



german-french academy
for the industry of the future
founded by IMT and TUM

Shaping Industry 4.0

german-french academy
for the industry of the future

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Table of contents

4	EDITORIALS
6	ABOUT THE ACADEMY
8	RESEARCH INTO INDUSTRY 4.0
14	Additive manufacturing
17	Networked cooperation
22	Cybersecurity
26	Artificial intelligence (AI)
32	TEACHING FOR INDUSTRY 4.0
34	Digital learning
35	Summer and winter schools
36	ENTREPRENEURIAL SPIRIT
38	A unique ecosystem for founders and startups
39	The Industrial Partner's Club
41	CONTACT
42	IMPRINT



We are in a new area of the digital transformation of business models, production processes, resource optimization and new forms of customer acquisition. This entails a complete re-think and a departure from previous working methods and conditions, especially in the field of technical engineering.

Digitalization allows engineers exciting new possibilities, but also requires new forms of training. France and Germany are truly proud of their engineering excellence, which is the result of world-class higher education. In order to remain successful, universities must train experienced engineers on-the-job as well as create a new generation of engineers with skills in Industry 4.0 technologies.

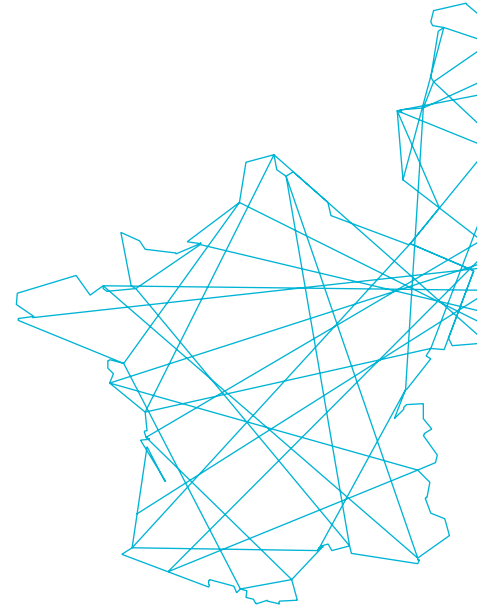
During the last German-French Digital Conference in autumn 2015, the French and German Governments proposed a binational set-up to tackle the challenges of digital transformation in respect of its impact on higher education and research in both countries. Based on these terms of reference, the Institut Mines-Télécom (IMT) and Technical University of Munich (TUM) brought

together their excellent scientists and competences with a view to establishing a joint German-French Academy for the Industry of the Future. Within this framework, research tandems from various departments were formed on strategic research and education areas. Some core activities and projects are already well advanced, others are currently being defined or will be developed in close interaction with industry. This IMT – TUM brochure provides a first glance at the manifold projects and ideas of our faculty.

The IMT and TUM initiative is the ideal basis to foster collaborative research and education to tackle the transformation to Industry 4.0 and to prepare our countries successfully for the “fourth industrial revolution”.

Digitalization will shape the 21st century. IMT and TUM are ready to face the challenges of the future.

Professor Wolfgang A. Herrmann
President, Technical University of Munich



Industry for the Future and the digitalization of economy, is about opportunities, disruptions, and risks. It calls for trespassing new technological frontiers, addressing new skills, imagining new pathways for competitiveness, social development and personal achievement.

Germany and France have a long standing history of innovation and economic development. Both countries have experienced the successive milestones of industrial revolutions, and progress. This legacy provides strong foundations to achieve a European leadership inside the fast developing Industry 4.0 context.

As leading higher education, research and technology institutions in their countries, Technical University of Munich (TUM) and Institut Mines-Télécom (IMT) recognize the importance of the challenges linked to the Industry of the Future. Addressing them adequately, and providing innovative responses is a matter of urgency. This put a special emphasis on the new paradigms, technologies, and business models incurred by the pervasiveness of digitalization in industries, services, and markets.

The German-French Academy for the Industry of the Future, a joint initiative of TUM and IMT launched in 2015, aims at jumpstarting a broader academic effort dedicated to these new challenges. Building jointly the Industry of the Future is also about crafting the University of the Future. We, TUM and IMT, are committed to both goals. For a strong economic and academic Europe, and for a better world.

A handwritten signature in blue ink that reads "Philippe Jamet". The signature is fluid and cursive.

Professor Philippe Jamet
Executive President of Institut
Mines-Télécom

Academy snapshot

The German-French Academy for the Industry of the Future is a strategic vehicle to promote close collaboration between two leading European research institutions, the Technical University of Munich (TUM) in Germany and the Institut Mines-Télécom (IMT) in France, and to strengthen German-French relations in the process. Focused on joint research, education and innovation, the Academy's mission is to

master the challenges accompanying the increasing digitalization of industry processes.

The Academy was established in 2015 during the German-French Digital Conference hosted by French President Emmanuel Macron and Germany's Vice-Chancellor Sigmar Gabriel.



Our vision: Creating strong ties between academia and industry



Signature of the joint TUM-IMT declaration (December 15, 2015)

(l to r): Prof. Hana Milanov (TUM), Prof. Francis Jutand (IMT), Prof. Wolfgang A. Herrmann (TUM), Prof. Christian Roux (IMT), Prof. Philippe Jamet (IMT), Dr. Andreas Gördeler (BMW), Dr. Hannemor Keidel (TUM), Emmanuel Caquot (MEIN), Jean-Jacques Pierrat (French Embassy)

The Academy was inspired by IMT and TUM's shared vision of excellence in research, education and innovation across Europe. Reaching beyond IMT and TUM, this European backbone is now looking to network with other academic and industrial partners in both countries.

