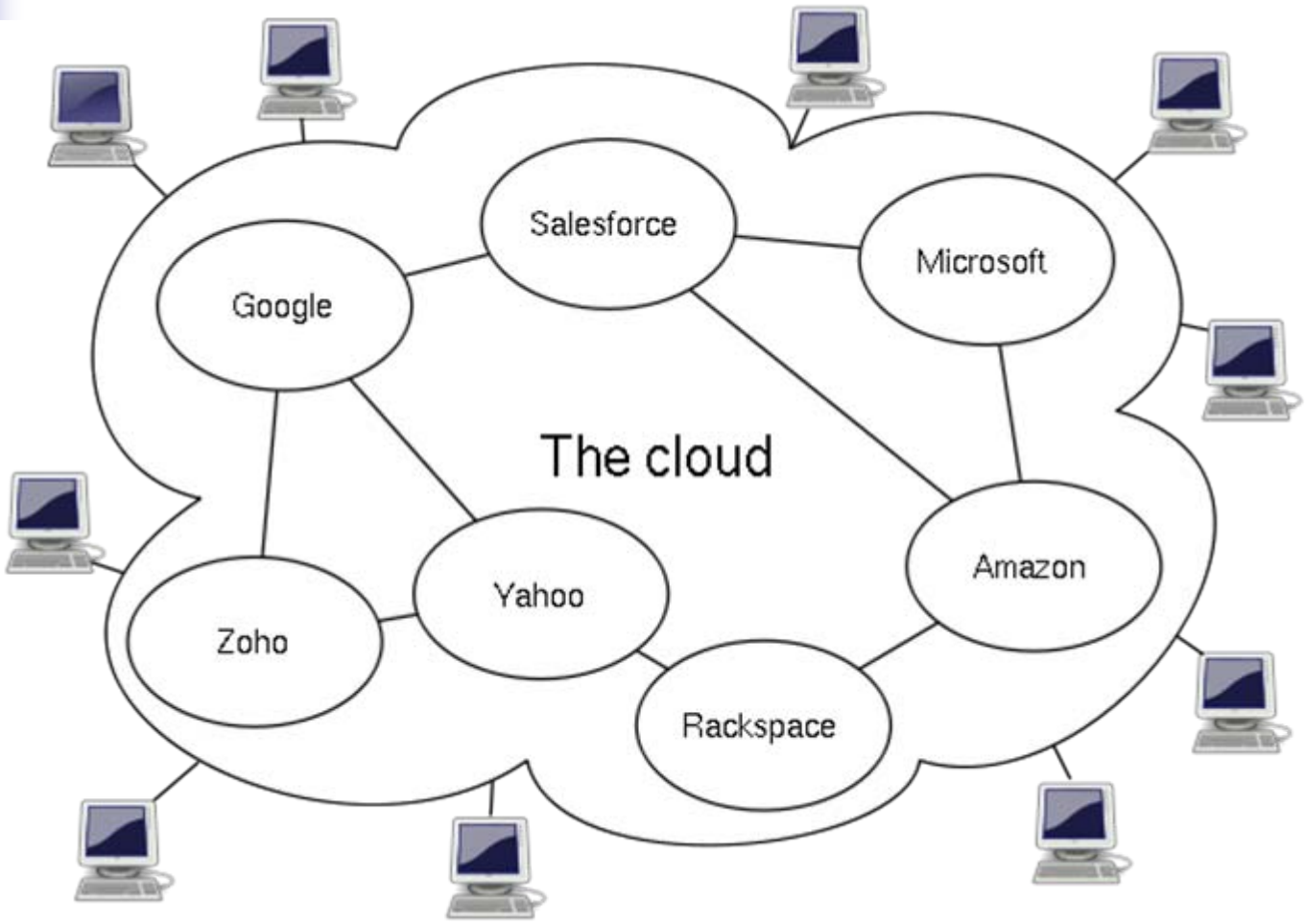
Matrix universities



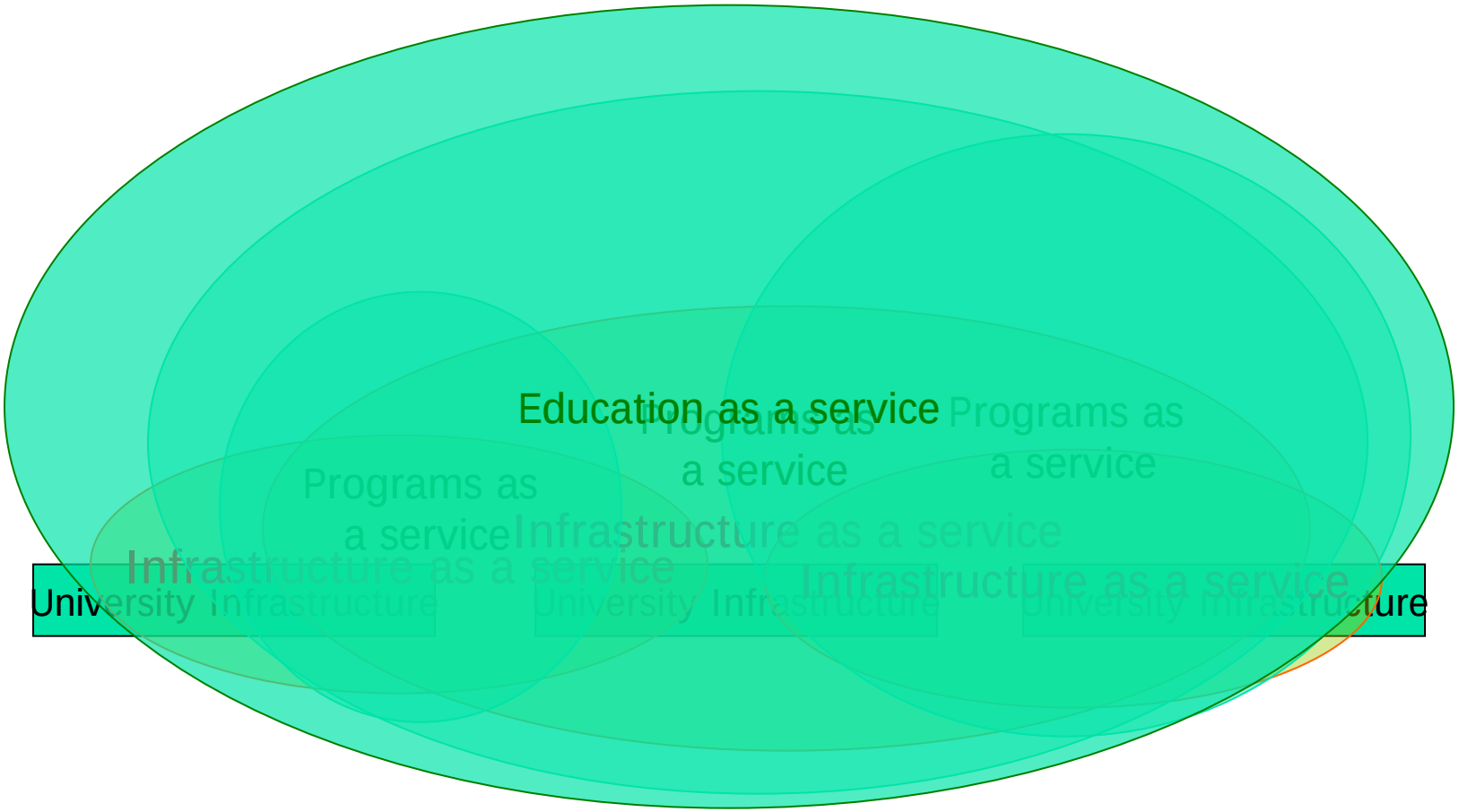
Network of universities / Network university



Cloud computing and .....



Cloud Universities



Black Sea Universities Network

- **Aim:** The Network was founded for the purpose of developing scientific, cultural and educational cooperation and exchanges among the Universities of the Black Sea Economic Cooperation Participating States and other institutions with similar concern for the sustainable development of the BSR
- **Members:** 120 Universities of 12 BSEC member countries
- **Bodies:** Conference of Rectors of BSR, Executive Board, President, IPS
- **Centers:** Center for Advanced Engineering Sciences (Romania), "B. S. Cobanzade" Research Center on Turkology, Baku State University, Center ACADEMICON (Turkey), Center for Coordination of Common Graduate Programs (Greece), Center for Coordination of Summer Schools & Short Term Certificate Courses (Ukraine), Center for Joint Research Projects (Azerbaijan), Center for BSUN Publications (Bulgaria),
- **Consortia:** BSUN Consortium on Economics & Business, Consortium on Oral Health, Consortium on Tourism, Consortium on RES.
- **Web site:** Http://www.bsun.org

UN Academic Impact

Academic Impact is a global initiative that aligns institutions of higher education with the United Nations in actively supporting ten universally accepted principles in the areas of human rights, literacy, sustainability and conflict resolution. The Academic Impact also asks each participating college or university to actively demonstrate support of at least one of those principles each year.

