AnthroPOLIS
HUMAN CENTERED MOBILITY

SystemX

CentraleSupélec

TRANSFORMING MOBILITY TOWARDS SUSTAINABLE URBAN FUTURES

COLLOQUIUM REPORT
OCTOBER 2022

AnthroPOLIS HUMAN CENTERED MOBILITY | SystemX | CentraleSupélec

Anthropolis Colloquium | 16 September 2022

TRANSFORMING MOBILITY TOWARDS SUSTAINABLE URBAN FUTURES

Final Report | October 2022

For its second edition, the colloquium of the Anthropolis Chair showcased the multidisciplinary research outcomes from 2021-2022. With offline and online participants from academia, the private sector and the Chair's partners, the event has been a great success for us.

Through the eyes of a family and their neighbours, we shared our vision on how to tackle today and tomorrow's daily mobility challenges: How much time will we spend in shared autonomous shuttles? Will we be encouraged to walk more with Mobility as a Service? How would different 2030 scenarios impact our way of life? What is our relation to sustainability challenges across local, regional, and national scales? To make our assumptions and propositions more tangible, we introduced fictional characters with different mobility habits: A family and a retired farmer who are living on the Saclay plateau in greater Paris, one of our areas of interest.

The first part of the colloquium addressed selected sustainability challenges for mobility. The morning speakers discussed urban challenges such as mobility stakes at regional and local levels and the sustainability conditions for mobility infrastructures, the appraisal of walking in Mobility as a Service solutions, and the spatial accessibility to healthcare facilities.

In the second part, we adopted a more projective position towards the future. The four contributions discussed future trends and uncertainties in 2030 scenarios, the co-evolution of new mobility modes and transportation networks, the impact of the Grand-Paris Express on travelers through agent-based simulation, and the optimisation of on-demand mobility with electric autonomous vehicles.

The colloquium has been organised by the Anthropolis Chair of IRT SystemX and CentraleSupélec. The Chair brings the partners EDF, Engie, Groupe Renault, Communauté d'Agglomération Paris-Saclay, and Nokia Bell Labs together to work towards people-centred urban mobility.

Partners of the Chair

EDF | ENGIE | GROUPE RENAULT | PARIS SACLAY Communauté d'agglomération | NOKIA Bell Labs

COLLOQUIUM 2022

Programme 16 September 2022

Three sessions with a total of nine presentations and one discussions made up this year's colloquium. Click on the sessions below to access the summaries.

The end of the document portrays the Chair's Vision and the Biographies of the Speakers. On our YouTube Channel, all available recordings are accessible.

9:30

WORDS OF WELCOME

Patrice Aknin, François Cluzel, Flore Vallet, Jakob Puchinger

10:00

INTRODUCING THE ANTHROPOLIS PROGRAM

Flore Vallet and Jakob Puchinger

10:30

ADRESSING SUSTAINABILITY CHALLENGES 1

Julien Baltazar, Flore Vallet

11:30

Break

11:45

ADRESSING SUSTAINABILITY CHALLENGES 2

Mariana Reyes, Ouidad Benhlima

12:45

Lunch Break

13:45

URBAN MOBILITY TRANSITIONS

Tjark Gall, Michele Tirico, Tarek Chouaki, Yue Su

15:45

DISCUSSING CONTRIBUTIONS+PERSPECTIVES

Flore Vallet, Jakob Puchinger, Yann Briand

16:10

CLOSING REMARKS

Flore Vallet

16:20

WORDS OF WELCOME

9:30-10:00 | Patrice Aknin, François Cluzel, Flore Vallet, Jakob Puchinger

In the opening session, Patrice Aknin, Scientific Director of IRT SystemX, and François Cluzel, Assistant Professor at the Laboratoire Génie Industriel, CentraleSupélec, representing its director Bernard Yannou, welcomed the participants and explained the context and ambition behind the Chair. The speakers highlighted interdisciplinary collaboration between industry, R&D, and academia, combining state-of-the-art technology projects in the Paris-Saclay area with people-centred and societal perspectives.