The Academy serves as a platform for high-level science and teaching communities, paving the way for joint research projects focused on Industry 4.0. It also promotes close collaboration with partners in industry, especially with companies that have strong collaborative ties between Germany and France.

At present, the Academy receives annual funding to the tune of around one million euros from each of the two founding partners. This money is primarily channeled into research projects, seed funding and infrastructure investments.

On the French side, the Academy is part of IMT's long-term strategic budget. In Germany, it is financed by the funds that TUM receives under Germany's Excellence Initiative, a federal- and state-funded program that promotes research excellence at international level.



Research into Industry 4.0

RESEARCH INTO INDUSTRY 4.0

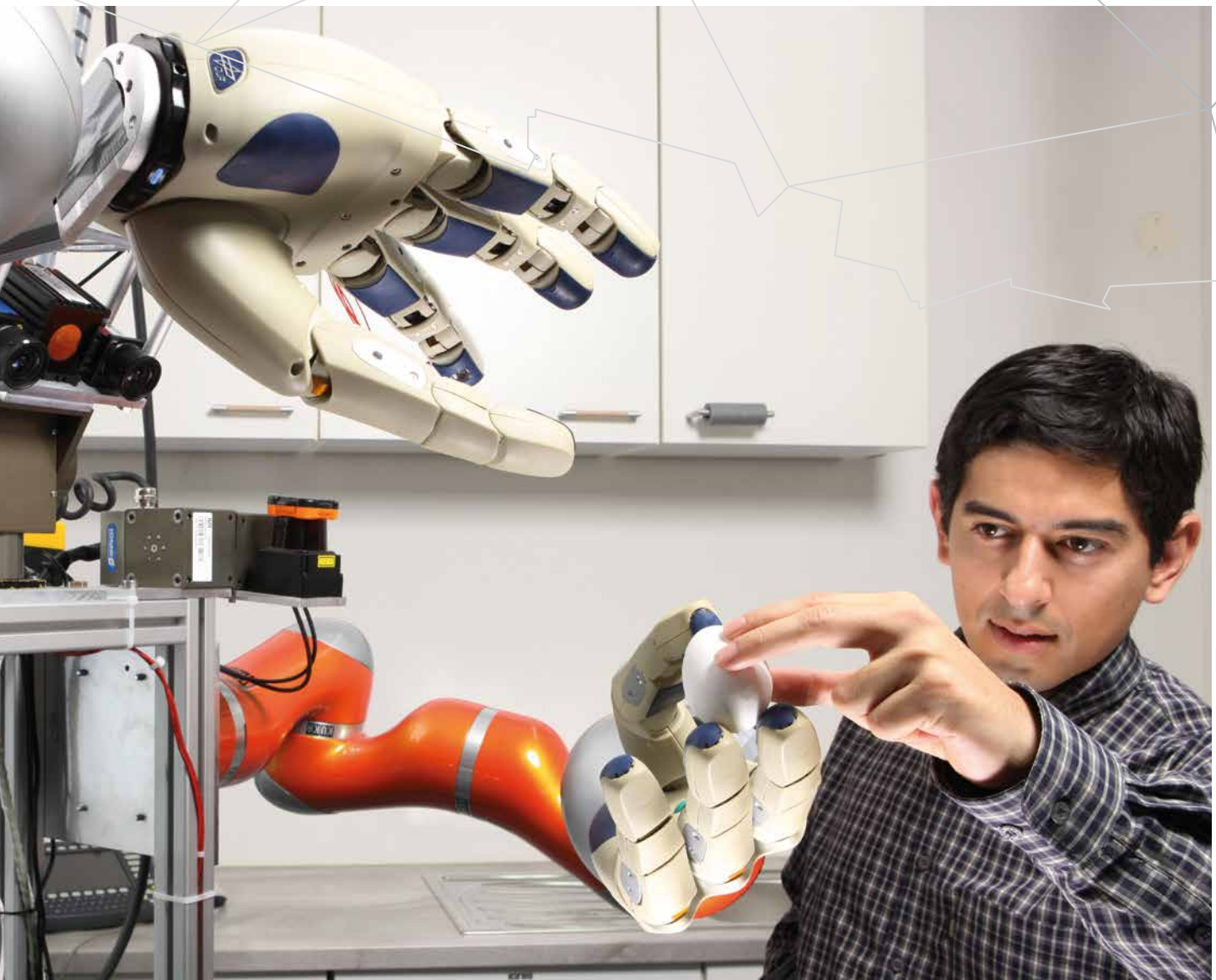
Advancing economic and industrial development

The German-French Academy for the Industry of the Future serves as a platform and collaborative network for many different research projects, bringing together outstanding researchers and scientists from Germany and France. These experts work together on specialist projects that are vital to the evolution of industrial digitalization.