Principles:

1. **A commitment to the principles inherent in the United Nations Charter as values that education seeks to promote and help fulfill;**
2. **A commitment to human rights, among them freedom of inquiry, opinion, and speech;**
3. **A commitment to educational opportunity for all people regardless of gender, race, religion or ethnicity;**
4. **A commitment to the opportunity for every interested individual to acquire the skills and knowledge necessary for the pursuit of higher education;**
5. **A commitment to building capacity in higher education systems across the world;**
6. **A commitment to encouraging global citizenship through education;**
7. **A commitment to advancing peace and conflict resolution through education;**
8. **A commitment to addressing issues of poverty through education;**
9. **A commitment to promoting sustainability through education;**
10. **A commitment to promoting inter-cultural dialogue and understanding, and the "unlearning" of intolerance, through education.**

UNAI Hub on Sustainability

Language: ENG

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United Nations Academic Impact Initiative

Academic Impact is a program of the Outreach Division of the Department of Public Information. It is open to all institutions of higher education granting degrees or their equivalent, as well as bodies whose substantive responsibilities relate to the conduct of research. Its essential frame of reference is:

EVENTS

- Sustainable Energy Day in Constantza (2011-04-12)
- International Conference on "Education & Governance for Sustainable Development" (2011-03-16 ⇒ 2011-03-19)
- CREATING A CULTURE OF INTELLECTUAL SOCIAL RESPONSIBILITY (2011-03-15)

more >>>

NEWS

- Research priorities on socio-economics aspects of the Danube River - Danube Delta - Black Sea region
- European Union Sustainable Energy Week 11-15 April 2011
- unai-sustainability.org website launch

UNITED NATIONS academic impact IN ACTION

Sharing a Culture of Intellectual Social Responsibility

We Believe

Black Sea Universities Network BSUN

SUSTAINABLE DEVELOPMENT

Sustainable Development: to meet the needs of the present without compromising the ability of the future generations to meet their own needs

Strategy Mix:

- efficiency – enhanced productivity / resource
- consistency – enhanced economies embedded in the natural cycles
- sufficiency – new concept of prosperity / satisfaction / material wealth

Management rules:

- the use of renewable natural resources must not exceed their regeneration rates
- the use of non-renewable natural resources must not exceed the rate of substituting their respective functions
- the emissions of pollutants must not exceed nature's capability to adapt

ECO-INNOVATION

The term environmental innovation, or shortly 'eco-innovation', relates to innovations aiming at a decreased negative influence of innovations on the natural environment.

Eco-innovation is "the creation of novel and competitively priced goods, processes, systems, services, and procedures designed to satisfy human needs and provide a better quality of life for everyone with a life-cycle minimal use of natural resources (materials including energy and surface area) per unit output, and a minimal release of toxic substances".

GREEN ECONOMY

Improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.

In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive.

Practically speaking, a green economy is one whose growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services.

UNEP, 2012

GREEN ECONOMY

- Emphasis on renewable sources;
- Minimal use of resources;
- Minimal release of emissions on a Life Cycle approach;
- Generation of new business opportunities;
- Generation of sustainable new jobs.

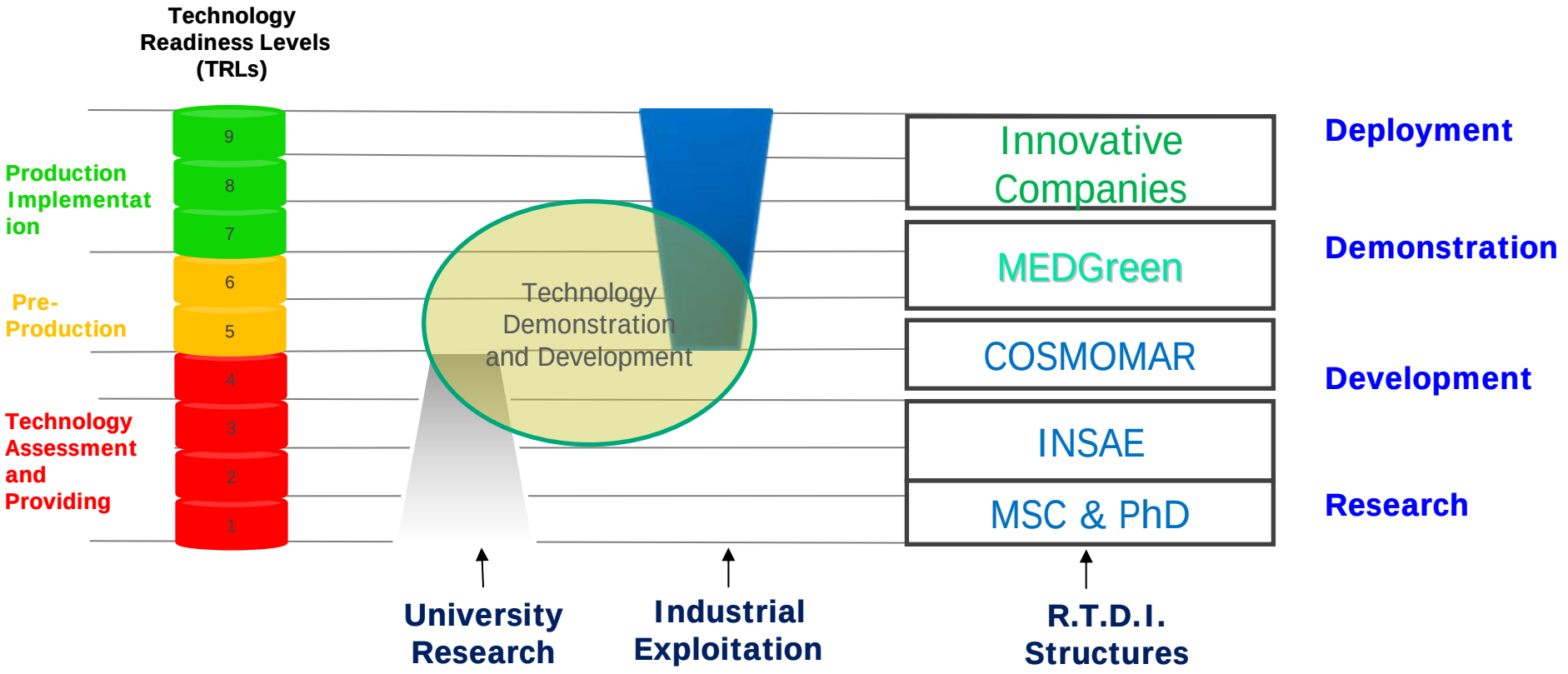
HOLISTIC ENGINEERING

The classical definition of engineering: The application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems

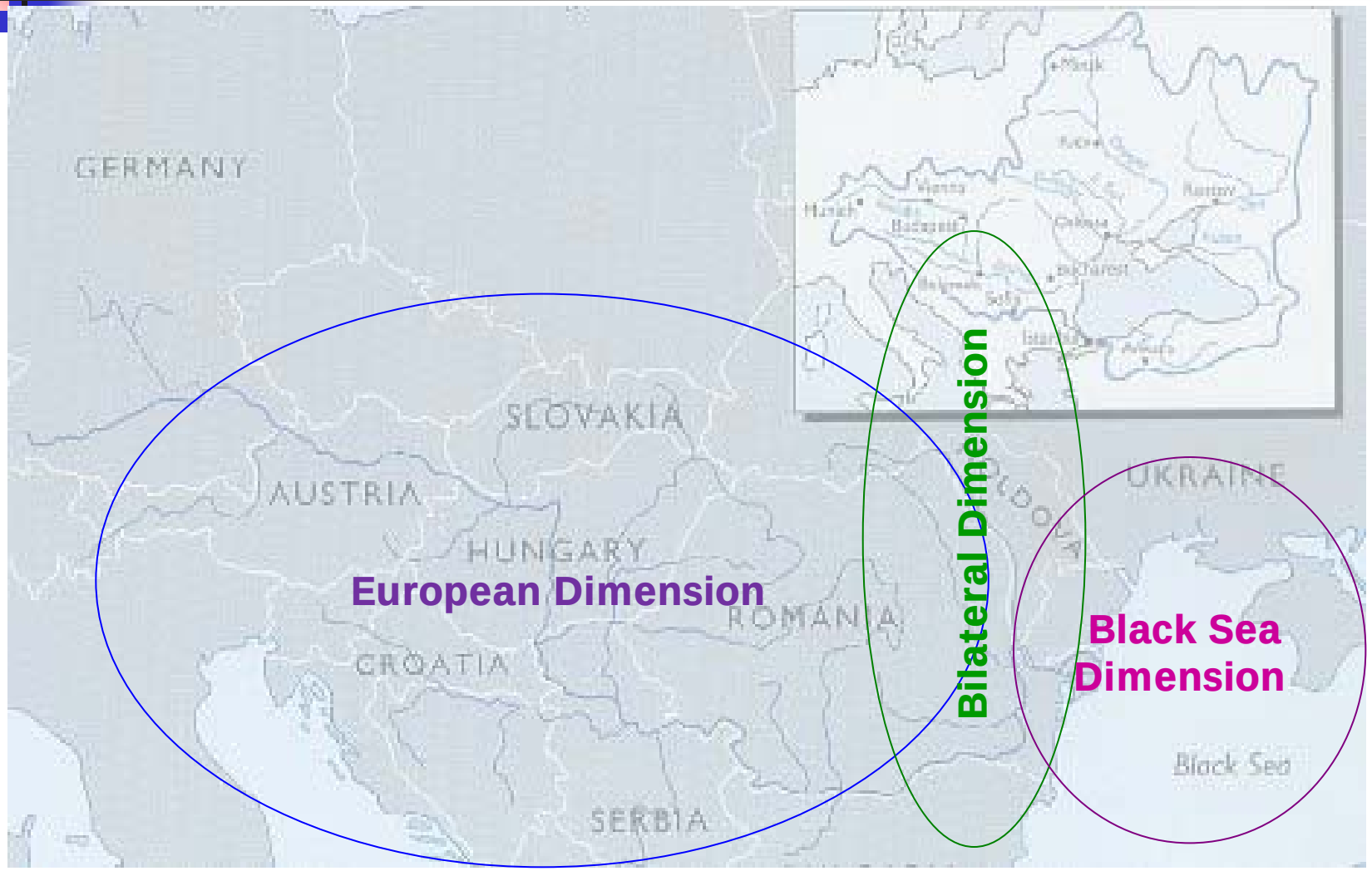
In the current context of the development of the mankind society complexity of the needs require to address them by emphasizing a more cross-disciplinary, whole-systems approach to engineering.

Holistic Engineering - the Art and Science of creating effective systems, using whole system, whole life principles.