INTRODUCING THE ANTHROPOLIS PROGRAMME: HIGHLIGHTS AND COLLABORATIONS

9:30-10:00 | Flore Vallet, Jakob Puchinger

Link to recording | presentation

In the first session, Jakob Puchinger, Chair holder from 2016 to 2022, and Flore Vallet, current Chair holder, introduced the overall vision and task structure of the Anthropolis Chair, complemented by its main contributions, its network, and the agenda and concept behind the colloquium. More details on the Anthropolis Chair and all speakers can be found at the end of this document where the tasks and contributions are outlined.

ADDRESSING SELECTED SUSTAINABILITY CHALLENGES FOR MOBILITY

How to include the environment in mobility decision-making? Insights from a territorial perspective

Julien Baltazar

Link to recording | presentation

Our story takes place in the inter-council partnership of Paris-Saclay. Its strong development dynamics make the design of its mobility ecosystem challenging. This presentation presented the context of future mobility in Paris-Saclay: How is mobility organised and planned? What are the main sustainability stakes? How are environmental impacts taken into account for the choice of the forthcoming mobility developments? What are the limits of current practices, and what could be improved for better decision-making?

How can we make mobility infrastructures more sustainable?

Flore Vallet

Link to recording | presentation

Mobility infrastructures are connected to public spaces: they constitute a spatial resource, shared, dynamically managed and (potentially) flexible. We conducted a structured analysis of various strategies to make mobility infrastructures as sustainable as possible, considering technological opportuni-

ties but also organisational and behavioural ones. Through several practical examples, we introduce interdependent questions to challenge the sustainability of mobility infrastructures, from the usage, data, and material intensity, to the artificialisation of soils, resilience, or the promotion of safety for users.

Appraisal of walking in MaaS solutions: Exploring a piece of the puzzle for future sustainable mobility
Mariana Reyes
Link to recording | presentation

Mobility as a Service (MaaS) gathers different transport services from different providers and natures (public/private). However, pedestrian mobility is not a service like any other and as such, innovation around walking and its related benefits risk being ignored when developing and implementing MaaS solutions. Despite that, pedestrian mobility concerns about 40% of individual trips in the Île-de-France. Not taking it into account for the development of MaaS solutions means ignoring the needs of all these Île-de-France residents. In this research, we focus our attention on the governance of the MaaS ecosystem and the respective stakeholders' perspectives towards walking in order to identify strategies for the appraisal of pedestrian mobility that could translate into societal, environmental and economic benefits at individual, organisational and territorial levels.

Casablanca multi-modal balanced floating Catchment area (CMBFCA) for measuring spatial accessibility to healthcare facilities
Ouidad Benhlima
Link to recording | presentation

The presentation is about calculating spatial accessibility to public hospitals using a new metric based on the balanced floating catchment area measurement. The latter metric addresses open data issues while considering different transportation modes and catchment sizes.

URBAN MOBILITY TRANSITIONS: HOW MIGHT WE MOVE TOMORROW?

Decision support under uncertainty for design processes of urban mobility solutions for sustainable futures
Tjark Gall
Link to recording | presentation

We provide an overview and examples of a design and decision support method developed as part of a doctoral project at the Anthropolis Chair. The method integrates future trends and uncertainties to prepare better today's design process for tomorrow's mobility solutions. 2030 scenarios of Paris-Saclay support two applications cases: 1) Testing intermodal mobility-on-demand solutions, and 2) Prioritising and selecting interventions to increase active mobility.

Urban forms and human transport. Modelling the co-evolution of new mobility modes and transportation networks
Michele Tirico
Link to recording | presentation

Historically, the introduction of new mobility modes has shaped urban forms (for example, the invention of internal-combustion engines has led to heavy environmental infrastructures, strongly contributing to urban sprawl). Nowadays, with the recent introduction of e-scooters, the higher consideration of active modes, the expected introduction of autonomous vehicles and the development of mobility-on-demand services, it could be argued that we are approaching another transportation revolution. In this work, we present a formalism to investigate how existing ad predicted mobility modes, technological innovations, and human behaviours shape the transportation system.

An agent-based simulation assessment of the future of mobility in the area of Paris-Saclay
Tarek Chouaki
Link to recording | presentation

Major changes are planned on the public transport side, with new lines coming into service in the Île-de-France region in general and, more specifically, in Paris-Saclay. The Grand-Paris Express project and future tramway lines will directly impact travellers: the routes they will take and the time it takes to perform their trips. Using agent-based simulations, we will be able to assess future lines' impacts on the considered individuals' mobility.