The Academy focuses on a wide range of research areas, including:

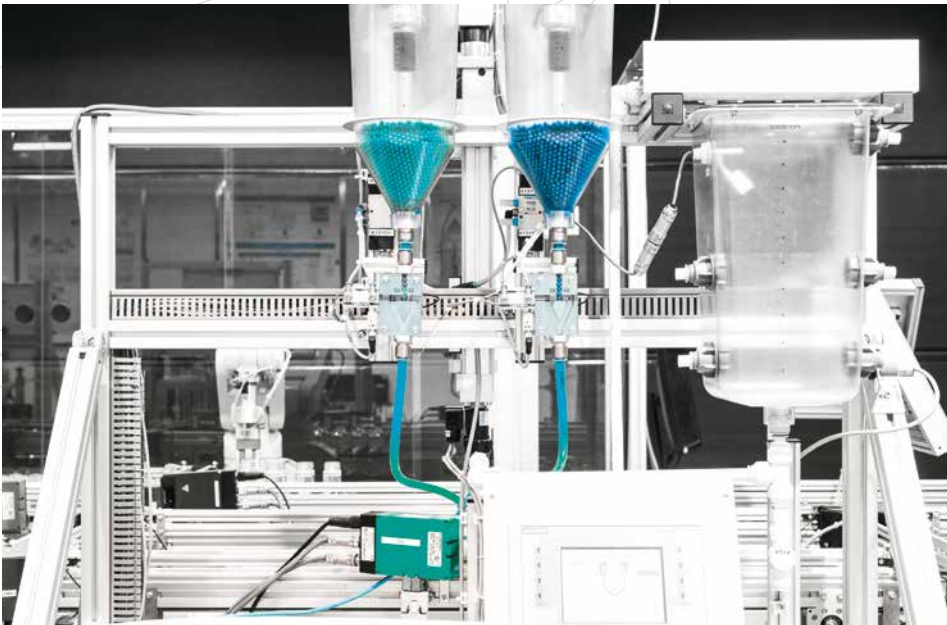
- *Artificial intelligence (AI) in Industry 4.0*
- *Cybersecurity*
- *The industrial Internet of Things*
- *Energy efficiency*
- *Additive manufacturing*
- *Industrial supply chains*
- *Industrial design and processes*
- *Advanced materials*



« The digitalization of economy is about opportunities, disruptions, and risks. ... »

« ... It calls for trespassing new technological frontiers, addressing new skills, and imagining new pathways. TUM and IMT face these challenges by jumpstarting a broader academic effort. Building the Industry of the Future is also about crafting the University of the Future. »

Professor Philippe Jamet
President, Institut Mines-Télécom





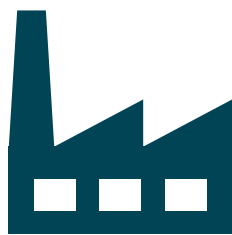
11

research projects



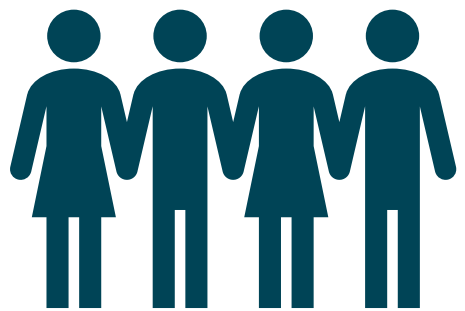
1

joint technological platform for AI & data




20 +

partners in industry



100 +

researchers, PhD students, engineers



Additive manu- facturing



RESEARCH
ADDITIVE MANUFACTURING

Additive manufacturing for the Industry of the Future

Key words / application areas:

Additive manufacturing, reorganization, industrial supply chain, industrial design, new business models

Principal Investigator at TUM

Dr. Uli Meyer
Munich Center for Technology in Society

Principal Investigator at IMT

Dr. Sophie Peillon
Mines Saint-Etienne

Goals

This project addresses the relationship between additive manufacturing technologies and the reorganization of contemporary industries, including industrial reorganization, corporate reorganization, and the reorganization of technology design and use.

RESEARCH
ADDITIVE MANUFACTURING

Alloy Design for Additive Manufacturing (ADAM)

Key words / application areas

Material design, big data, additive manufacturing, laser beam melting, real-time monitoring

Principal Investigator at TUM

**Prof. Dr.-Ing. Michael Zäh
Andreas Bachmann**
*Institute for Machine Tools and Industrial
Management*

Principal Investigator at IMT

Julien Favre
Mines Saint-Etienne

Project focus areas:

- *Designing alloys by selecting optimal compositions that will enhance mechanical properties.*
- *Using optical methods such as high-speed cameras and high-speed thermography to investigate the stability of the melt pool during laser beam melting (LBM).*
- *Studying the microstructure and defects of manufactured samples to determine how the alloy's composition affects powder bed melting and the solidification process.*

Goals

This project researches new alloy compositions for additive manufacturing that will help improve the mechanical performance and the competitiveness of 3D-printed products.



Net- worked coopera- tion

*« The convergence of the Internet of Things,
industrial robotics and artificial intelligence
is the key to the 4th industrial revolution. »*

Prof. Dr. Härrä
Eurecom



Industry without borders?

« We investigate the complex relationships between organizations and their environments by focusing on how organizations interrogate, span, open up, protect, and negotiate their multiple borders. »»

Dr. Judith Igelsböck
Researcher Department of Social Studies of Science, TUM



RESEARCH
NETWORKED COOPERATION

The transformation of organizational control in the Industry of the Future

Key words / application areas

Digital transformation, industry, organization studies, management, organizational borders, control, business models

Principal Investigator at TUM

Dr. Uli Meyer
*Munich Center for Technology
in Society*

Principal Investigator at IMT

Prof. Dr. Madeleine Besson
IMT Business School

Goals

This project aims to:

- *analyze and understand changes in organizational borders resulting from digital transformation,*
- *identify the opportunities and challenges that come with these changes,*
- *identify organizational forms and business models that utilize the opportunities and mitigate the challenges resulting from these changes.*



RESEARCH
NETWORKED COOPERATION

Smart Cyber-Physical Environments for Industry of the Future (SCHEIF)

