WORKSHOP 3 : 13:15 – 15:30 PM JUNE 9, 2016

« Roads of the future : towards durable and multi-functional infrastructures »

Co-chairs: Nicolas Hautière and Pierre Hornych, Ifsttar (France)

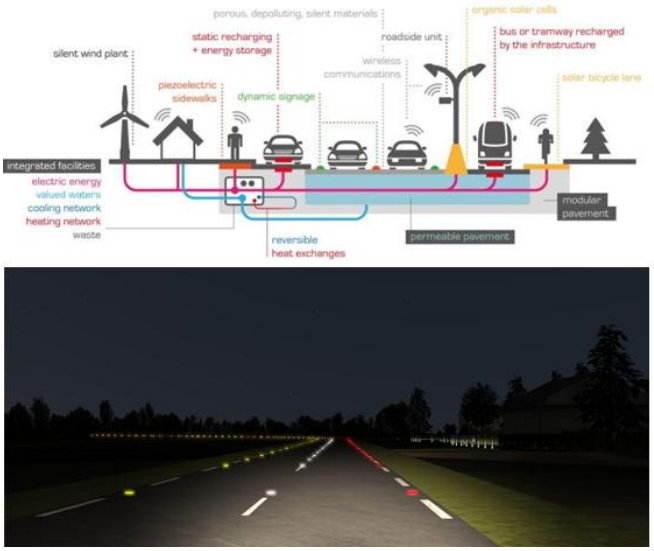
Nicolas HAUTIÈRE is Project Director at the Components and Systems Department (COSYS) of the French Institute of Science and Technology for Transport, Development and Networks (IFSTTAR). He leads the flagship program Route 5e Génération. He cochairs the strategic domain dealing with intelligent mobility solutions at the Mov'eo competitiveness cluster and is member of the operational committee of IDRRIM on research, innovation and education. At the European level, he is member of the Forever Open Road Experts committee of FEHRL.

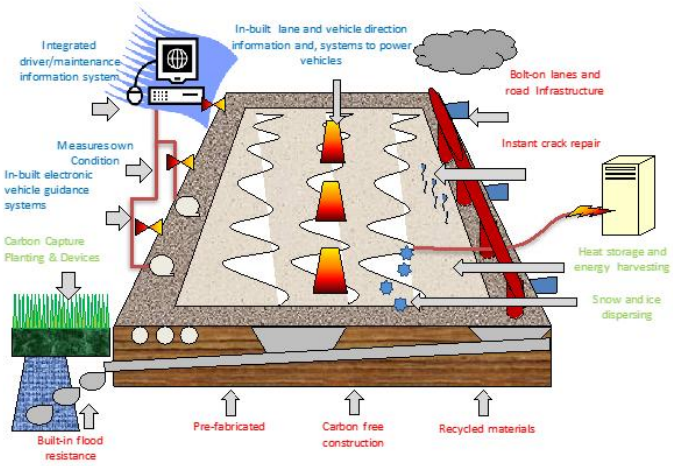
Pierre HORNYCH is head at IFSTTAR of the Laboratory for Modelling, Experimentation and Survey of Transport Infrastructures (LAMES), which activities include pavement modelling, full scale testing, monitoring, and pavement management systems. The LAMES is managing the IFSTTAR full scale accelerated testing facility. Pierre Hornych is a senior researcher, with over 100 Journal and conference publications,. His research interests include pavement modelling and design, full scale accelerated testing, bituminous and unbound materials. He is leading several projects on future road concepts and road monitoring,

Workshop Introduction

First part – Nicolas Hautière

Abstract. According to the Forever Open Road FEHRL's concept, future roads will be adaptable to future travel demand, automated and resilient to climate change. According to the French R5G program, they will have to support and enable green, connected and autonomous vehicles. This workshop aims at discussing these technical and functional issues of the roads of the future, and at demonstrating how both perspectives are progressively converging thanks to new technologies.