On-demand mobility with electric autonomous vehicles: An optimisation approach
Yue Su
Link to recording | presentation

With the astounding growth in automobile ownership, there has been a series of transport-related problems worldwide (e.g., greenhouse gas emissions and urban traffic congestion). Two efficient methods are proposed to reduce these problems: using electric vehicles and investigating ride-sharing services. The Dial-A-Ride Problem (DARP) consists of designing minimum-cost routes by scheduling a fleet of vehicles to provide ride-sharing services to a set of customers who specify their origins and destinations. In recent years, many demand-responsive systems have been constructed, such as the mobile-based app of BlaBlaCar in France and Didi Hitch in China. With the resurgence of on-demand ride-sharing services, how to strike a good balance between operational costs and user convenience becomes a big challenge.

INTRODUCING THE ANTHROPOLIS CHAIR VISION

Introduction

As shown on the figure below, the research plan of the chair is organised according to three interconnected themes (Urban Mobility Futures; Mobility as a Service and Infrastructures). An addition transversal topic is addressing Sustainability Challenges for urban mobility. Based on this scheme, the chair presented its research agenda during the colloquium.

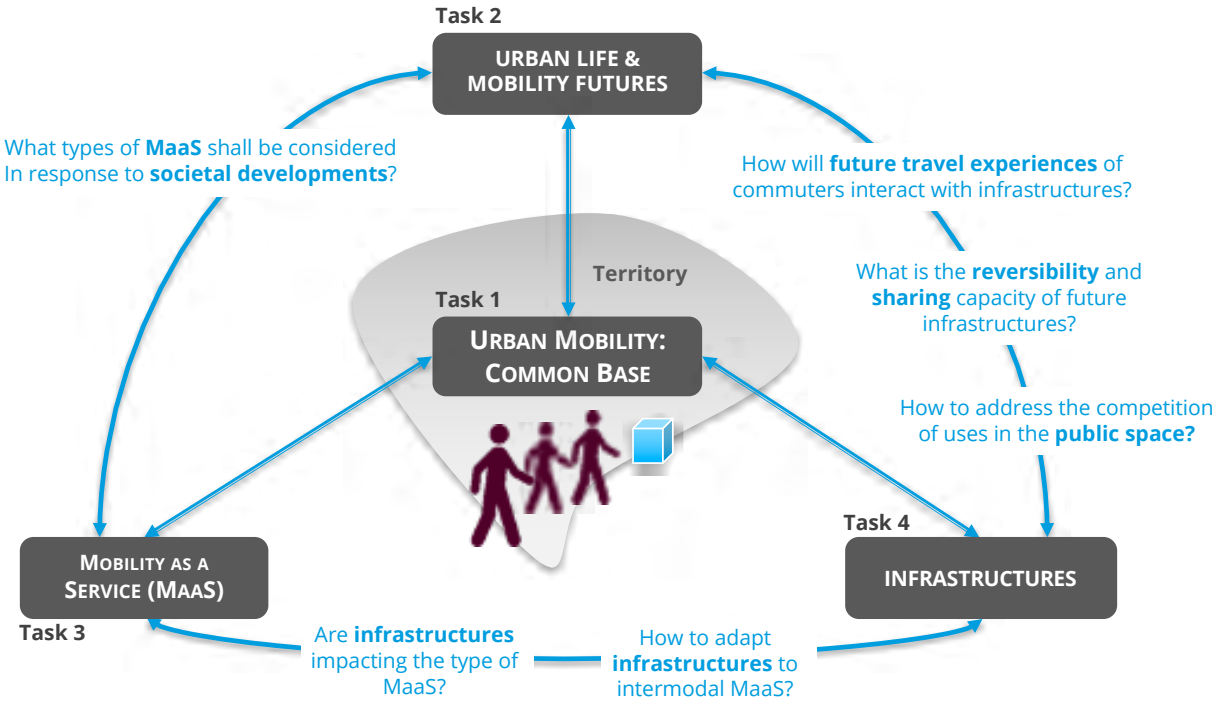
Sustainability Challenges

This part of the contribution is placed under the umbrella of Sustainable Development Goal 11 – Sustainable Cities and Communities. Our goal is set by the Paris Agreement with the Zero Carbon Emission target in 2050. A part of the long-term strategy to reduce Green House Gases Emissions is the Paris ban on combustion and diesel-fuelled engines by 2030.