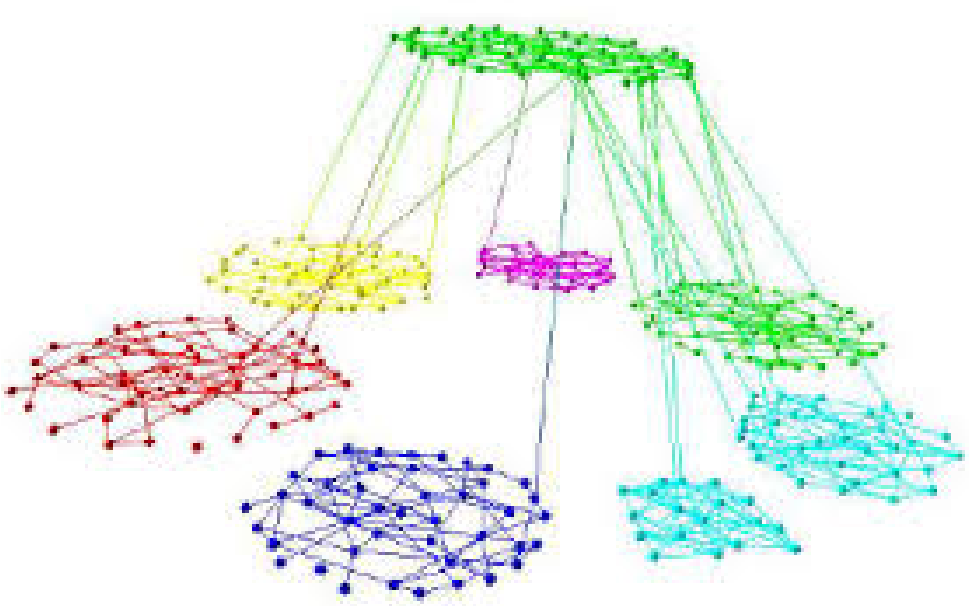
Implementing an ecoinnovation culture!

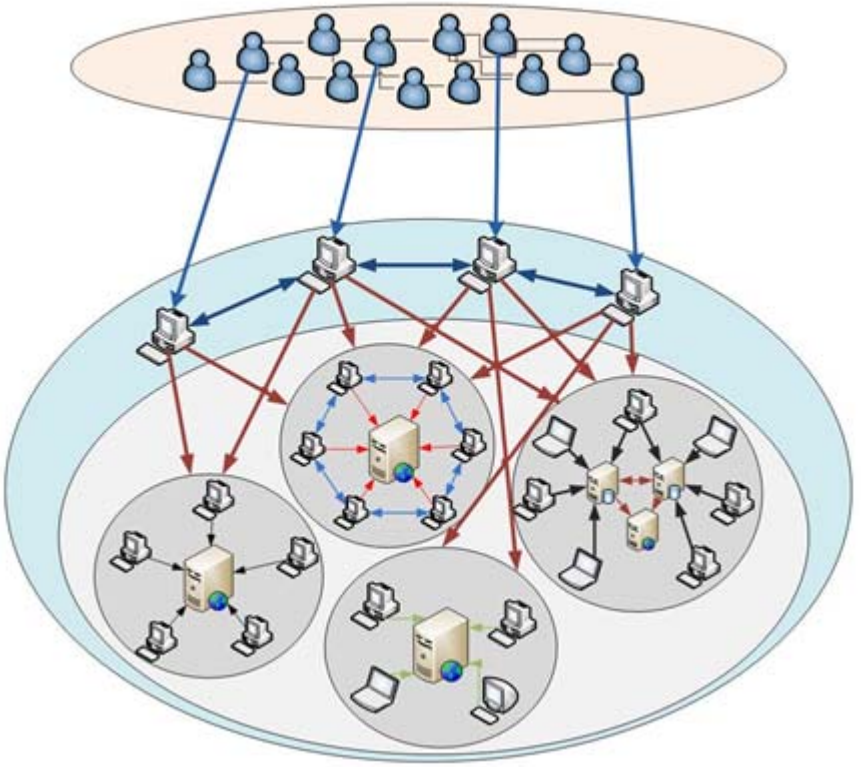


SCALES

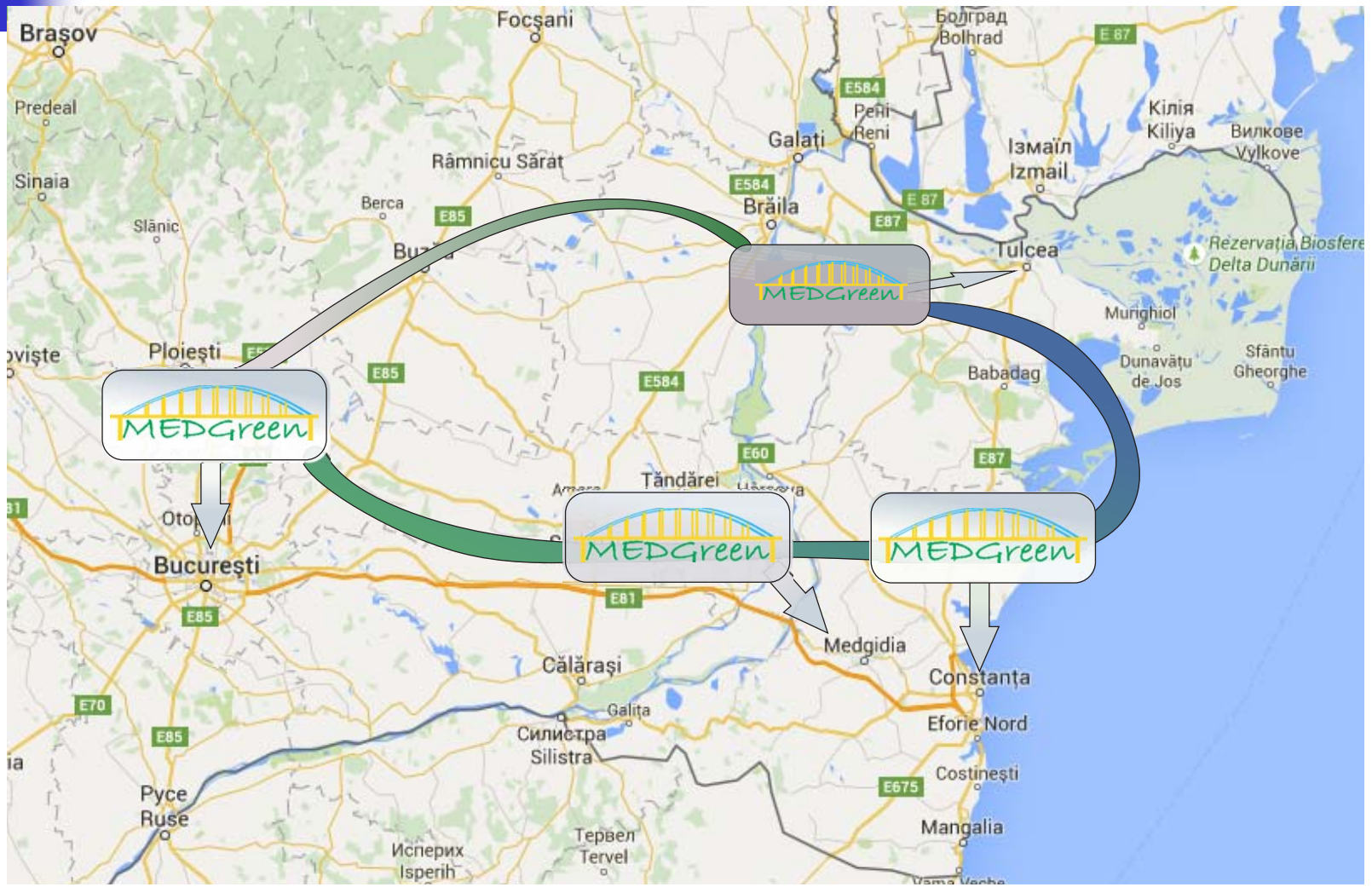

GERMANY
SLOVAKIA
AUSTRIA
HUNGARY
ROMANIA
CROATIA
SERBIA
UKRAINE
Black Sea
European Dimension
Bilateral Dimension
Black Sea Dimension

CLUSTER STRUCTURES





Case study: Cluster MEDGreen



The MEDGreen Cluster

The MEDGreen Cluster is a cluster of innovative companies and stakeholders for promotion of eco-technologies and alternative sources of energy.

In 2012, it has been established a National Pole of Competitiveness on Green Economy involving the most relevant partners as companies, research organizations, universities and local authorities.

The grouping has been registered in 2013 as the Association MEDGreen-Innovative Cluster of companies specialized on ecotechnologies and alternative sources of energy.

The association has been granted with the financial support for the implementation of the project “The development of solutions innovative products and services that will enhance the competitive advantages of companies associated in the cluster MEDGreen".

MEDGreen Cluster is collaborating with the other national and European associations specialized on the promotion of bio-energy on the Romanian and European market.

