

Systems and Control for Societal Impact: TC9.2. Developments and Vision

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TC9.2 Main Goals:

- IFAC World Congress
- CPHS Workshop
- Educational activities in collaboration with the TC9.4
- Structure new research topics
- Collaborating with the different IFAC technical committees.

















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- [Mahdi Zargayouna](#), Univ. Gustave Eiffel, France.

- Computer and Internet revolutions → **major transformations and numerous new possibilities in control/AI systems** (healthcare, industry, ground transportation, aerospace and energy management).
- The IFAC TC 9.2 addresses the impact of systems and control: on sociotechnical systems and organizations, on the human individual, and on society in the global scale.
- The underlying question is →

How to plan the systems design in order to obtain the maximum of benefits and at the same time anticipate their possible adverse effects?

Control for Societal-scale Challenges: Road Map 2030, Eds. A. M. Annaswamy, K. H. Johansson, and G. J. Pappas, IEEE Control Systems Society Publication, 2023, <https://ieeecss.org/control-societal-scale-challenges-road-map-2030>

F. Lamnabhi-Lagarrigue, Annaswamy, S. A. Engell, A. Alf Isaksson, P. Khargonekar, Richard M. Murray, Henk Nijmeijer, Samad, D. T. Tilbury, and P. Van den Hof. **Systems and control for the future of humanity, research agenda: Current and future roles, impact and grand challenges**. Annual Reviews in Control, 43, 2017.

A. Annaswamy, P.P. Khargonekar, F. Lamnabhi-Lagarrigue, and S.K. Spurgeon (Eds.). **Cyber-Physical-Human Systems: Fundamentals and Applications**. IEEE Press Series on Technology Management, Innovation, and Leadership, Wiley, 2023.

A. Martinesco, M. Netto, A. Miranda Neto, and V. H. Etgens. **A note on accidents involving autonomous vehicles: Interdependence of event data recorder, human vehicle cooperation and legal aspects**. IFAC PapersOnLine 51-34, 2019.

S. Jonas and F. Lamnabhi-Lagarrigue. **Ethics and Responsibility of Industrial Cyber-Physical Systems**. In Digitalization and Control of Industrial Cyber-Physical Systems: Concepts, Technologies and Applications (Eds. O. Cardin, W. Derigent and D. Trentesaux). Wiley, 2022.

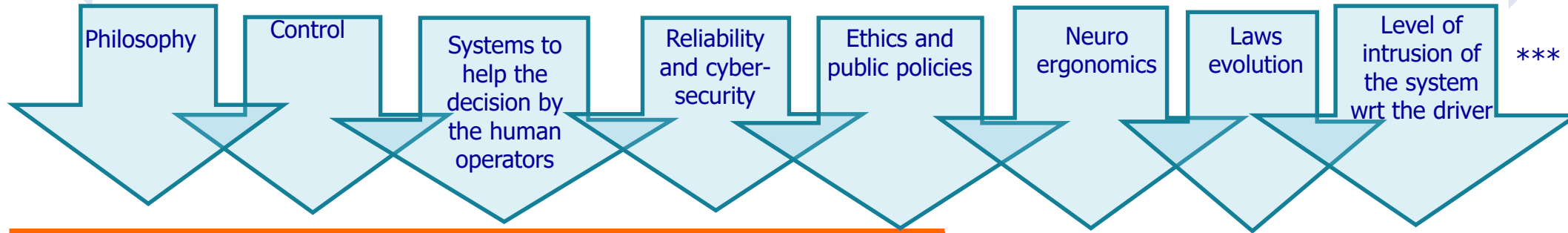
Ethically aligned design. Technical report, IEEE Press, 2019.

M. Sampath and P.P. Khargonekar. **Socially responsible automation: A framework for shaping the future**. National Academy of Engineering Bridge, 48, 2018.

About Cyber-Physical & Human Systems

From Machine to CPS towards CPHS...