In our work, we intend to balance and examine sustainable value creation as well as negative (environmental and social) impacts generated by mobility solutions. We also consider resources in a broad sense, meaning material and energy, as well as data flows.

A special interest is placed in social impacts when building future scenarios for mobility and urban life, and more specifically the expected equity of scenarios for different social groups.

Regarding value creation, the sustainability of MaaS business models is taken into account, as well as the privacy when using mobility data. Another emerging topic concerns the quantification of environmental impacts associated with mobility data along their life cycle, i.e., data production, storage, and analysis.



For the infrastructure theme, we focus on the joined environmental impacts of infrastructures and vehicles, for instance in the case of electric mobility. Our intent is to consider more impacts than greenhouse gas emissions or energy consumption to better embrace the diversity of impacts generated. We combine eco-design and transport approaches with a spatialised vision, considering mobility practices in the model. Finally, in line with the special issue for Sustainability journal called 'Reconciling High tech and Low tech for Sustainable urban mobility', we discuss the sustainability challenges jointly raised by the usage of high-tech solutions for mobility (for managing data for instance) or low-tech solutions mostly based on usage shifts.

Urban Mobility Futures

The second task of the Anthropolis Chair expands on the future methods' research and personarrative approach of the first cycle of the Chair; responding to the question of how the future of urban mobility may look like and how we can prepare, plan, or impact its materialisation. The goal is to find new pathways to contribute to a sustainable transition towards more human-centred mobility in the urban areas of tomorrow.

The specific objectives are to create a state-of-the-art overview on foresight and forecast methodologies; to compile and to analyse impacting societal, behavioural, and technological trends; observe individuals' needs, behaviours, and preferences through theoretical and participatory research; and finally, develop a systematic and creative method for alternate future scenarios of urban mobility. These methods and tools are applied in the Communauté d'agglomération Paris-Saclay and lead to multiple, human-centred, and place-based urban mobility scenarios which can guide and support product, service, and policy design.

Mobility as a Service

The vision of the Anthropolis Chair on Mobility as a Service (MaaS) starts by emphasising the place that MaaS could take in the futures of urban mobility as a human-centred mobility solution.

We are building our MaaS research on economic, social, and technological axes, as well as the transversal axis eco-innovation. In the economic axis we propose to analyse value creation, capture and redistribution models as well as the overall value chain restructure in the ecosystem for sustainable MaaS' solutions. We are creating a typology of business models that permits us to further examine more scaled and territorialised MaaS deployments and its outcomes and to create more specific indicators for the evaluation of these criteria. In the social axis we seek to identify the aftermaths of governance dynamics in reconfiguration and MaaS' societal effects regarding equity of access to mobility through MaaS, issues of spatial justice in the public space, sustainability, and health impacts. In the technological axis we approach the issues of creation, ownership, and management of data by all the services integrated in MaaS solutions. We further assess the role of parallel technological innovations in the evolution of MaaS, for example how infrastructure will be integrated as well as new mobility services like automated shuttles or charging networks for electric vehicles

Exploring MaaS from an ecosystemic approach, we have come up with initial research goals:

• To identify the status of MaaS definition and monitor and map its evolution.
• To clarify the effects of governance configurations on the value chain in the ecosystem.
• To identify the sustainable outcomes of MaaS business models to assess them and provide recommendations to stakeholders.

We are keen to identify the policies and regulations that might enable a more successful merge between innovation and sustainability in MaaS, in other words, assure that MaaS solutions will be developed under an eco-innovative approach.

Lastly, we want to approach the scenarios of urban mobility futures and model what MaaS could look like in these scenarios.

Further, we are working on the appraisal of active modes in MaaS towards more sustainable MaaS business models that promote walking and cycling and provide an added value to customers and to MaaS operators. Some of the steps in our research include identifying methods and tools that permit us to assess MaaS under a series of sustainability criteria as well as under technological and organisational perspectives. Regarding this, we are mapping MaaS actors and create a topology of the new economic dynamics and governance configurations between them.

Infrastructures

The theme of the infrastructures of the future first raises the question of user interactions between people and these infrastructures (for example, pick-up and drop-off facilities for carpooling), as well as the notion of competition between uses. Within a shared public urban space, it is becoming more and more imperative to question the place given to people on the move and to infrastructures, as evidenced for example by the tensions brought about by unlimited individual means of transport. (electric scooter and free-floating bike, electric scooters).