Design Framework

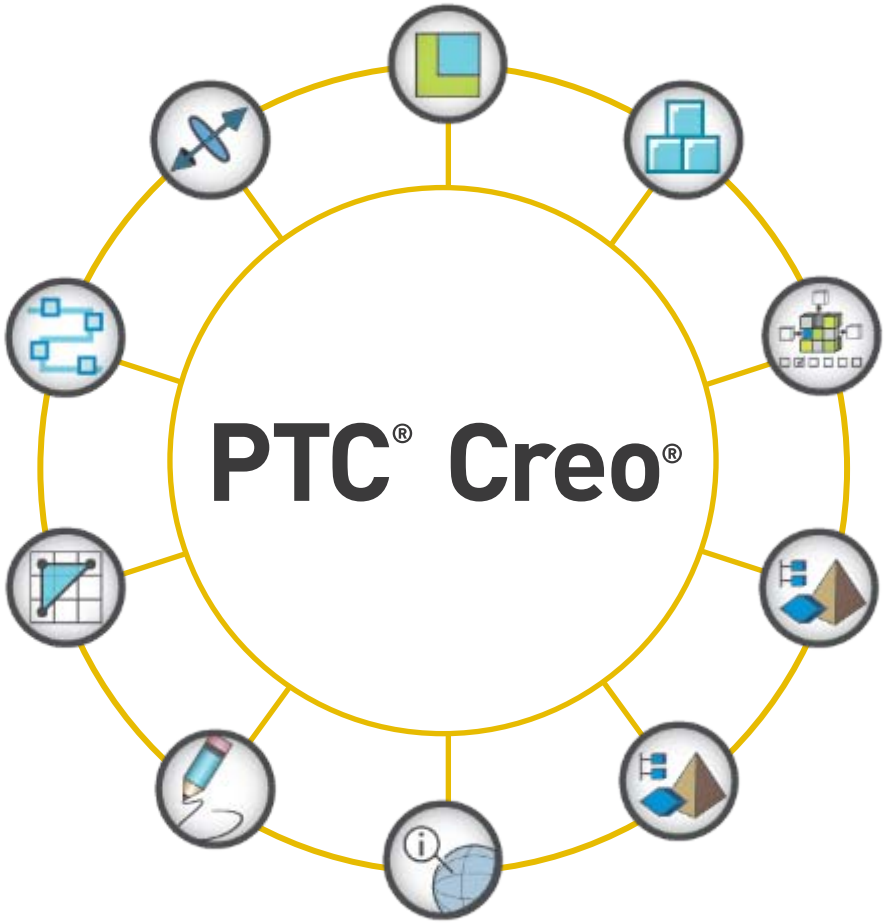
A usable suite of product design software

•Configurable user interface

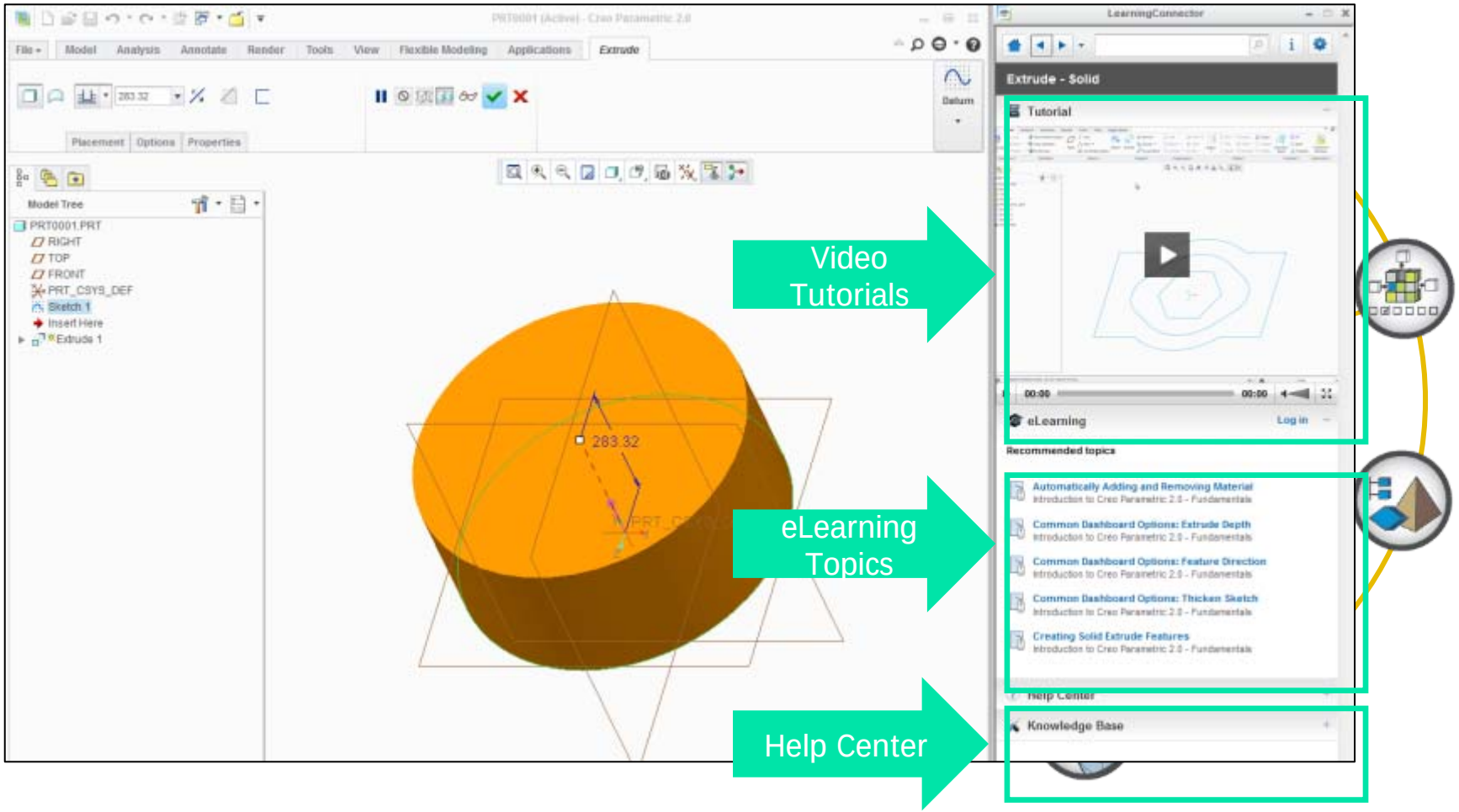
•Quickly capture design intent:
Freestyle

•Make late stage design changes:
Flexible Modeling Extension

•One demand support:
PTC Learning Connector



Design Framework



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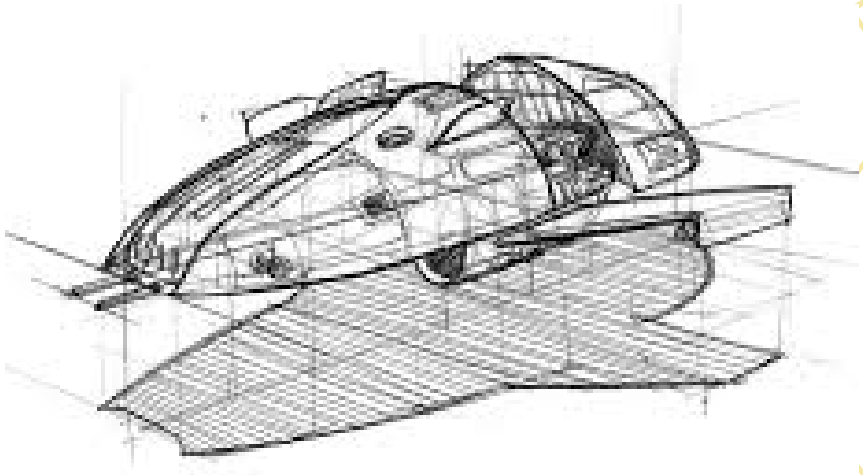
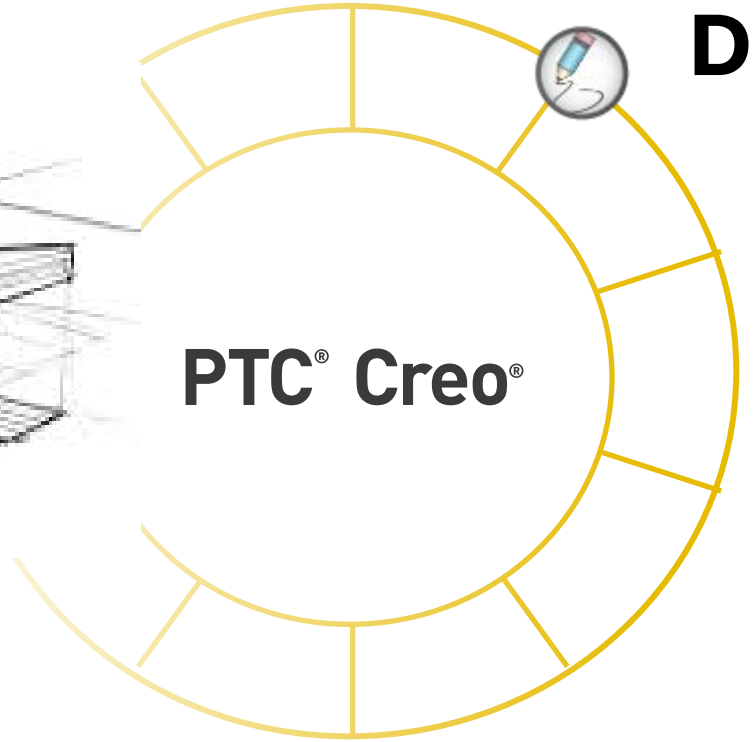
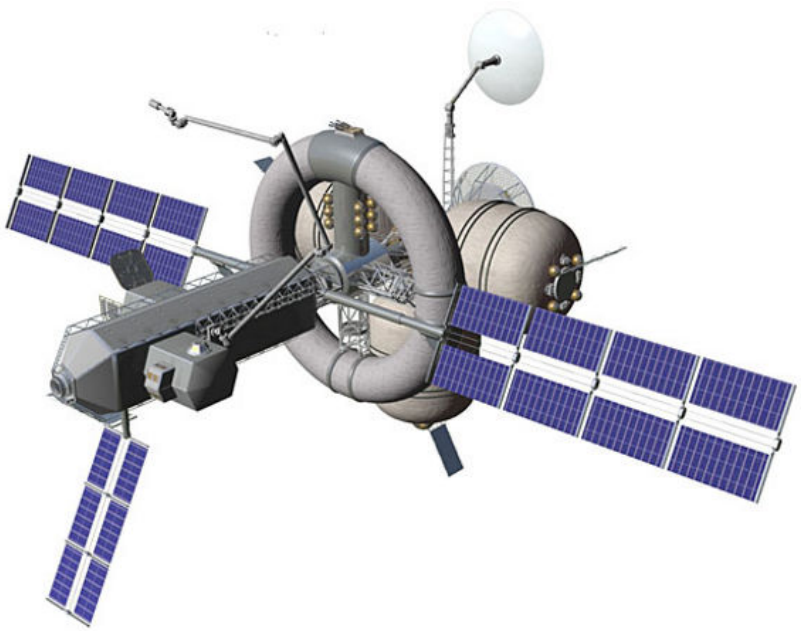