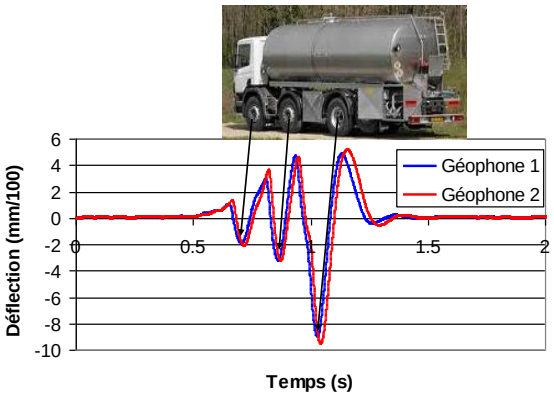




Second part – Pierre Hornych

Abstract. This presentation will describe recent projects carried out at IFSTTAR, as part of the R5G program; to evaluate different classical and innovative solutions for pavement instrumentation and monitoring, including strain sensors, geophones, fiber optic sensors, and piezo-electric sensors. In a first part, several test carried out on the IFSTTAR accelerated pavement testing (APT) facility, to evaluate different optical fiber sensors (for strain measurement, or damage detection) and several piezo-electric weight in motion sensors, used to measure dynamic vehicle loads, are presented. In a second part, results obtained on two instrumented motorway sections will be presented. These sections are equipped with remote monitoring systems, based on the use of wireless, low cost and low consumption PEGASE data acquisition boards, connected with different sensors (temperature sensors, geophones, strain gages). The continuous monitoring of these sections, under real traffic, allows to follow accurately different parameters like traffic loads, pavement deflections, layer moduli, and to calculate different indicators of pavement performance.

The Pegase data acquisition platform

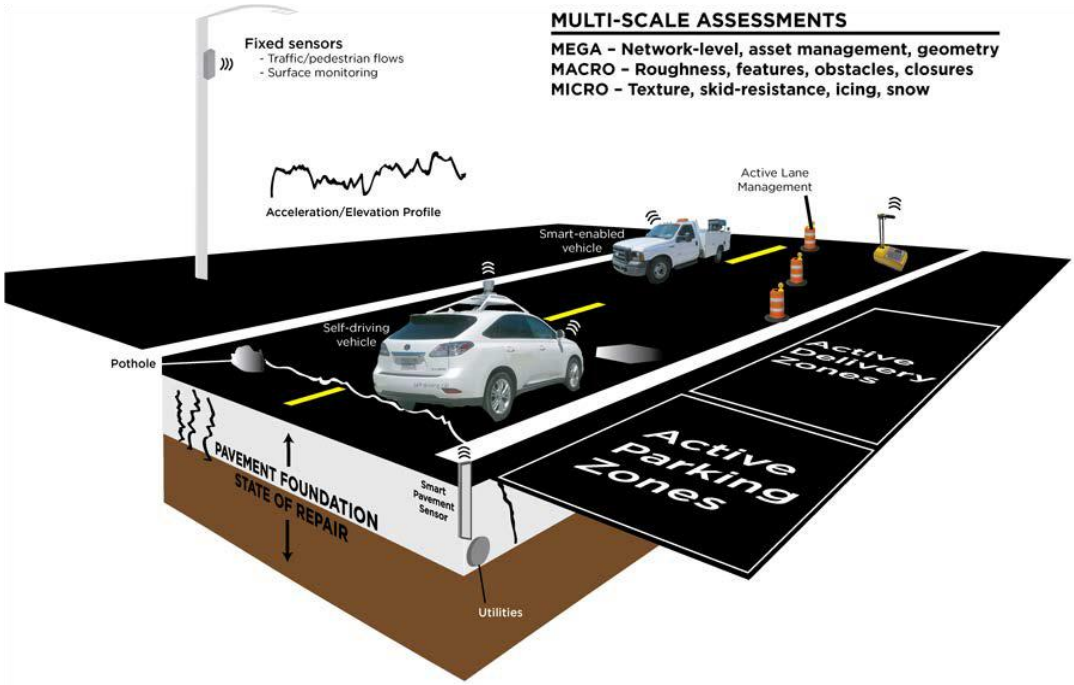


Measurement of pavement deflections with geophones

« Vision for an integrated & active digital pavement management system »