Key words / application areas

Industry 4.0, Internet of Things (IoT), robotics, automated vehicles

Principal Investigators at TUM

Prof. Dr. Georg Carle
*Chair of Network Architectures and
Services*

Prof. Dr. Andreas Herkersdorf
Institute for Integrated Systems

Dr. Marc-Oliver Pahl
*Chair of Network Architectures and
Services*

Principal Investigators at IMT

Prof. Dr. Jean-Marie Bonnin
*IMT Atlantique, Network, Security,
Services*

Prof. Dr. Ulrich Finger
Eurecom, Director

Prof. Dr. Jérôme Härri
Eurecom, Communications Systems

Goal

The aim of this project is to design a hardware and software reference architecture, decision flows, and additional technical enablers for creating smart, decentralized cyber-physical environments (D-CPE). One of the core concepts of the project is to integrate intelligent, context-aware, connected and responsive agents. This D-CEP for Industry 4.0 aims to achieve:

- *high performance, low latency, and energy efficiency as well as*
- *high availability through secure and resilient designs.*

Data-driven Collaboration in Industrial Supply Chains?

Key words / application areas

Collaborative supply chain, optimization, data sharing

Principal Investigators at TUM

Prof. Dr. Stefan Minner

School of Management, Logistics and Supply Chain Management

Dr. Miray Öner Közen

School of Management, Logistics and Supply Chain Management

Principal Investigators at IMT

Prof. Dr. Alexandre Dolgui

IMT Atlantique, Department of Automation, Computer-Integrated Manufacturing and IT (DAPI)

Prof. Dr. Guillaume Massonnet

IMT Atlantique, Department of Automation, Computer-Integrated Manufacturing and IT (DAPI)

Prof. Dr. Fabien Lehuédé

IMT Atlantique, Logistic and Production Systems

Goals

This project investigates the design of data-sharing mechanisms by considering centralized and decentralized approaches in collaborative supply chains. The resulting system optimization will be distributed among the multiple stakeholders.

- *Designing optimization procedures and mechanisms for data disclosure.*
- *Quantitatively evaluating the potential savings gained through sharing information.*
- *Investigating costs and benefits of sharing among stakeholders and using game theory models to identify the best collaboration partnerships.*
- *Using analytics methods to develop tools that support advanced planning and decision-making processes in order to help European industries exploit their data more effectively and promote efficient collaboration in the future.*



Cyber- security

*Security is becoming a major concern
with the digitalization of industry.
Cybersecurity will soon be part of the
industrial culture of companies.*

Hy- Block- Arch

RESEARCH
CYBERSECURITY

Hybrid Blockchain Architectures for the Industry of the Future (HyBlockArch)

Key words / application areas

Blockchain technologies, Industry 4.0, energy management, security

Principal Investigator at TUM

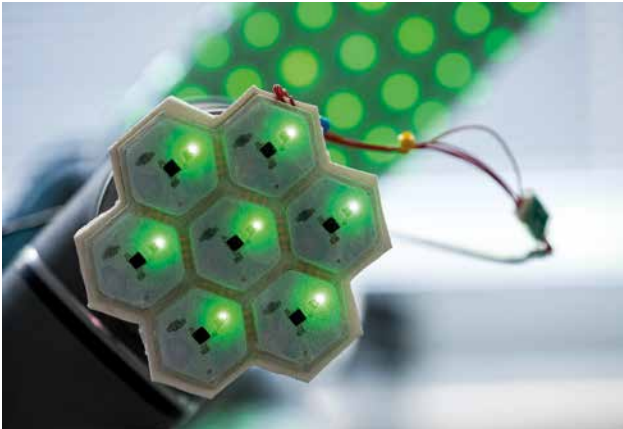
Prof. Dr. Georg Carle
*Chair of Network Architectures and
Services*

Principal Investigator at IMT

Prof. Dr. Gérard Memmi
*Télécom ParisTech, Networks and
Computer Science Department*

Goals

- *Designing an innovative industrial platform with a hybrid blockchain architecture and implementing a prototype of this.*
- *Evaluating the platform in different use cases, including accountable data exchange (multitenant, data analytics, IPR governance) and service consumption control (electricity services and communication services).*



RESEARCH
CYBERSECURITY

Secure Connected Industry of the Future

Key words / application areas

Dual tenure-track program, machine communication, networks, network security

Principal Investigators at TUM

Prof. Dr. Gerhard Kramer
Institute for Communications Engineering

Prof. Dr. Georg Sigl
*Chair of Security in Information
Technology*

Prof. Dr. Wolfgang Utschick
Chair of Signal Processing

Principal Investigators at IMT

Prof. Dr. David Gesbert
*Eurecom, Communications Systems
Department*

Prof. Dr. Refik Molva
Eurecom, Digital Security Department

This program builds upon the following main components:

- *Funding for two tenure-track professorships, one at TUM and one at Eurecom.*
- *A specific research fund promoting collaborative research projects within the two professorships.*
- *A complementary research fund designed to promote collaboration with the existing faculty in the cross-disciplinary areas of communication and security.*
- *Multiple initiatives to encourage student exchanges and a joint event to discuss results.*

Towards a Secure Internet of Things (ASSET)

Key words / application areas

Internet of Things (IoT), cybersecurity, cyber protection, cyber defense, cyber resilience