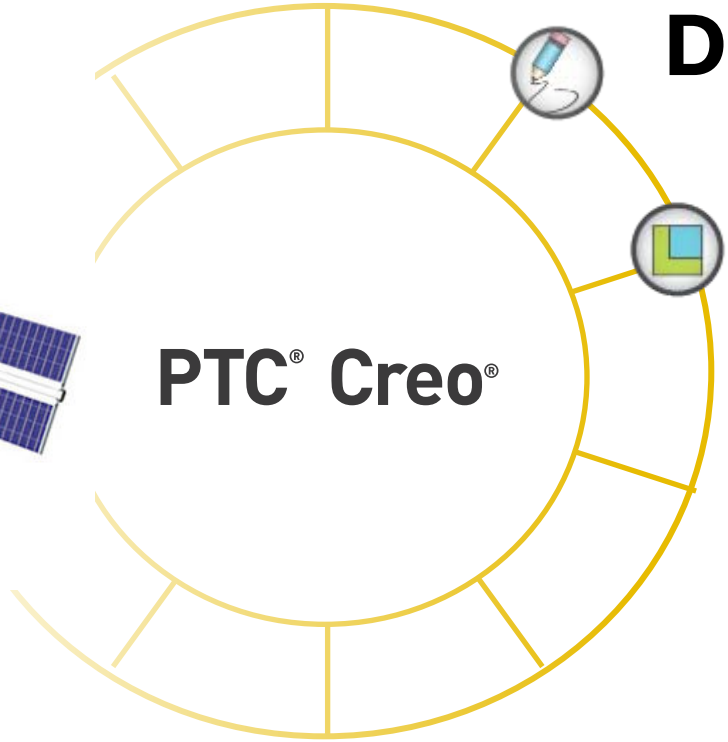


PTC Creo Sketch

PTC Creo Schematics

Design Framework





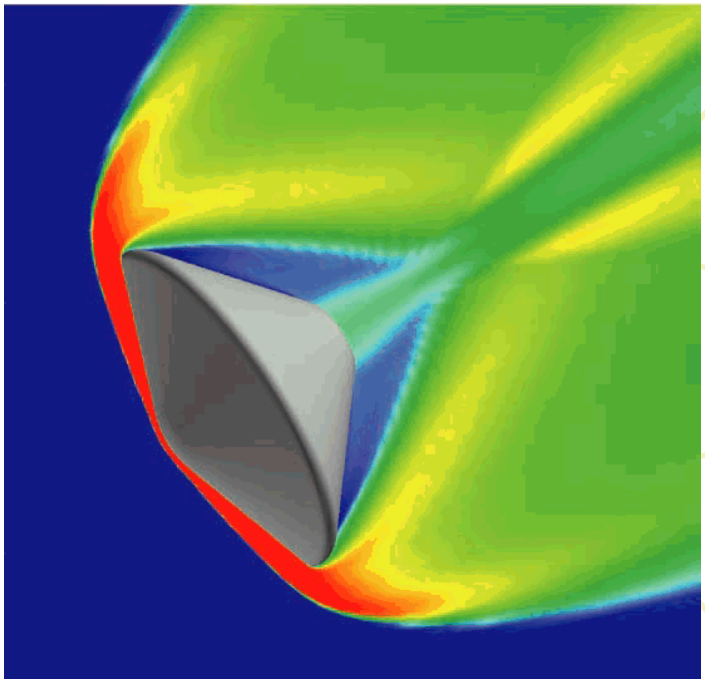
Draw

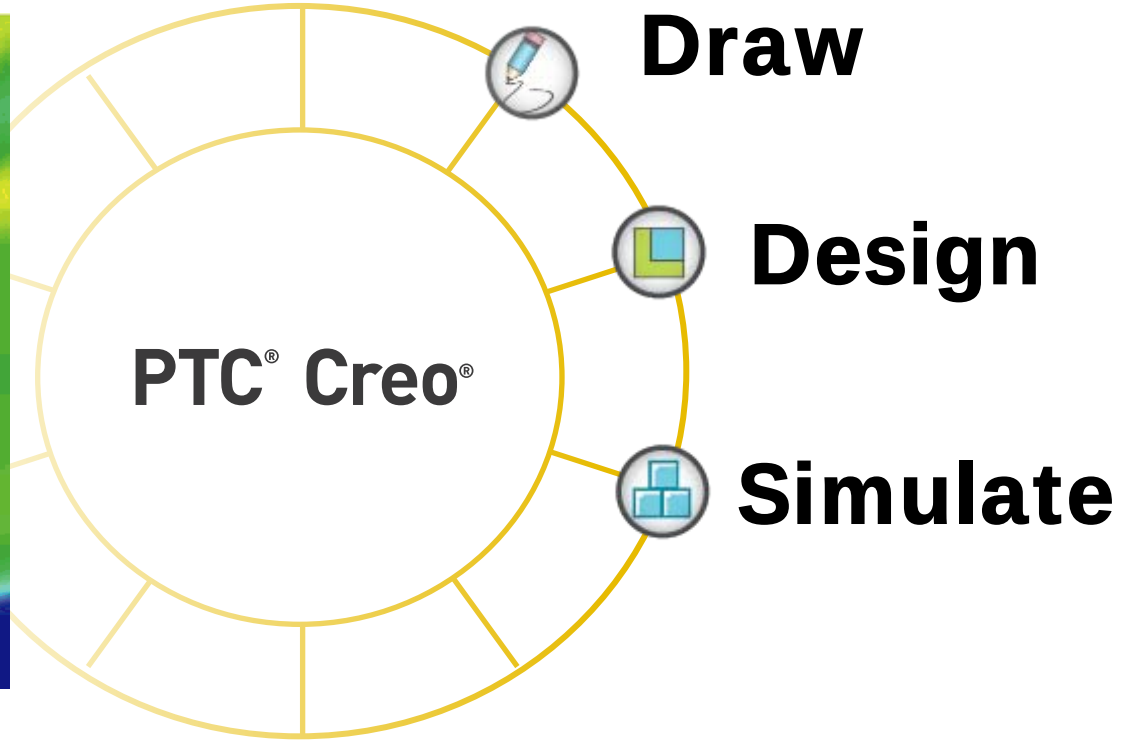
Design

PTC Creo Parametric

PTC Creo Direct

Design Framework



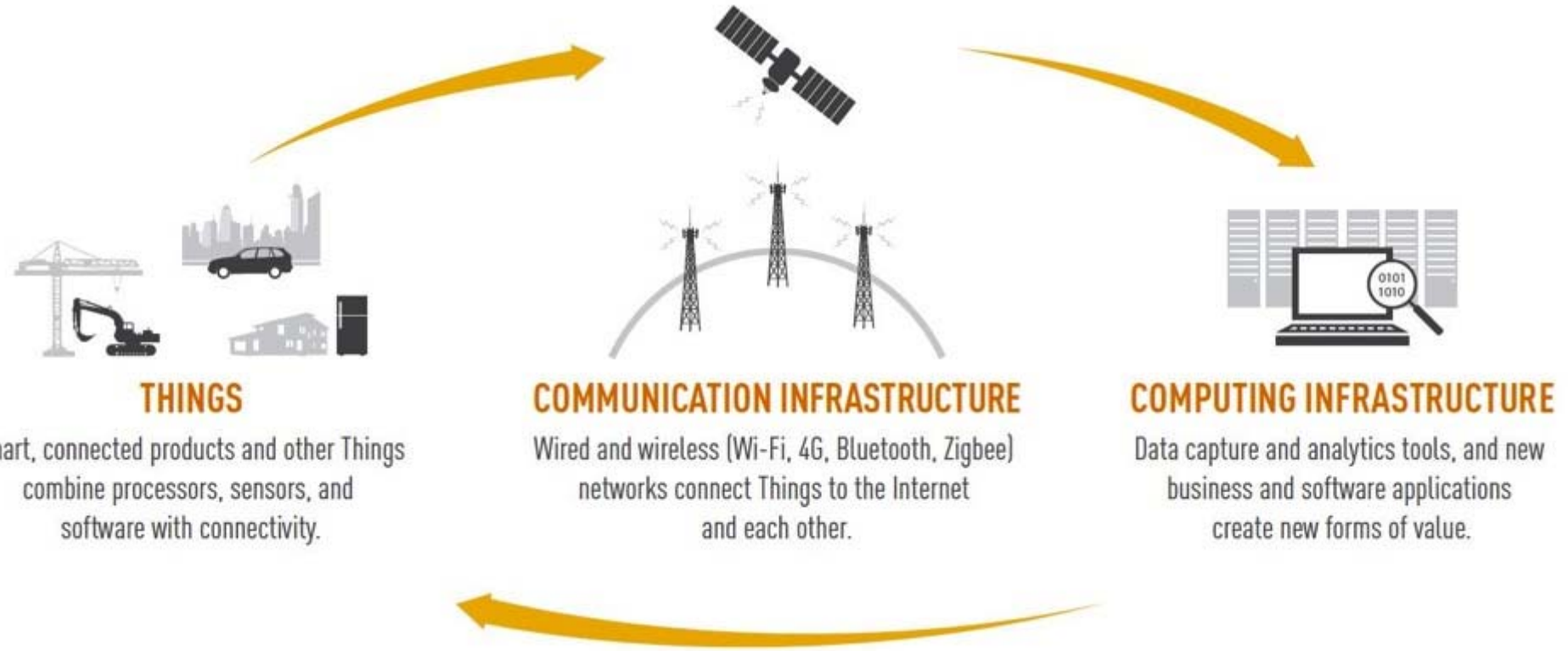


PTC Creo Simulate

Design Framework

PTC Creo Parametric

Smart, connected products, products systems and other Things connected through Internet-like communication infrastructure to a computing infrastructure that are changing the world.