Recently, **Dr. BUTTLAR** was named the Glen Barton Chair in Civil and Environmental Engineering at the University of Missouri-Columbia (MU), where he oversees the Missouri Asphalt Pavement and Innovation Lab (MAPIL) on the 'Mizzou' campus. For the past 20 years, Dr. Buttlar served as Professor of Civil and Environmental Engineering at the University of Illinois at Urbana-Champaign (UIUC) and held the title of Narbey Khachaturian Endowed Faculty Scholar and Associate Dean. Dr. Buttlar is the chair of RILEM TC-MCD, is an Editor-In-Chief of the International Journal of Road Materials and Pavement Design, and serves on the Board of Directors of the Association of Asphalt Paving Technologists (AAPT). He is a founding member of City Digital at U+ILabs in Chicago, Illinois, and provides leadership in smart infrastructure initiatives at the center.

Abstract. In this presentation, a vision for a highly integrated, active digital pavement management system will be presented. Combined with other fixed and mobile sensor inputs (i.e., from vehicles and cell phones), an intelligent system is being developed that will trigger appropriate near-term maintenance and long-term capital program recommendations using machine learning to promote a safe, sustainable, and active asset management system for owner-agencies. Recently, a crowd-sourcing approach to collect large amounts of pavement roughness and feature data has been developed and validated. In the upcoming work, a smart service system will be developed, including cloud computing infrastructure, dashboards, and mobile sensor GUI/API design. A combination of new embedded and non-invasive sensors with associated communication technologies is proposed, to be integrated with street-level mounted sensors and a data collection and cloud connectivity system. An in-pavement, multisensor module will be developed, featuring a new wireless communication system. Cloud-connected and GIS-tagged apps and field measurement devices will also be developed.