Pluridisciplinary



4 big families

MODELLING				
e.g. models of the human being cognitive activity level, cybernetic driver models, models of the motion of groups of human beings (work on flocky logic from N. Leonard and S. Marshall), models of the creativity processes.				
DECISION and CONTROL				
	Human-Centric	Machine-Centric		
	Human-machine symbiosis	Humans as operators of complex eng. systems	Humans as agents in multi-agent teams	Humans as elements in controlled systems
MEDICAL APPLICATIONS	Individualized neuroprosthetics: overlaps with the modelling and control domains, with therapy to the specific patient	Robots for cancer surgery		
TRANSPORTATION AND INDUSTRY		Aircraft pilots, train drivers, car drivers, process plant operators	Coordination of UAVs and piloted aircraft in commercial airspace; Traffic control	
SMART GRIDS				Comfort control in homes & buildings

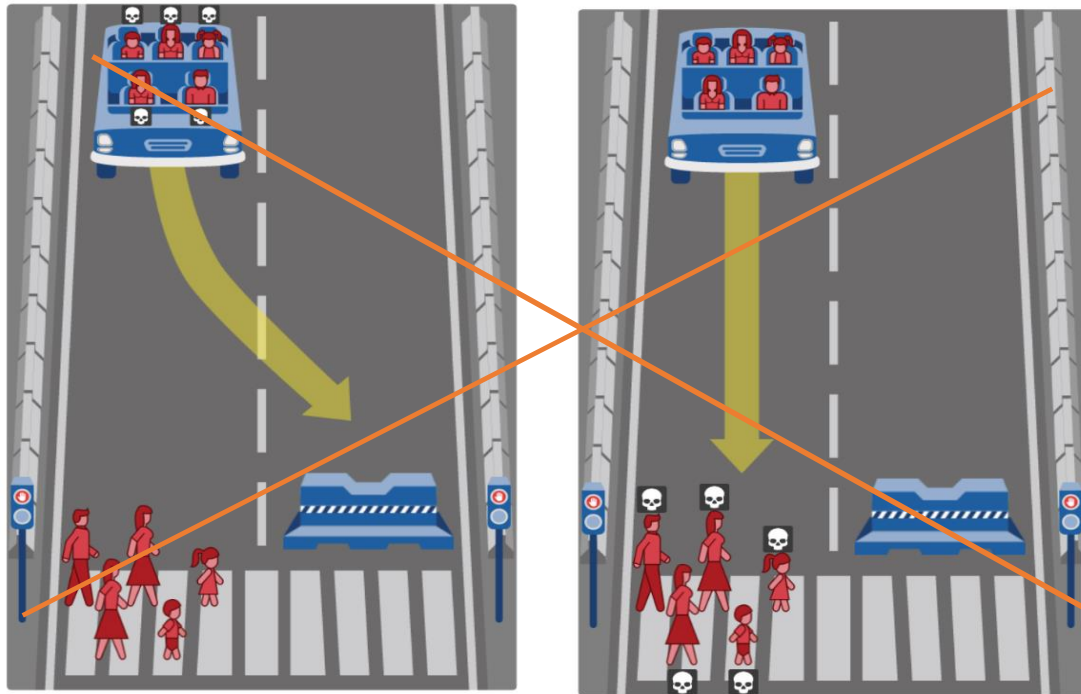
Cyber-Physical Systems (**CPS**) are systems constructed from, and dependent of, the synergy between computer and physic components.

Tariq Samad, *Human-in-the-Loop Control and Cyber-Physical-Human Systems: Applications and Categorization*, CPHS: Fundamentals and Applications, A. M. Annaswamy, P. Khargonekar, F. Lamnabhi-Lagarrigue, and S. K. Spurgeon, Eds. UK: Wiley, 2023.

Elements for positive impacts:
some examples

Elements for positive impacts: some examples

- Philosophy as a propulsion to design ethical control systems



https://commons.wikimedia.org/wiki/File:Moral_Machine_Screenshot.png

Attribution: Iyad Rahwan, CC BY-SA 4.0 <<https://creativecommons.org/licenses/by-sa/4.0/>>, via Wikimedia Commons

Jeroen Van den Hoven, Gert-Jan Lokhorst, and Ibo Van de Poel. Engineering and the problem of moral overload. Sci Eng Ethics, 2012.

➔ Engineer responsibility to prevent situations which are morally dilemmatic (J.V. Hoven).

➔ Further: Is there a risk that the human be changed by the use of the system?

Elements for positive impacts: some exemples*

- Full automation, manual or mixed mode? Uses cases
- Previewed impact of the desired system on the human or on the social system
- Liability issues
- How to couple Artificial Intelligence (AI) with control and at the same time ensure transparency, accountability, explicability and reliability? (EAD [2019]).
- Human cognitive representation modelling of the automated system
- The gap between the theory and practice.
- Reversibility of systems: can we change the direction of an on-going technological transformation?
- The Paradoxe of automation

Ethically aligned design. Technical report, IEEE Press, 2019.
<https://standards.ieee.org/news/2017/eadv2.html>.