Smart, Connected Product
Connected through a wire or wireless

Many to Many

One to Many

One to One

Smart Product

Enhanced UI
Ability to Interact

Software
Ability to Think

Sensors
Ability to Sense

Electronics and Controls
Ability to Process

Physical Product

Electrical

Mechanical

The Internet of Things Changes Business Models

	Definition	Traditional	IoT
Value Creation	Activities that increase the value of a company's offerings	Solve for existing needs in a reactive manner	Address needs in real time and predict future needs
Value Capture	How to get people to pay for what a company offers	Sell the product or device	Enable recurring revenue

ThingWorx – Complete & Designed for Purpose

Dynamic Applications

ThingWorx Rapid Application Dev. Platform

MASHUP BUILDER | SQUEAL | 3RD PARTY TOOLS

REST APIs

SYSTEM SERVICE INTEGRATION

BUSINESS LOGIC
Properties/Services/Events

3D STORAGE ENGINE

COMMUNICATIONS AlwaysOn™, REST, API, MQTT, Sockets, etc.

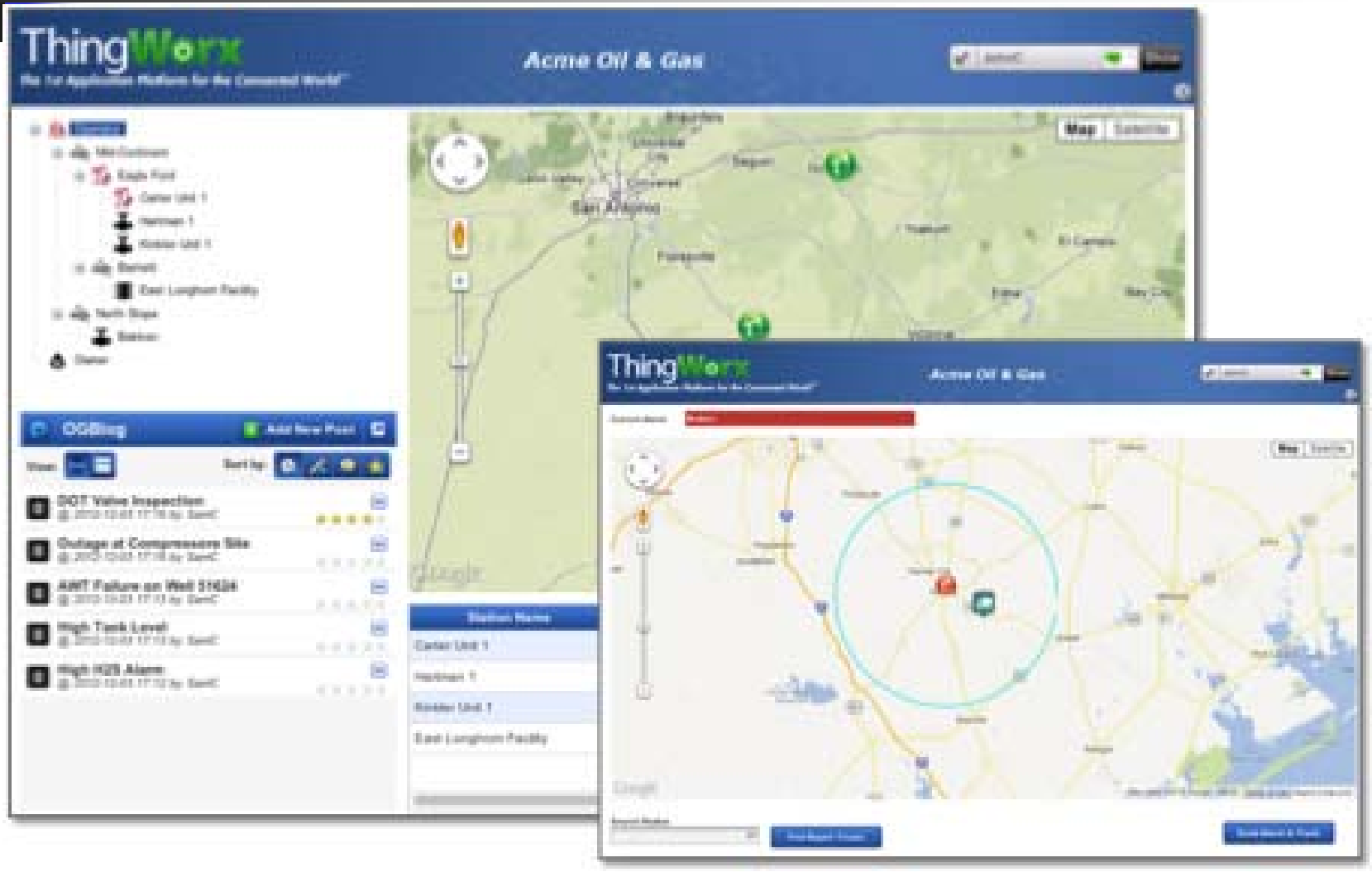
ThingWorx
A PTC Business

The Network

Sensors, Devices & Equip.