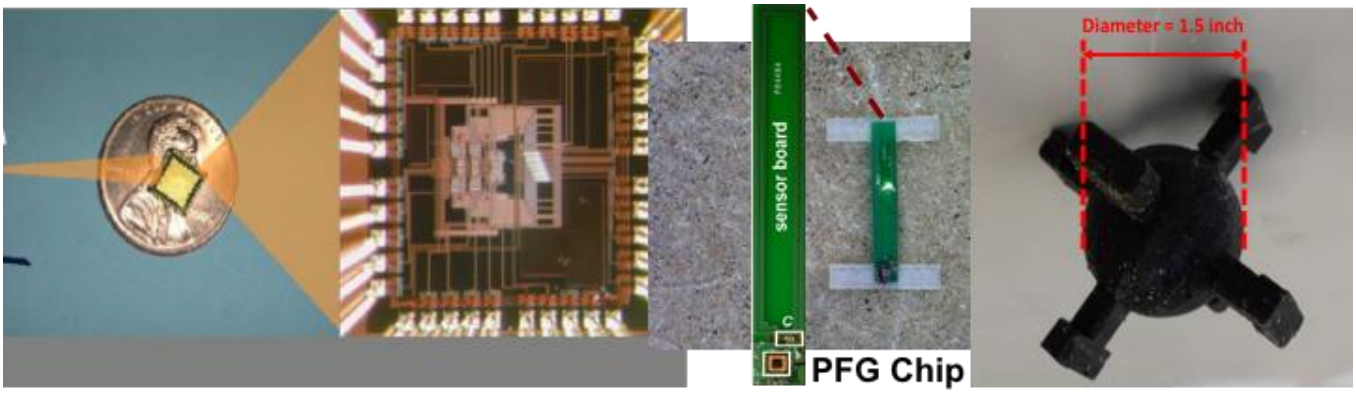


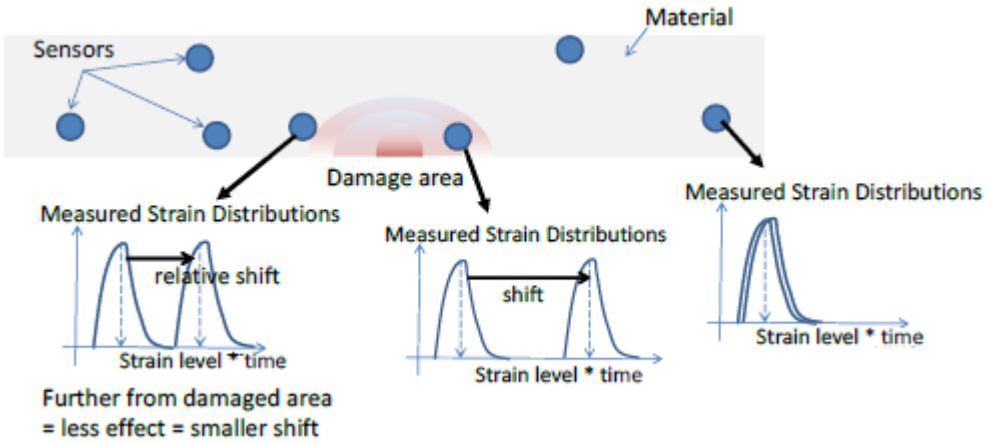
« Ultra-low Power Wireless Sensing System for Multi-metric Self-Powered Monitoring of Highway Infrastructure »

First part – Karim Chatti

Karim Chatti is Professor and Director of the Center for Highway Pavement Preservation at Michigan State University (USA). He also served as Associate Dean for Research and Associate Chairperson. Dr. Chatti has been involved in more than thirty-five research projects, and is the author of some 150 papers. He is past associate editor for the ASCE Journal of Transportation Engineering, past chair of the ASCE highway pavements committee and a member of several Transportation Research Board pavement related committees. He is also a board member of the International Forum for Road Transport Technology.

Abstract. This presentation will describe a new approach for the continuous health monitoring of pavements based on piezoelectric self-powered sensing technology. The uniqueness of this technology is that the signal sensed by the piezoelectric transducers from traffic loading can be used both for empowering the self-powered sensors and damage diagnosis. Numerical and experimental results from several projects funded by the Federal Highway Administration (FHWA) to evaluate the damage detection performance of the proposed self-sustained sensing system will be presented.