Principal Investigators at TUM

Prof. Dr. Georg Carle
Chair of Network Architectures and Services

Prof. Dr. Claudia Eckert
Chair of Security in Information Technology

Prof. Dr. Georg Sigl
Chair of Security in Information Technology

Principal Investigators at IMT

Prof. Dr Frédéric Cuppens

Prof. Dr. Nicolas Montavont

Prof. Dr. Laurent Toutain

Dr. Nora Cuppens

Dr. Simon Foley

IMT Atlantique, Network Systems, Cyber Security and Digital Law

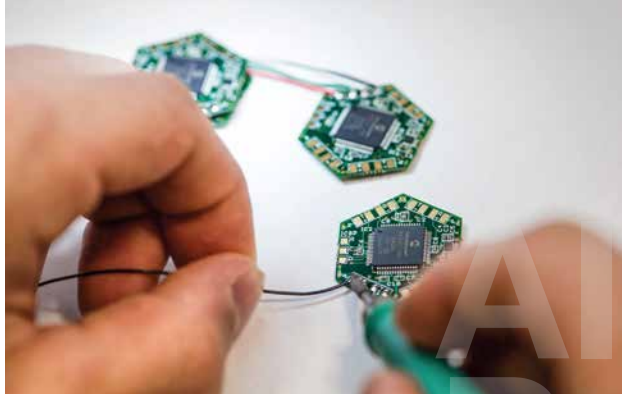
Goals

This project investigates new solutions aimed at enhancing security in the Internet of Things (IoT) and strengthening its resilience against cyber-attacks:

- *Cryptographic authentication, authorization and communication protocols, supporting secure dynamic coalitions of users with the IoT.*
- *IoT cyber defense techniques for detecting and measuring threats, drawing conclusions about them and acting upon them. This includes machine learning techniques for detecting IoT anomalies and setting up automated defense.*
- *Methods for IoT cyber resilience for continuing to operate in a partially compromised state.*
- *Postquantum cryptography.*

The background of the page is a light beige color. Overlaid on this background is a complex, abstract pattern of thin white lines. These lines form various geometric shapes, including triangles, quadrilaterals, and polygons, some of which are nested or overlapping. The lines are scattered across the entire page, creating a sense of depth and complexity.

Artificial intelligence



AI4 Performance

RESEARCH
ARTIFICIAL INTELLIGENCE (AI)

Smart Artificial Intelligence based Modeling and Automation of Networked Systems (AI4Performance)

Key words / application areas

Network architecture, network measurement, machine learning, artificial intelligence (AI)

Principal Investigators at TUM

Prof. Dr. Georg Carle
*Chair of Network Architectures and
Services*

Dr. Fabien Geyer
*Chair of Network Architectures and
Services*

Principal Investigators at IMT

Prof. Dario Rossi
Telecom ParisTech, INFRES Department

Dr. Leonardo Linguaglossa
Telecom ParisTech, INFRES Department

Goal

The project aims to develop a smart approach for testing networked systems and thereby collecting meaningful data sets. The collected data will be processed using the innovative machine learning method Graph Neural Network.

RESEARCH

ARTIFICIAL INTELLIGENCE (AI)

RDS-Production: Modelling and Decision-making Platform for Reconfigurable, Digitalized and Servitized Production Systems

Key words / application areas

Modelling of reconfigurable production components, design of reconfigurable systems, reconfiguring decision-making processes, artificial intelligence (AI), production systems for Industry 4.0, integration of services in production system lifecycles

Principal Investigators at TUM

Prof. Dr.-Ing. Gunther Reinhart
Chair for Industrial Management and Assembly Technologies

Prof. Dr.-Ing Michael Zäh
Chair for Machine Tools and Manufacturing Technology

Principal Investigators at IMT

Prof. Dr.-Ing. Xavier Boucher
Mines Saint-Etienne

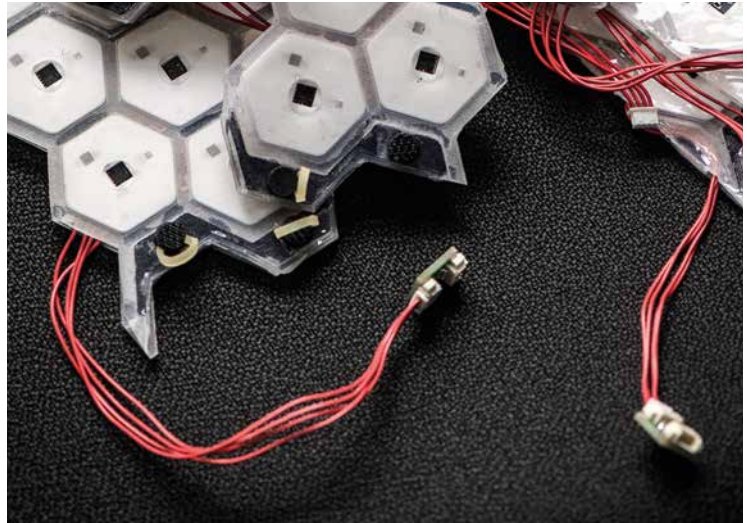
Prof. Dr. Alexandre Dolgui
IMT Atlantique, Department of Automation, Computer-Integrated Manufacturing and IT

Dr. Xavier Delorme
Mines Saint-Etienne

Goals

This project aims to develop an innovative method for the design of reconfigurable production systems, employing digital production modules (using modularity and interoperability) to address key challenges industry will face in the future:

- *Modelling of interoperable production components and software solutions within reconfigurable systems (e.g. digital twin models).*
- *AI and mathematical optimization to support reconfiguration through dynamic decision-making processes.*
- *Servitized lifecycles for production equipment enabling the switch from traditional to innovative economic models based on selling the usage or the performance of production lines.*
- *Multi-criteria decision-making to integrate economics spanning human, energy and ecological factors into technology designs.*



RESEARCH
ARTIFICIAL INTELLIGENCE (AI)