*M. Netto. Systems and Control for Societal Impact: TC9.2. Developments and Vision – Contribution to the CC9 milestone session 2023. In IFAC WC 2023.

« If you build systems where operators are rarely required to respond, then they will rarely respond when required » (Bainbridge 1983, Hancock 2015)

Interdisciplinarity – an example

How control connects to law?



The Vienna Convention (1968) and the Geneva Convention (1949)

Both request that a person (the driver) be in capacity of ensuring the driving tasks.

➔ The Amendment to the Vienna Convention (23 March 2016).

Legal frame for a set of systems appearing in the market

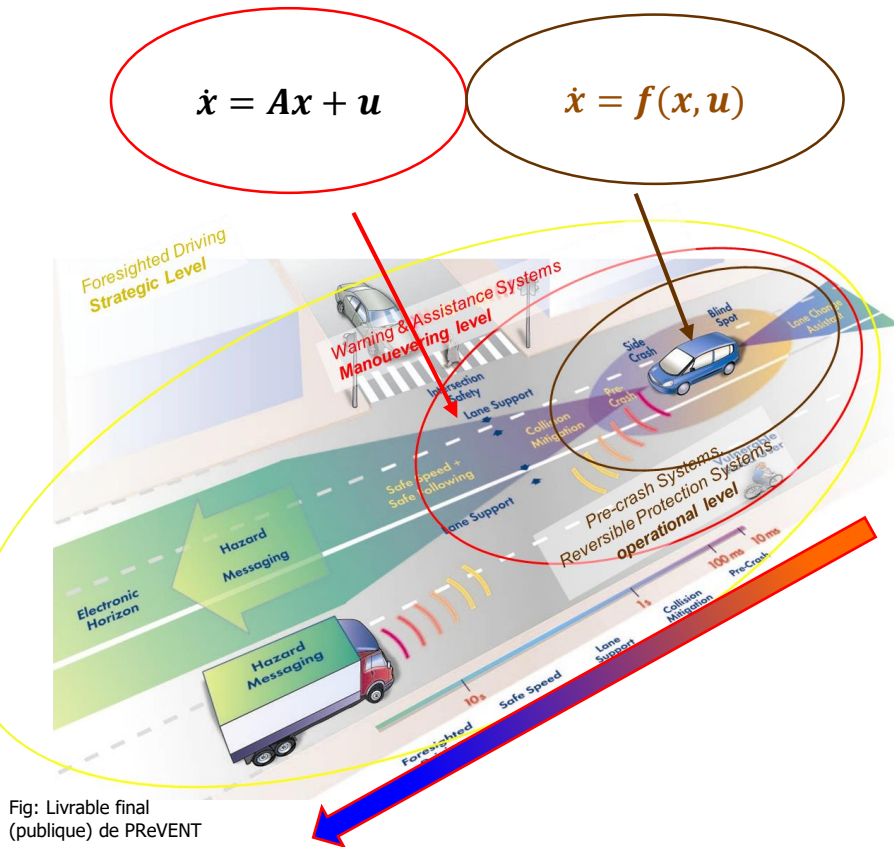


«The Embedded systems influencing in the driving tasks »