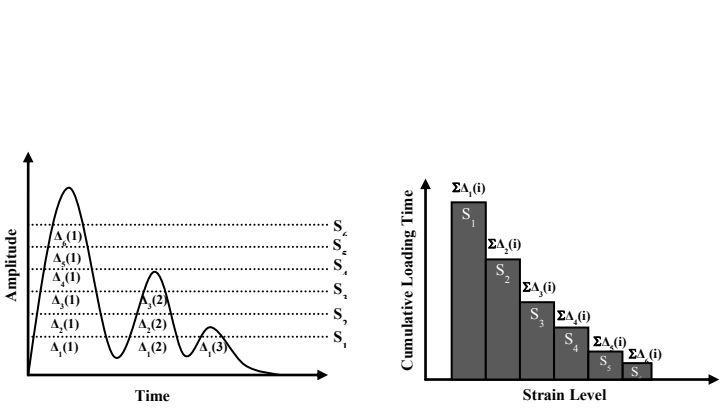




Second part – Nizar Lajnef

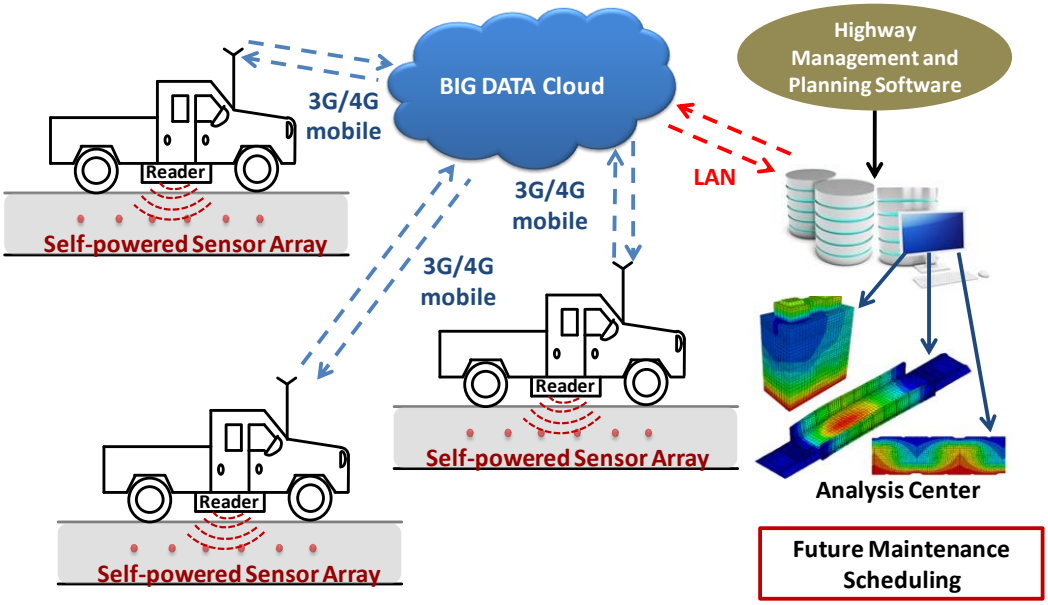
Nizar Lajnef is an associate professor of civil engineering at Michigan State University. His research is focused on sensors design for structural health monitoring and damage detection. He holds two patents and is the author of some 50 publications in the area of sensors design and energy harvesting. He was a recipient of the Lilly Teaching Fellowship in 2012 and the Nothstine fellowship in 2007. Dr. Lajnef is a member of the American Society of Civil Engineers (ASCE), the Institute of Electrical and Electronics Engineers (IEEE), and serves on the Energy Harvesting committee for the American Society of Mechanical Engineers (ASME).

Abstract. This presentation will describe a new sensing technology developed at Michigan State University that offers several novel features which are not available in other classical SHM methods including: low power requirements (~80 nW); self-powered continuous sensing; possibility of deployment in dense networks; autonomous computation and non-volatile storage; wireless communication; and low cost. In order to achieve all the described capabilities, the data is compressed and stored on the sensors as histogram of cumulative events. This unique type of data requires specific data interpretation techniques. These advanced techniques along with future planned developments will also be presented.