Smart Sensor Technology with Decentralized Processing Architecture

Key words / application areas

AI for the Industry of the Future, smart sensors, automotive, e-Health, decentralized embedded systems, Internet of things (IoT)

Principal Investigator at TUM

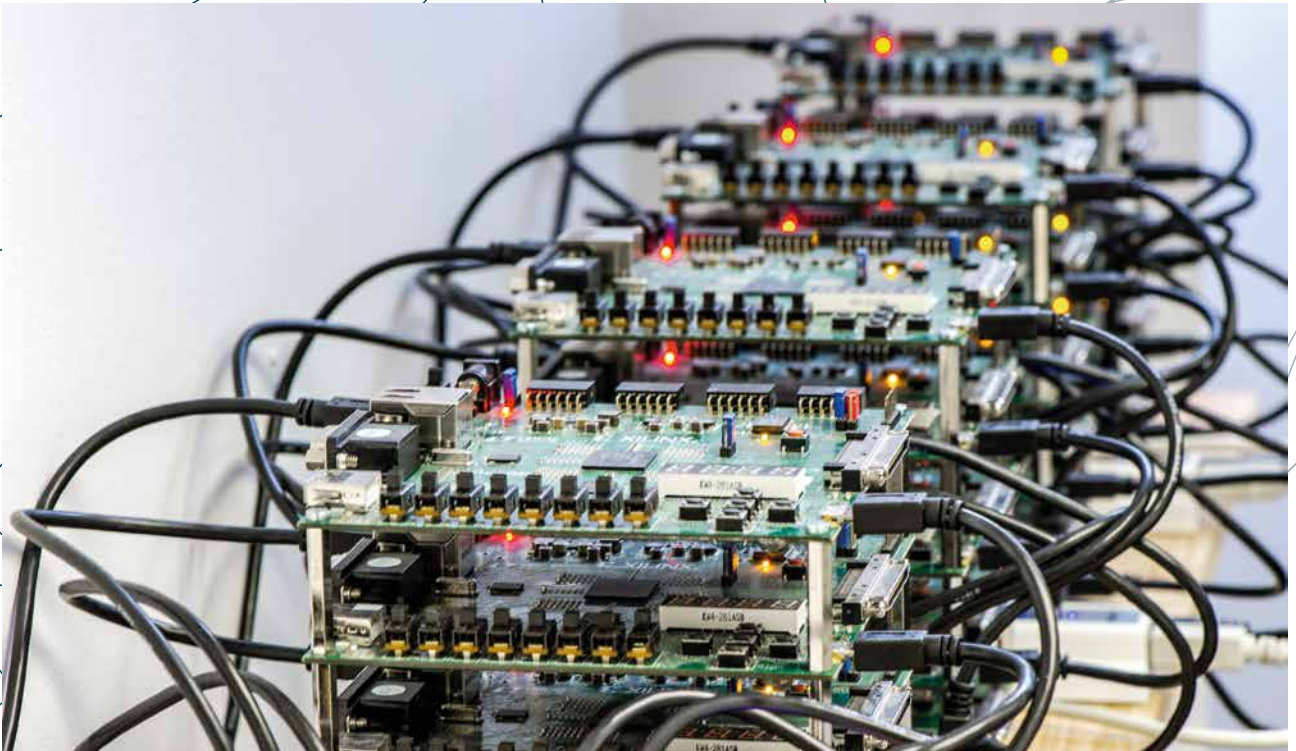
Prof. Dr. Sebastian Steinhorst
Embedded Systems and Internet of Things

Principal Investigator at IMT

Dr. Jean-Louis de Bougrenet de la Tocnaye
IMT Atlantique, Electrical and Computer Engineering

Goals

- *Co-design of a decentralized sensor/system architecture.*
- *Self-organizing allocation of computational resources based on the current scenario and the corresponding sensor data.*
- *Automotive use case: Eye-control of advanced driver assistance system (ADAS) functions.*



RESEARCH
ARTIFICIAL INTELLIGENCE (AI)

Joint Platform and Tools for Artificial Intelligence based on Data-Intensive Research and Data Governance

Key words / application areas

AI for the Industry of the Future, platform, TeraLab, access to data, data-driven projects