Associated with the question of the sharing of public space, we must look systemically at parking (public and residential), the methods and locations of charging/smart charging stations for the various electrical equipment, the spaces reserved for car-sharing and autonomous shuttles, or delivery areas. Further, there is the challenge of developing active modes in urban areas, in their connection with other modes of travel.

The operation of the infrastructures of the future will be based on emerging technologies which we must consider here. In a non-exhaustive way, these technologies make use of sensors, connectivity and information devices, connected (intelligent) road structures for all modes, or wireless charging methods.

Infrastructures can also be seen from the angle of their function of inducing or controlling the mobility of people and goods and the continuity of travel without interruption. These same infrastructures can also have the function of giving a more human image to the city. In medium and long-term temporal projections, the infrastructures must be designed with a view to reversibility, as for example in the case of urban parking spaces.

SPEAKERS' BIOGRAPHIES

In order of appearance.

Flore Vallet
Anthropolis Chair Holder at IRT SystemX and CentraleSupélec

Researcher on Human Centered Design at IRT SystemX and Assistant Professor at CentraleSupélec, she joined the Anthropolis chair in 2016 and is the chair holder since September 2022. Before, she was assistant professor at the Mechanical Systems Engineering Department of the Université de Technologie de Compiègne (UTC). She graduated in mechanical engineering design at the ENS Cachan (1993), and obtained a Master's degree in industrial design from UTC in 1999. In 2012, she completed a PhD on the dimensions of eco-design practices towards education of engineering designers. She is a member of the French EcoSD (Eco-Conception de Systèmes Durables) network and of the Design Society. Her fields of interest are practices of eco-design and eco-innovation in industry and for education, human centered approaches in design and eco-design.

Patrice Aknin
Scientific Director, IRT SystemX

Patrice Aknin manages the scientific arm of the Institute by supporting and assisting its scientific growth and coordinating relationships with its partners in public research and higher education. A PhD of Université Paris-Sud and "Habilitation à diriger des Recherches" of the Ecole Normale Supérieure in Cachan, his career was one of research at Inrets, later known as Ifsttar (French Institute of Science and Technology for Transport, Developpement and Networks). In 2008 he was appointed Research Director at Ifsttar. In 2013, he was appointed Scientific Director of the SNCF in the Innovation & Research division, in charge of the group's doctoral studies, academic partnerships, expert network and innovative design. He is currently a professor at Ecole des Ponts ParisTech.

Jakob Puchinger
Scientific Advisor,
Anthropolis Chair

Jakob Puchinger is professor in Supply Chain Management and Logistics. He joined EM Normandie in 2022. He is also affiliate professor at the Laboratoire Génie Industriel at CentraleSupélec, Université Paris-Saclay and co-director of the Future Cities Lab with Centrale Pékin. Jakob Puchinger holds a doctoral degree from TU Wien obtained in 2006. His thesis investigated the combination of metaheuristics and integer programming for solving cutting and packing problems. His main research interests are in logistics and urban mobility, disruptive technologies and the optimisation of the underlying transport systems. Before joining EM Normandie, Jakob Puchinger was Anthropolis Chair Holder at IRT SystemX and CentraleSupélec. Jakob Puchinger co-authored more than 80 scientific publications.

François Cluzel
Assistant Professor,
CentraleSupélec

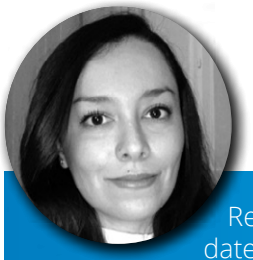
François Cluzel is an assistant professor and head of the Design Engineering research group at Laboratoire Genie Industriel (Industrial Engineering Research Department) at CentraleSupélec, member of Université Paris-Saclay. He holds a PhD in industrial engineering from Ecole Centrale Paris (2012) and an engineering degree in mechanics from Supméca Paris (2008). His research and teaching activities deal with innovation engineering and circular economy. He is a member of the Design Society, and of the French network of eco-design researchers EcoSD.