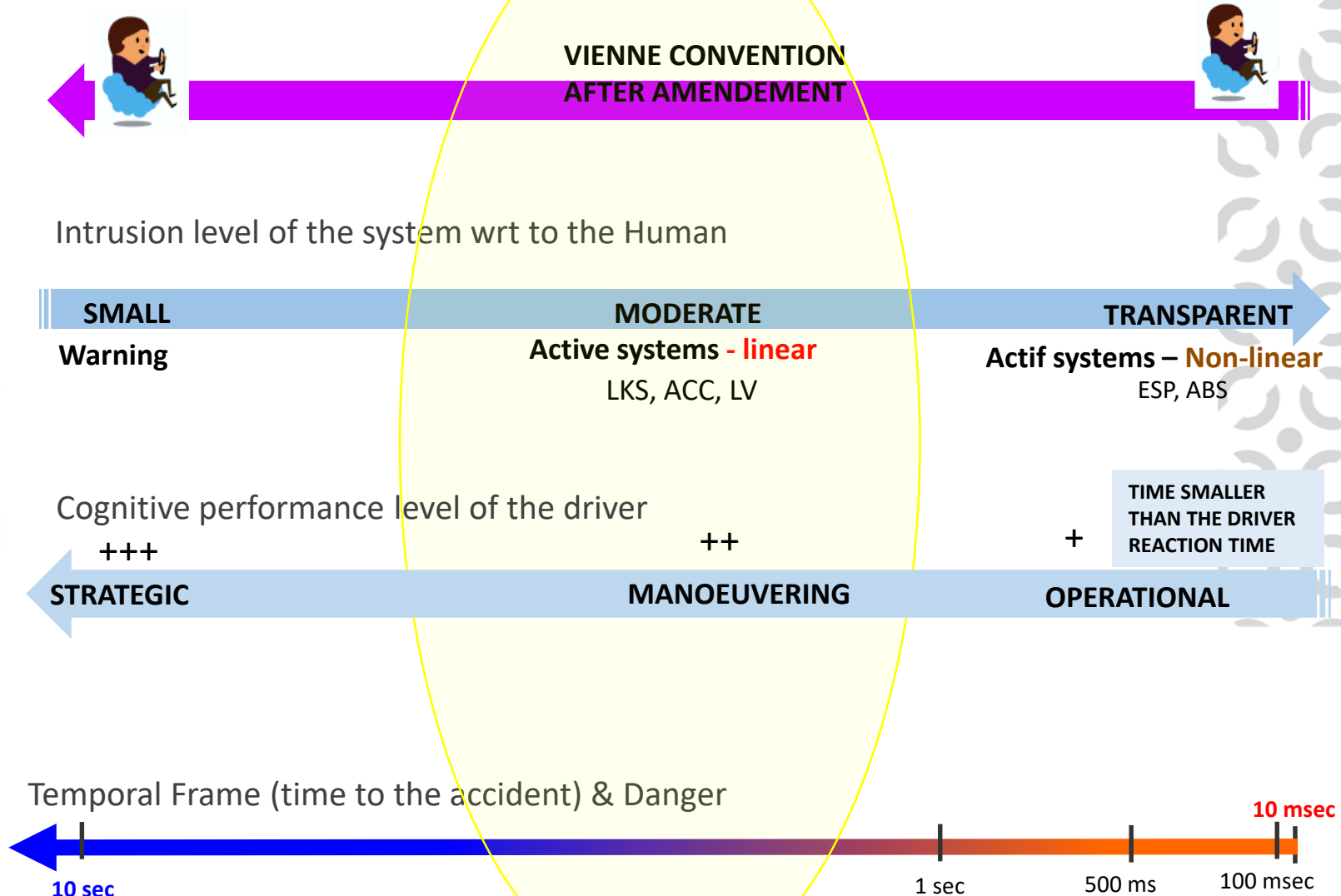
New art.8§5 bis : **Authorized if the driver is able to override the system**

Interdisciplinarity – an example: ADAS (Advanced Driving Assistance Systems)

Intuitive thought « the more intrusive the system is wrt to the human, the less he (she) can be considered liable »



3 groupes of ADAS: Scholliers, Blosseville, Netto, Leanderson, et al 2007, livrable PREVAL-PREVENT: D16.3 Proposal of procedures for assessment of preventive and active safety functions



M. Netto, J.-M. Burkhardt, A. Martinesco, and D. Gruyer. Les degrés croissants de la robotisation de la voiture, de la conduite manuelle au tout automatisé : points de vue croisés des sciences technologiques, des sciences cognitives et des facteurs humains, et du droit, pages 171–206. Presses universitaires de Valenciennes, 2020.

Contributions of the TC9.2 in the trienium 2020-2023

- 1) **New name of the TC9.2: Systems and Control for Societal Impact** and start of reformulation of its research directions: **new scope+**
- 2) **Cyber Physical & Human Systems Workshop (CPHS) - editions 2020 & 2022++ held with success** (despite covid) – main sponsors TC9.2 & TC9.1
- 3) Actions for students
 - a) **KIDS IN CONTROL: A workshop for promoting STEM and Automatic Control for kids from 8 to 10 years old ***
 - b) **(Re)Creative Mobile Robotics for Kids**** (Joint work TC9.2 and TC9.4).
- 4) **CPHS book, June 2023*****
- 5) **Contributions to the IFAC WC 2023** (next slide)

+ With thanks to All colleagues from the TC9.2 that have given valuable comments to it.