Principal Investigator at TUM

Prof. Dr. Georg Carle
Chair of Network Architectures and Services

Principal Investigator at IMT

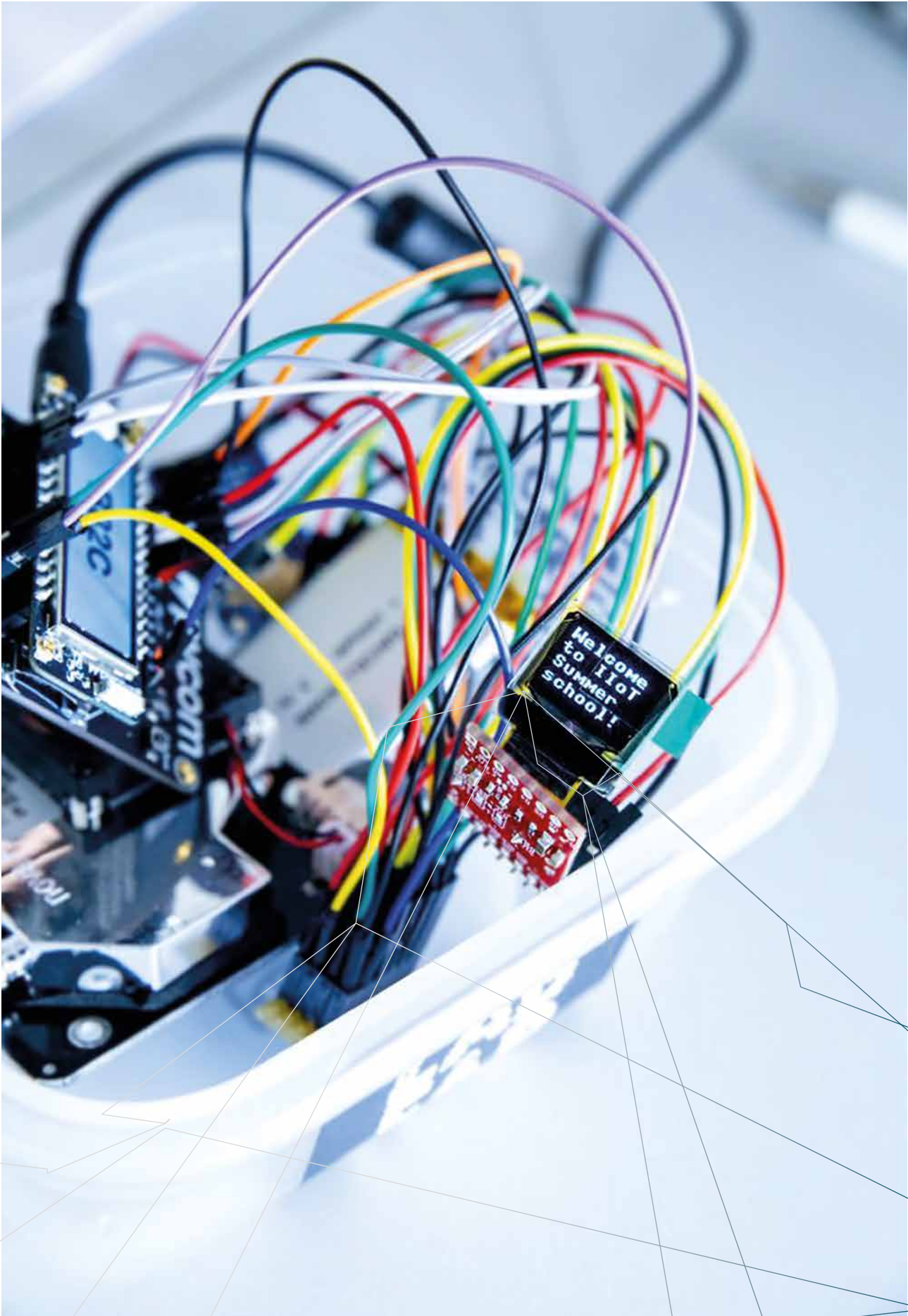
Anne-Sophie Taillandier
TeraLab IMT



About the platform

In order to accelerate joint research programs, IMT and TUM are building a shared platform for AI based on data-intensive research. The platform combines and enhances IMT and TUM's existing infrastructure and services, and provides access to the data and computing power of both organizations. The platform supports collaborations in many different ways and enables collaboration beyond the lifetime of individual projects.

IMT's TeraLab hosts research projects on real industrial data and is crucial to the joint platform. This common platform will be enriched by installing software, in particular TeraLab software in TUM's infrastructure, and by adding TUM's software and tools to TeraLab's infrastructure.



Teaching for Industry 4.0

« France and Germany are truly proud of their engineering excellence, which is the result of world-class higher education. In order to remain successful, universities must train experienced engineers on the job as well as create a new generation of engineers with skills in Industry 4.0 technologies. »

Prof. Wolfgang A. Herrmann
President of TUM

Digital teaching: MOOCs



Lifelong learning is a key requirement in today's society. Digital technology is a crucial tool that helps us deal with the resulting huge increase in learners and meet their individual requirements. The German-French Academy for the Industry of the Future takes teaching to a new level by exploring and supporting the use of digital technology.

The Academy offers an ever-growing portfolio of high quality training modules aimed at developing and establishing innovative methods of collaboration in higher education and research. Institut Mines-Télécom (IMT) and Technical University of Munich (TUM) work together to produce Massive Open Online Courses (MOOCs) for educational institutions and industry.

What do we offer?

Our MOOCs focus on strategic topics that will impact industry as we move forward. We support the creation of digital teaching materials that align with our own research topics. This includes subjects such as the Internet of Things (IoT), cyber-physical systems, blockchain, and artificial intelligence (AI).

Who are our courses aimed at?

Our modules are aimed at regular university students and, crucially, professionals who want to improve their qualifications on the job.

Goals

- *Foster collaboration: By launching digital teaching modules, we want to create new partnerships between academia and industry.*
- *Improve qualifications: Specialist training sessions will help professionals adapt to new job requirements.*
- *Up-to-date knowledge about Industry 4.0: Students who use our training modules will enter industry equipped with the latest knowledge about Industry 4.0.*

Summer and winter schools in collaboration with industry



The German-French Academy for the Industry of the Future organizes summer and winter schools that enable researchers, PhD students and professionals from industry to share their experiences on strategic issues and associated use cases. At these events, participants can also find out about state-of-the-art research into topics related to Industry 4.0.

Opportunity for recruiting PhD graduates

At the Academy, we design our summer and winter schools in collaboration with leading partners in industry. All of our events give the research and HR departments of companies in the industrial sector the chance to establish personal, exclusive contact with young researchers from all over the world.