Yann Briand
R&D Manager, Mobility &
Logistics Leader at IRT SystemX

Yann Briand is responsible for the mobility and logistics domain at IRT SystemX. Fostering applied digital engineering, Yann takes part in the setting up and coordination of collaborative projects, at national and European level. Yann is involved in mobility challenges for more than 15 years, supporting industrials and academics in their innovation programs. Yann Briand graduated from Ecole des Mines and Sciences Po.

Julien Baltazar
PhD Candidate,
LGI, CentraleSupélec

Julien Baltazar's thesis deals with the development of territorial environmental assessment for passenger mobility. He aims to create a diagnosis and simulation tool that would be useful to local authorities for the design of their mobility plans and projects. During a collaborative project within the EcoSD Network, he has worked on electric vehicle performances considering long-distance trips. Julien Baltazar also teaches engineering design, circular economy, and industrial ecology at CentraleSupélec.



Mariana Reyes
PhD Candidate,
Anthropolis Chair

Researcher and PhD candidate on "Mobility as a Service: Concepts, governance and business models." Mariana has a degree in Architecture and a diploma in Urban Planning and Management of Metropolitan Mobility in Mexico. She joined the Chair in November 2020, after completing a MSc in Urban Planning, Transportation and Mobility at the Ecole d'Urbanisme de Paris (UGE-ENPC) with the research topic of "Governance of Mobility as a Service and its effects on public transport systems".

Ouidad Benlima
PhD Candidate,
CentraleSupélec

Ouidad Benhlima is a PhD candidate at the LGI and has been an R&D Engineer at Centrale Casablanca since November 2020. Her educational qualifications include an engineering degree from the Mohamedia School of Engineers (EMI) and an MSc in Circular Economy from IMT Nord Europe. Ouidad's research interests include the analysis of urban mobility and spatial accessibility in an emerging city such as Casablanca in central-western Morocco.

Tjark Gall
PhD Candidate,
Anthropolis Chair

Tjark pursues a PhD on developing people-centred scenarios of urban mobility futures to include uncertainties into solution design processes, applied to the areas of Paris-Saclay and New Cairo. He is an urbanist with experience in urban development, climate change, and the effective use and visualisation of urban data to strengthen evidence-based decision- and policy-making. He obtained a MSc Urban Management and Development Studies course at IHS, Erasmus University Rotterdam (NL), and MSc Architecture at the Technical University of Brunswick (GER).

Tarek Chouaki
PhD Candidate,
Anthropolis Chair

Tarek Chouaki obtained a Master's degree in Artificial Intelligence from Sorbonne Université in 2019. His major fields of interest are Artificial Intelligence and Multi-Agent Systems. His current work, in the scope of his PhD, focuses on the design and operation of Mobility-on-Demand systems using agent-based simulation framework MATSim and reinforcement learning techniques, with an emphasis on the area of Paris-Saclay and the prospective assessment of the impacts of future public transportation systems.

Michele Tirico
Post-Doc, FutureCitiesLab
LGI, CentraleSupélec

Michele Tirico is a Postdoctoral researcher on "modeling co-evolution of urban forms and human transport". He received his PhD in computer science from the University of Le Havre Normandy (France), a M.Sc. in engineering from the University of Pisa (Italy) and a M.Sc. in geography from the University of Côte d'Azur (Nice, France). He joined the Future Cities Lab and the laboratory LGI (CentraleSupélec, Paris-Saclay University) in January 2022. His approaches are drawn from complexity theory, network science, artificial intelligence and agent-based systems.

Yue Su
PhD Candidate,
LGI, CentraleSupélec

Yue Su is a researcher and PhD candidate in Operations Research. She earns double master's degrees in general engineering and transportation engineering from Ecole Centrale de Lille and Southwest Jiaotong University, respectively. She begins her PhD in 2019 and works on "The electric autonomous dial-a-ride problem". Her research interests include exact and heuristic methods for vehicle routing problem and machine learning methods.

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The Anthropolis Chair, operated by IRT SystemX and CentraleSupélec, brings together the partners EDF, Engie, Groupe Renault, Communauté d'Agglomération Paris-Saclay, and Nokia Bell-Labs to work towards human-centred mobility. The Future Cities Lab is a joint initiative of Centrale Pékin, Beihang University Beijing, and Laboratoire Génie Industriel (LGI), CentraleSupélec, Université Paris-Saclay. To get to know more about ongoing activities, visit the Chair's website and join the mailing list.

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