++ General chairs: T. Samad & F. Y. Wang; M. Oishi (and with many participations of the TC9.2 members in the committees. And many thanks also to the CPHS steering committee.)

* Led by A. Parisio, TC9.3, C. M. Verrelli, TC9.2, and with the participation of El Arayshi and Tiberti.

** Led by C. Stoica Maniu, together with S. Bertrand and A. Thakker. Several students from the “Innovative pedagogy and EdTech” Projects Cluster of CentraleSupélec are part of this project.

*** co-edited by A. Annaswamy, F. Lamnabhi-Lagarrigue, P. Khargonekar and S. Spurgeon, June 2023.

Contributions of the TC9.2 to the IFAC World Congress 2023

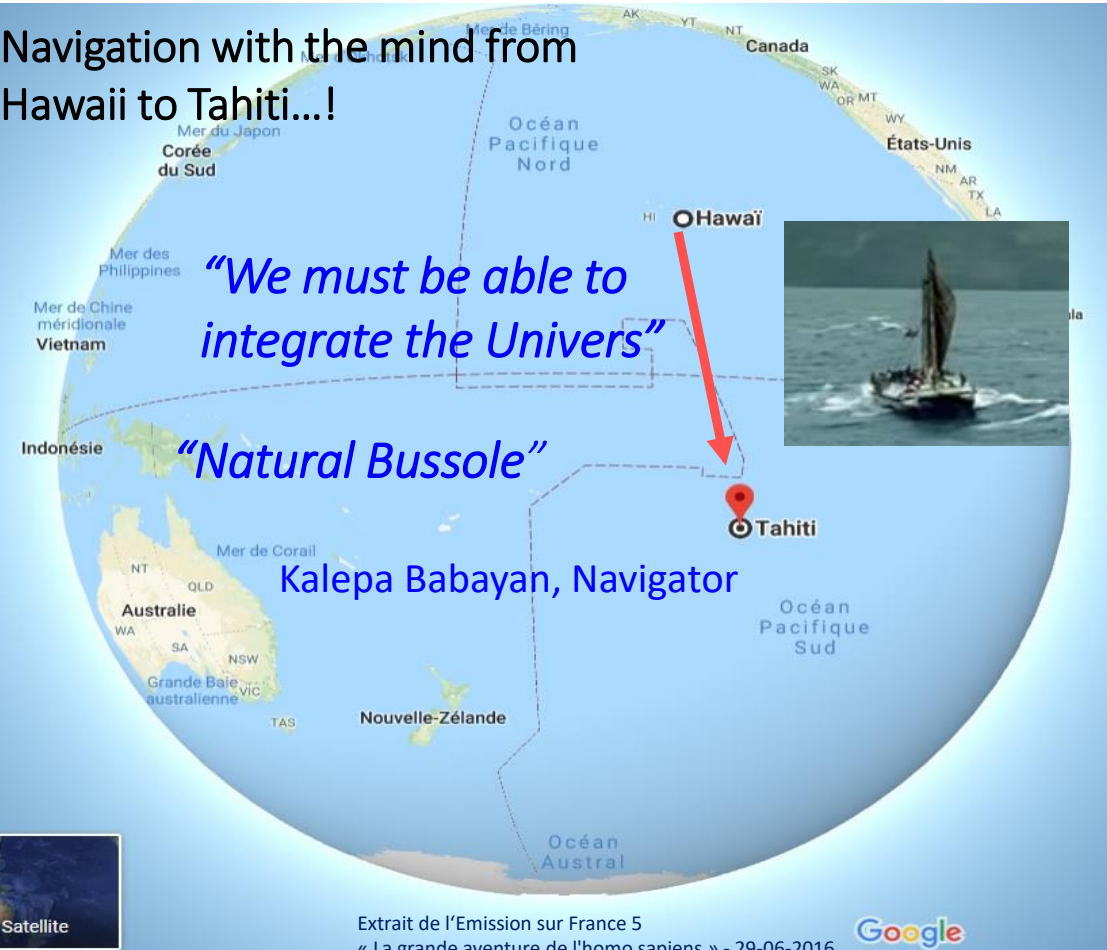
- 1 Invited session⁺ and 1 open invited track⁺⁺
- CC 9 Milestone invited section led by the CC 9 Chair L. Stapleton
- “IG Forum (SG07): Automatic Control for Smart Cities: Can people accelerate control of urban systems? led by Michi Kohno, President and Chief Executive Officer of Michi Creative City Designers Inc. in Japan.
- Demonstrator paper (Verrelli et al. [2023]) on the Kids in Control action
(Kids in Control: Educational Activity and Devices for International School Students)

⁺M. Inoue et al. ; ⁺⁺ P. Frasca et al.