Past events and examples for summer school topics:

Connected vehicles driving on digital roads

TUM, Eurecom, BMW Group

Human factor aspects of cooperative system design

TUM, Eurecom, Mines ParisTech

Ad-hoc industrial Internet of Things

TUM, IMT Atlantique, Texas Instruments

Visit our website to find the latest information on upcoming events:

www.future-industry.org



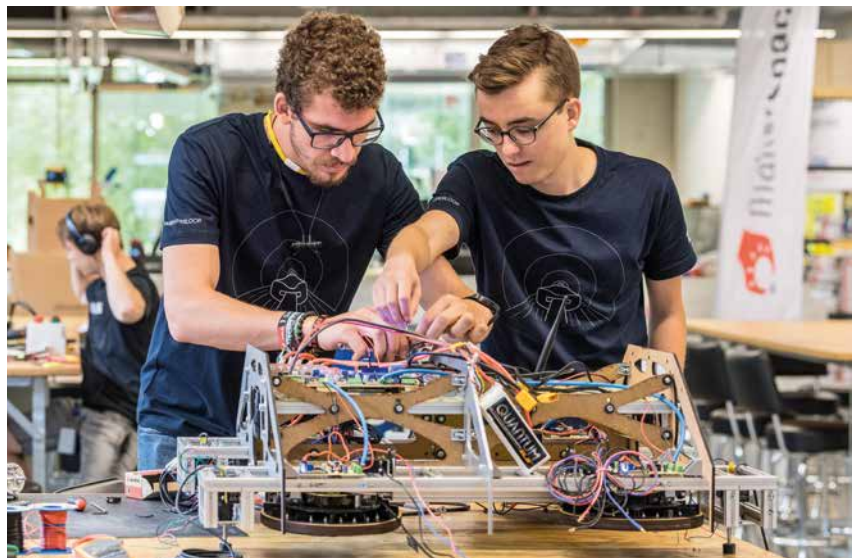
Entrepre- neurial spirit

ENTREPRENEURIAL SPIRIT

A unique ecosystem for founders and startups

The German-French Academy for the Industry of the Future embodies the entrepreneurial culture of its two founding institutions: Institut Mines-Télécom (IMT) and the Technical University of Munich (TUM). It provides a

high-profile platform for startups and founders, giving them the opportunities and the tools they need, e.g. to present their businesses at tech conventions, fairs and startup events such as VivaTechnology in Paris.



Students, researchers, and startup entrepreneurs at the Academy have access to the unique infrastructures of IMT and TUM to help them successfully grow their businesses:

TUM

The Entrepreneurship Center at the TUM campus is home to a host of services and facilities, including a maker space, an incubator and office facilities. Here, young entrepreneurs can rely on in-depth support every step of the way from their initial idea to the subsequent growth phases. Around 70 startups are founded in this environment every year.

IMT

IMT's graduate schools have links to eleven business incubators. Entrepreneurs receive support at every stage of the startup process – from defining a business model and legal formalities through technology development to financing. Every year, almost 100 startup and spin-off companies are founded in these incubators.



ENTREPRENEURIAL SPIRIT

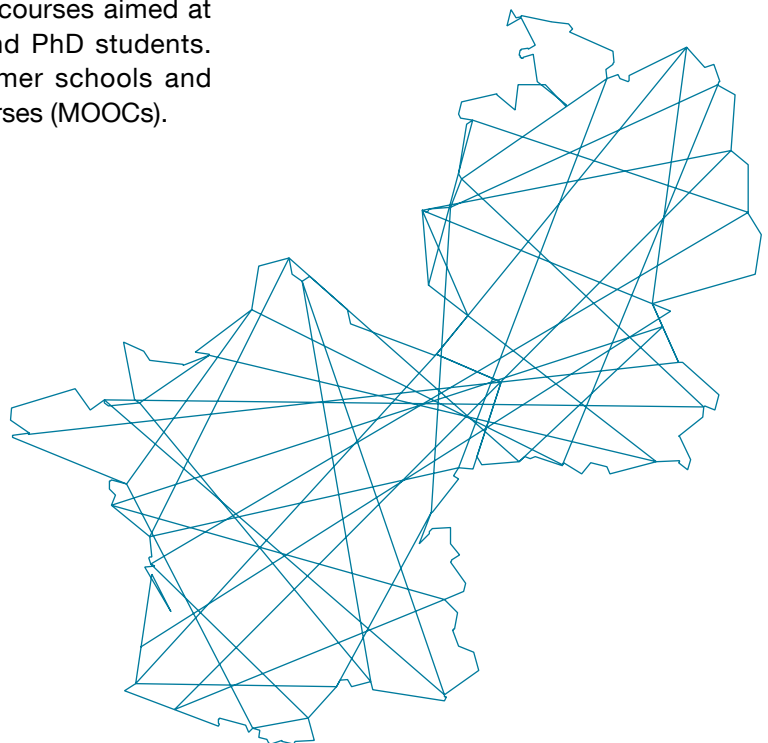
The Industrial Partner's Club

The Industrial's Partners Club allows companies to connect with peers in an exclusive network comprising international academic and industrial players and decision-makers involved in Industry 4.0.

Membership in the Industrial Partner's Club can help companies to develop and advance new research projects focused on Industry 4.0. Club members can also participate in new bi-national training courses aimed at companies, students and PhD students. These include our summer schools and massive open online courses (MOOCs).

An advantageous tax system

A donation to the Industrial Partner's Club in France qualifies for fiscal benefits under a scheme run by the Fondation Mines-Télécom. All donations to the Foundation are tax-deductible up to 60% of the French corporate income tax, subject to a 0.5% turnover limit.



Shaping Industry 4.0 through research, education and innovation

german-french academy
for the industry of the future



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Digitali- zation will shape the 21st Century

The Institut Mines-Télécom and the
Technical University of Munich
are ready to face the challenges of
the future.



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