Applications in Manufacturing

Applications in Oil & Gas

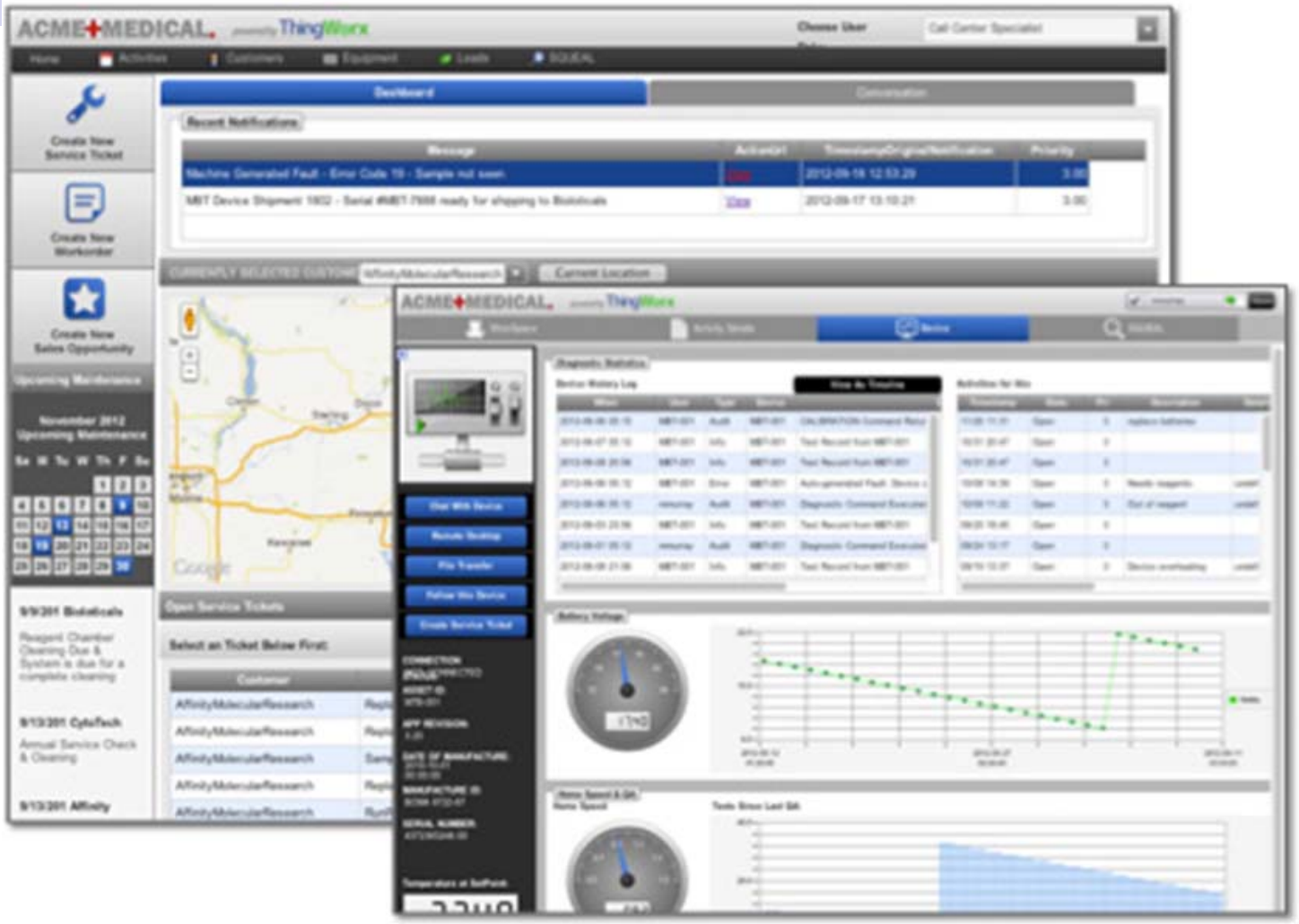


Smart Grids / Energy

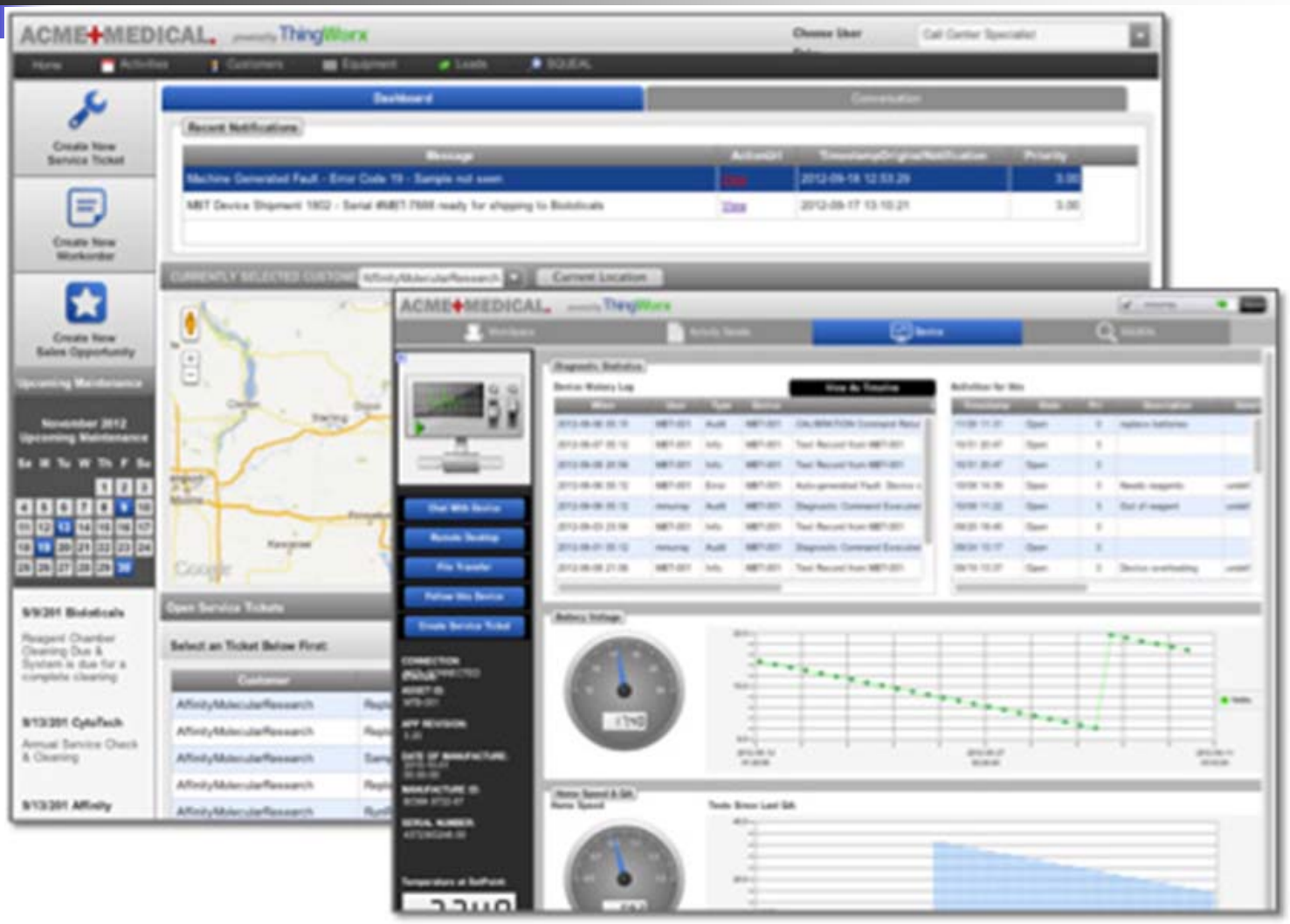
Applications in M2M

Complex Machinery

Applications in Medical Devices

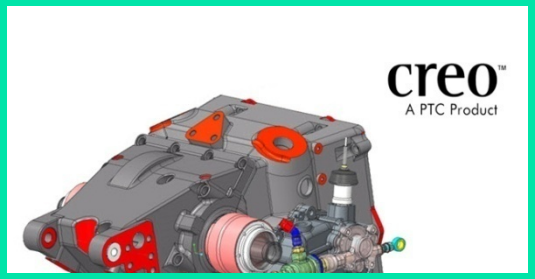


Applications in Transportation

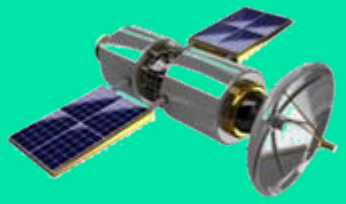



Space Research

COSMOMAR



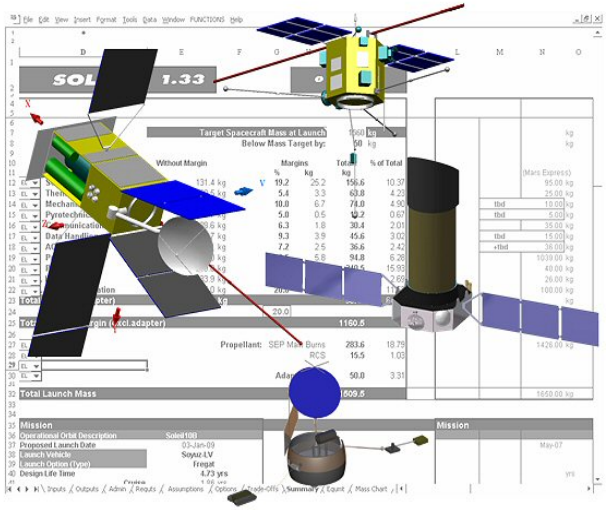
Application Layer



Infrastructure Layer

Concurrent Design Facility

ESA Concurrent Design Facility: Concurrent Engineering applied to space system development



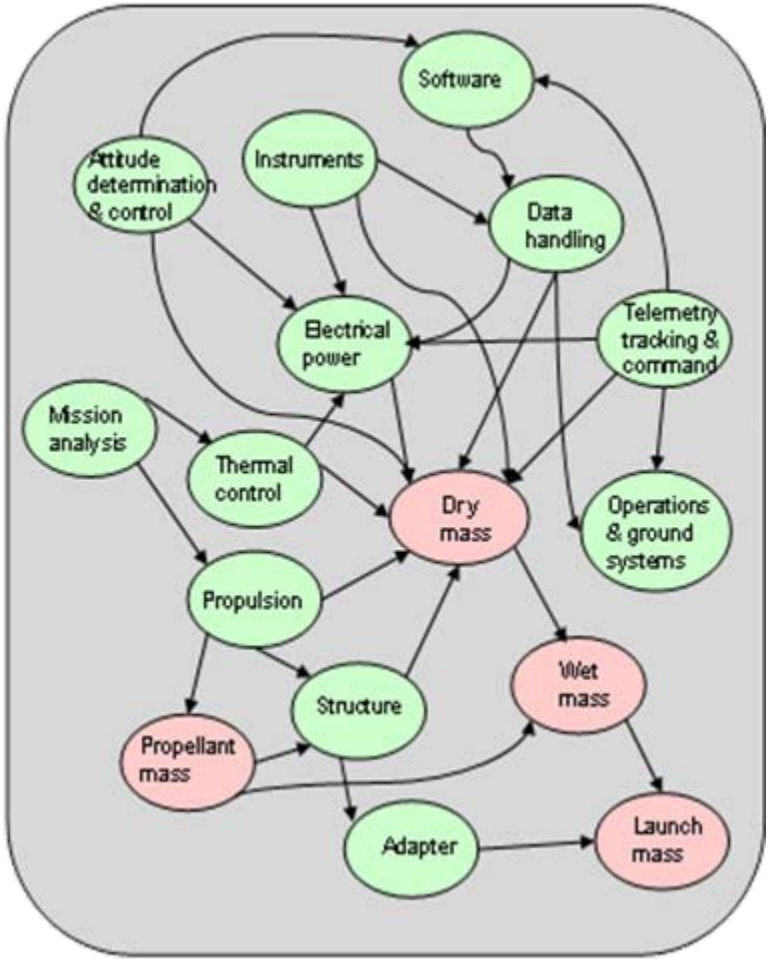
Concurrent Design Process Flow

Mission requirements & constraints

- Objectives
- Environment
- Lifetime
- Payload
- Reliability
- Schedule
- Technology
- Budget

Study requirements

- Products
- Study Level
- Planning
- Resources



Study results

- System Design
- Configuration
- Launcher
- Risk
- Cost
- Simulation
- Programmatics
- Options

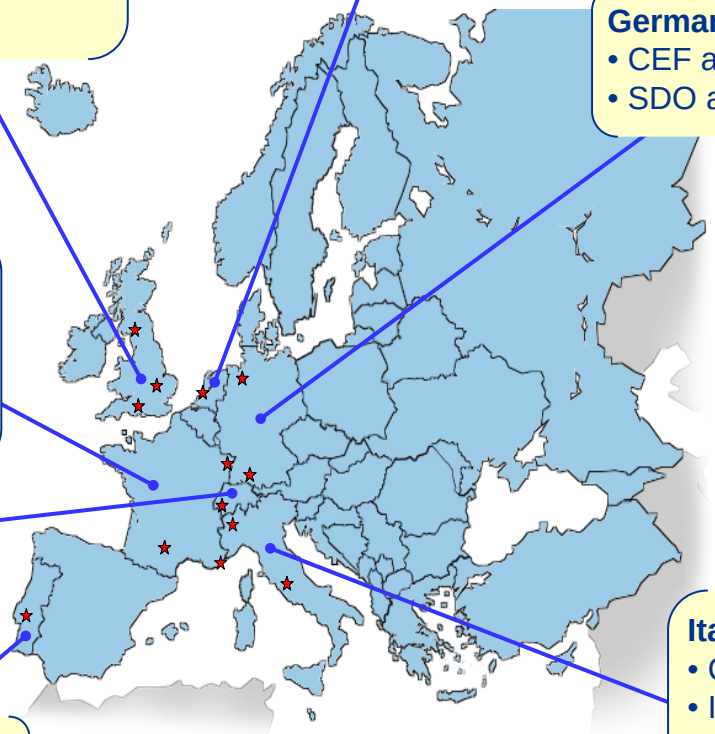
Conceptual model of mission & spacecraft design process