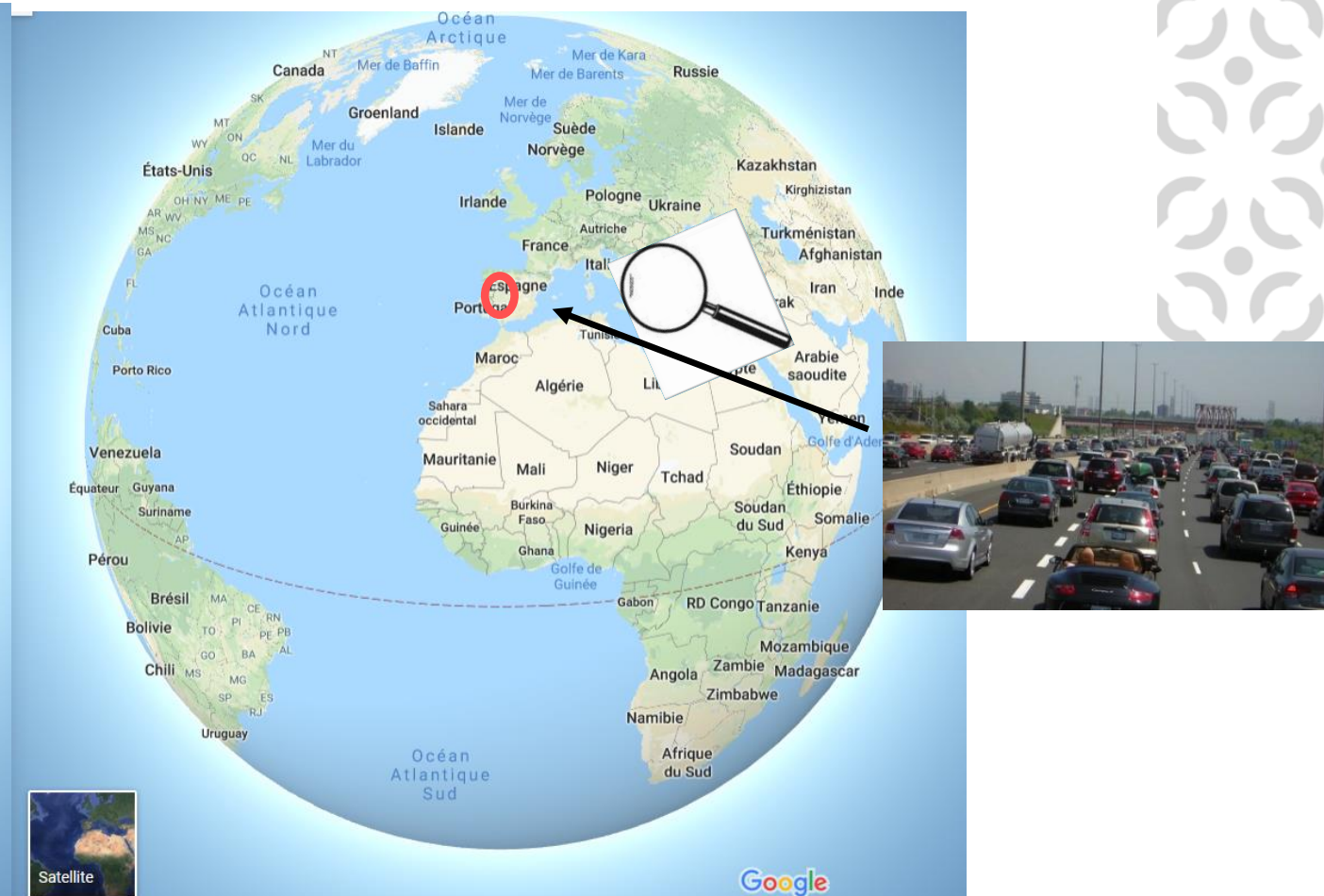
- *Real needs?*
- *Technology potentials?*
- *Limits to impose?*
- *Use cases?*
- *System Reliability?*
- *Change of competencies*
- *Responsible control design*

Past

Navigation with the mind from
Hawaii to Tahiti...!



Present



Thank you for your attention!
Questions?

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