Data compression protocol

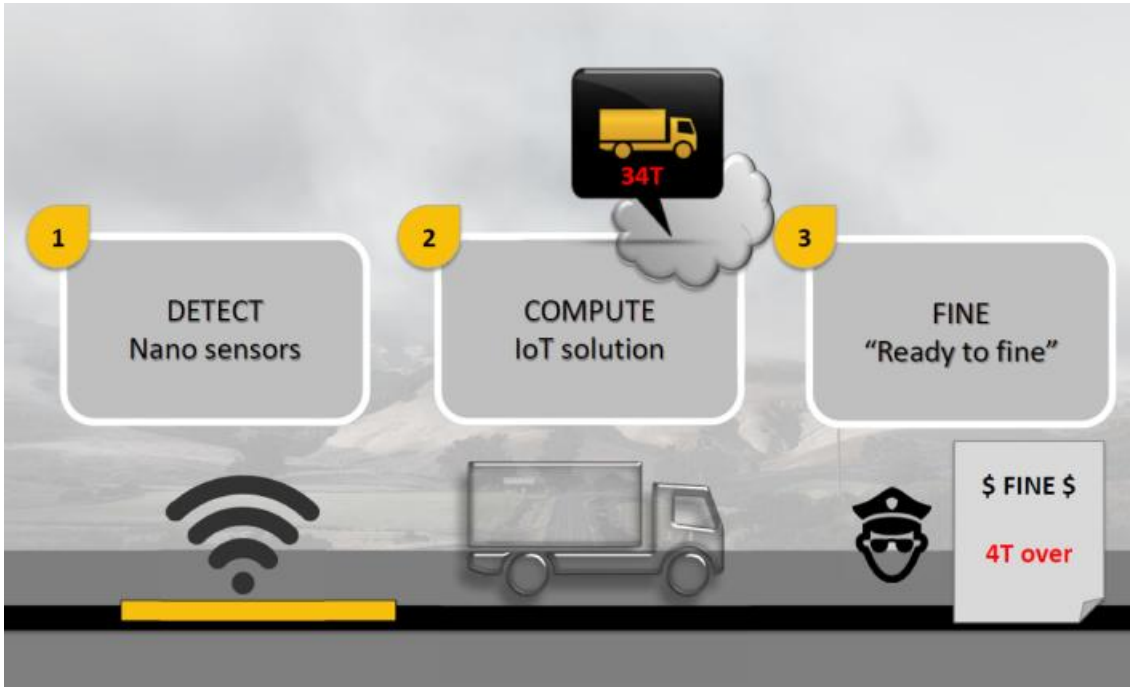
Damage detection using evolutionary approaches



« Smarter roads via mobile, nano-enabled sensors for detection of traffic patterns and overweight vehicles »

Bérengère LEBENTAL (F) graduated from Ecole Polytechnique's Engineering and MSc Program in 2007. She completed her PhD from Université Paris-Est, France, in 2010. Since 2010, she is research scientist at IFSTTAR and at LPICM (a joined research team between Ecole Polytechnique and CNRS). A physicist specialized in carbon-based nanomaterials, her research work focuses on the development of reproducible and reliable nanosensors for applications to civil engineering and urban sustainability.

Abstract. We present the SmartR concept, an innovative technology integrating cutting edge sensors within the road, increasing user safety thanks to the immediate detection of emergency patterns and overweight vehicles and yielding added-value services such as direct interactions with passing vehicles or real time road durability monitoring. Patented by Ecole Polytechnique and IFSTTAR, our invention relies on the massive deployment of nano-enabled strain gauges with high precision and low production cost.



« Implementing recharging inductive technology on heavy duty pavement bringing unlimited autonomy to electrical vehicles »

Sergio A. PÉREZ R. is a Civil and Roads Engineer Expert at BOMBARDIER Primove. He has followed a Master in materials at the ENPC and completed a doctoral thesis at the IFSTTAR. He joined the Belgium Road Research Center (BRRC) as researcher until 2011 when he was invited to join Primove team inductive charging system for electrical vehicles. His role at Primove is to design and create solutions allowing Bombardier to implement its inductive system in a smart way into the infrastructure and the pavement.

Abstract. The future in mobility shall be guided by invisible, smart and environmentally friendly systems. Recently, Bombardier Transportation has developed a new system to supply by induction electrical public transportation vehicles. It consists in integrating electrical supply cables, creating an electromagnetic induction field, in a prefabricated concrete slab implemented in the road. A key aspect of the development is to ensure a standard pavement design meeting durability and service life requirements couple with the vehicle charging capabilities. For this purpose, it was decided to carry out a full scale test on prototype slabs at the accelerated pavement testing facility of IFSTTAR in Nantes. The present communication brings the developments made to define an innovative pavement structure from the design concept to its evaluation after one million loads using IFSTTAR full scale test facility test equipment.