17 Concurrent Design Centres in European Space Sector

United Kingdom
- CDF at **Univ. of Strathclyde**, Glasgow
- SDO at **EADS/Astrium**, Stevenage
- CDF at **Univ. of Southampton**, Southampton
- CDF at **Harwell Institute**, Oxford

The Netherlands
- CDF at **ESA/ESTEC**, Noordwijk

Germany
- CEF at **DLR**, Bremen
- SDO at **EADS/Astrium**, Friedrichshafen



France
- CDF at **ISU**, Strasbourg
- PASO at **CNES**, Toulouse
- SDO at **EADS/Astrium**, Toulouse
- CDF at **Thales Alenia Space**, Cannes

legenda

Agency
Industry
University

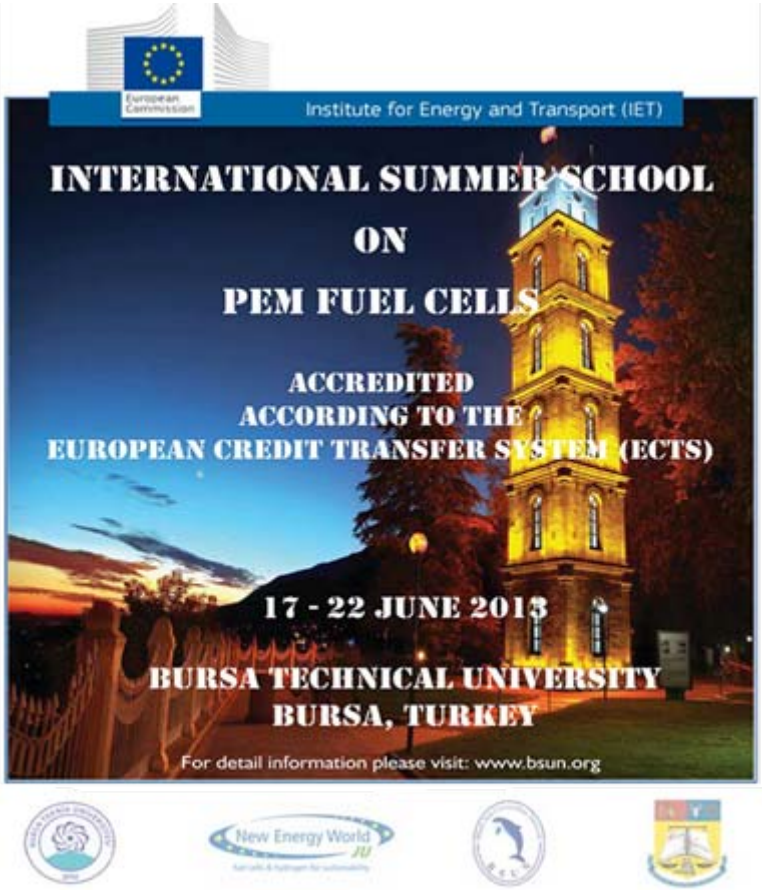
Switzerland
- CDF at **EPFL**, Lausanne

Italy
- COSE at **Thales Alenia Space**, Torino
- ISDEC at **Thales Alenia Space**, Roma
- CDF at **La Sapienza Univ.**, Roma
- CEF at **ASI**, Roma

Portugal
- CDF at **Univ. Técnica de Lisboa**, Lisbon

ARGOS Project

ISS on PEMFC


European Commission
Institute for Energy and Transport (IET)
INTERNATIONAL SUMMER SCHOOL
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PEM FUEL CELLS
ACCREDITED
ACCORDING TO THE
EUROPEAN CREDIT TRANSFER SYSTEM (ECTS)
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Nevsehir, Turkey

Upcoming Events

PTC®

International Summer School on:
Virtual Engineering Software Solutions for Space Applications as Nano-Labs & Nano-Sats using the PTC ThingWorx Platform - VESPER

- A Hack-a-Thon Event -

September 5th – 16th 2016, Constantza, Romania

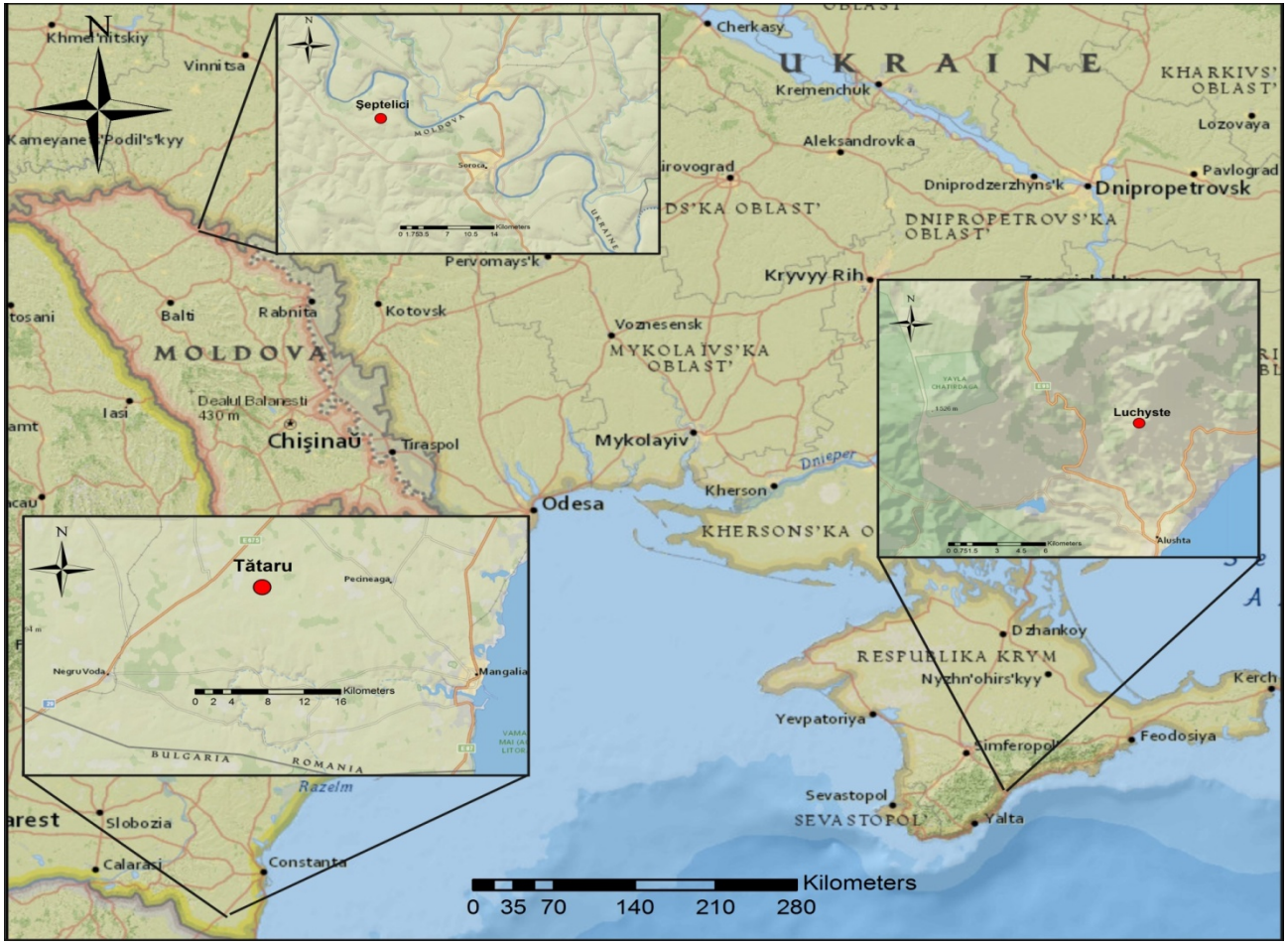
Chairmanship:

Dumitru Dorin Prunariu, Romanian Cosmonaut
Acad. Michaylo Zgurovski, Rector of National Technical University of Ukraine

Aim & Objectives:

The aim of the summer school is the evaluation of the state of the art in the field of Virtual Engineering Software Solutions for Nano-Labs and Nano-Sats and to focus the efforts of very talented and experienced students in software engineering to develop reference frameworks for such applications using PTC ThingWorx Platform.

Joint Research



Conclusions

- **The competitiveness of the Black Sea Region is depending fundamentally on the understanding, learning and implementing ecoinnovation as a basic principle of corporate culture and in such a way to be able to cope with the complexity of the factors connected to sustainable development and green economy by paving the road to Industrial Revolution 4.0.**

- **The Universities could be partners with high potential to contribute to the development and consolidation of the innovation capacity of the highly competitive suppliers of products and services from the region.**

Conclusions

- **A new kind of literate is needed, one who can innovate by reasoning broadly across disciplines and by considering the human dimensions that are at the heart of every challenge.**
- **If for centuries, in education it has been followed an approach based on the use of logics, math and sciences by linear, mechanistic and discreet reasoning, in the new context we have to move towards interdisciplinary, eco-innovative and holistic approaches.**
- **This means that by integrating knowledge across disciplines, to deal with complex problems for better serve humanity and in this way to serve ourselves.**
- **In order to be prepared for these challenges, aside from comprehensive knowledge in all traditional courses, our students have to understand the connections among the courses and to integrate, or "unify," their learning.**

Vivat, Crescat, Floreat ZNTU!

Thank you for your attention!

and please, send your comments at:
emamut@univ-ovidius.ro