Associated with the Forever Open Road programme.

Short description

Today, users expect roads that are forever open. For road managers, this implies proposing infrastructures that are continuously tailored to the needs of travellers, while offering a growing number of services; these infrastructures should also be stealthily maintained and resilient to weather events. However, the pressure of societal issues and budget constraints has made it more and more difficult for these managers to ensure an optimal operation of their networks. In synergy with the **Forever Open Road** program, IFSTTAR has launched the "5th Generation Road" program to tackle this huge challenge. This program aims at designing full scale demonstrators integrating the numerous innovations that are already available within research centres, and demonstrating the synergies among them.

Need for R5G

Lots of technologies are already available in private and public research centers. A strong willingness to test and industrialize all the promising solutions and gather together the existing innovations in all fields on the same site is missing today. These innovations may benefit from two recent technological trends. Firstly, energy, materials and information are converging fields, which means that in the close future, road infrastructures will be able to transport not only people and goods but also energy and information. Secondly, the development of smart vehicles can potentially be to the benefit of road infrastructures, in particular through the development of cooperative systems. A holistic approach, which would cover the different aspects of road construction, operation and maintenance, road energy and environment, is then necessary. This is exactly what the 5th Generation Road implementation program presently envisions: a new road generation, built through a system approach, which gathers the best current ideas and demonstrates the synergies among them.

Technical Approach

Today, when a new technical solution is proposed to answer an open call for tenders, failure is not allowed, and this situation limits the possible risk taken by the company as the failure of the tested solution would be indeed very problematic for the image of the company. In the same way, companies are unlikely to propose complex systems, which gather the competencies of different industries, e.g. car manufacturers and road industry. Consequently, early stage innovative solutions are not likely to be implemented. Conversely, the design, construction and operation of **full-scale research demonstrators**, where risk is mainly (but not entirely) taken by the road authority, is likely to make a great difference.

As a matter of fact, thanks to such demonstrators, the most innovative solutions, but also the more risky ones, and especially those proposed by research centers, are more likely to be tested and problems related to their implementation identified and further solved. However, these demonstrators must show a clear improvement with regard to the past and propose a technological breakthrough, so as to best meet societal objectives.

Methodology

The program is organized into a 2D matrix (see Figure 1). The first dimension deals with the type of network. Each type of road has indeed its own particularities in terms of design, construction, maintenance and operation. Four different types of road networks can be classically considered: urban, peri-urban, interurban and local networks. In the second dimension of the matrix, the research themes are organized into three interdependent elements, like the Forever Open Road program. The **adaptable road** element deals with the low carbon design, construction and maintenance of roads. The **resilient road** element relates to the resilience of road networks regarding climate change and their energetic efficiency. The **automated road** element deals with the automation of traffic and operations thanks to ICT. In addition to the three aforementioned elements, R5G is developing the **acceptable road** element, which deals with the socio-economic aspects of the program in order to facilitate its implementation. In particular, this fourth element aims at developing a system approach along with the associated tools to ensure that the different societal objectives of the program are likely to be reached.

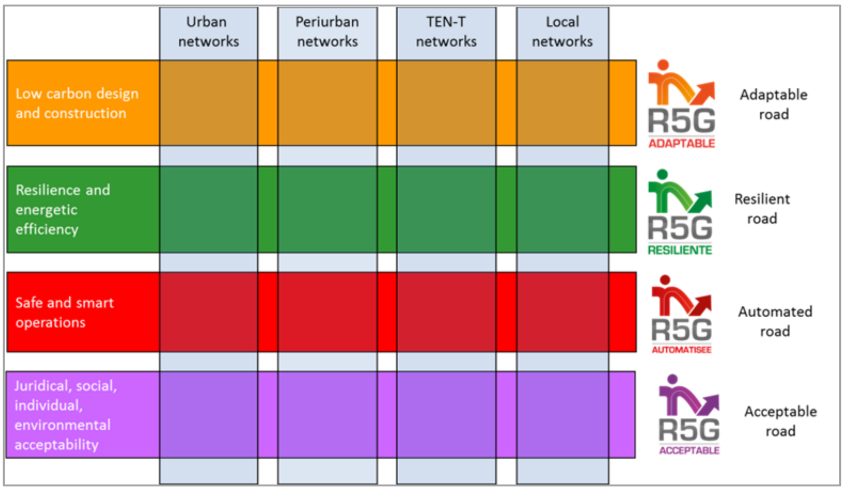

Figure 1 – Priorities of the R5G program.

Actually, in the field of technological innovation, a dominant trend is indeed to highlight technology, without always taking into account the users' needs; this is called a **"Technology-Centered Design."** Therefore, if this approach may seem legitimate on the purely technical level, the risk is to develop technologies that do not fulfil the needs and expectations of actual users. These technologies may then be badly accepted, which can lead to irrelevant or even dangerous human behaviours. Because of the growing complexity of systems and transport networks, this purely techno-centric view is not defendable anymore. To ensure a better success of technological innovations, the user must be put at the heart of the design process, which the ergonomists defined as a **"Human-Centered Design".** In the case of road infrastructure, a human-centered design approach is necessary because the road is, by definition, a place where different users interact (drivers, cyclists, pedestrians).

However, the road also performs other functions that may have a very indirect link with the users travelling on it; for example, other types of networks (water, telecommunications, and electricity) can pass through it. In addition, residents are not necessarily road users, but they are nonetheless affected by it (living environment, biodiversity, air quality, etc.). In this aim, the “human-centered design” method itself may appear as too restrictive with regard to these other indirect functions. So, it would seem necessary to develop a method that will be centered on the functions performed by the road: the so-called **"Function-Centered Design"** (see Figure 2).

Figure 2 – Illustration of the acceptable road

Subsystem proving – Design and construction of full scale research demonstrators

Given the complexity of the complete implementation, it is not relevant to directly design and construct an R5G demonstrator. It is thus proposed to start with sub-R5G demonstrators. This has led us to adopt a first organization of the program described in Figure 3. The **first phase** (2010-2014) is dedicated to the testing and **labeling of single innovations**, which are ready to be implemented in research demonstrators. The **second phase** (2014-2018) will be devoted to the integration of several innovations in a few selected **research demonstrators**, which, in the end, will ultimately make it possible to design a full **R5G demonstrator** (2020) through the **cross-fertilization** of the different research demonstrators.

The conception of the different demonstrators will be carried out before next winter in partnership with the different stakeholders.

Co-modality urban space

Co-modality was introduced by the European Commission in 2006 in the field of transport policy to define an approach of the globality of transport modes and their combinations. Co-modality refers to a "use of different modes on their own and in combination" in the aim to obtain "an optimal and sustainable utilisation of resources". New mobility services such as carpooling, car-sharing, bicycle-sharing systems are in progress. They are environmentally friendly and relied on a cooperative approach. Their common feature is the lack of investment in terms of infrastructure, using existing roads and public spaces.

High Speed Automation of Highways

The urban DARPA challenge has shown that autonomous driving was possible. The Nevada State (USA) just authorized the circulation of automated vehicles. However, such vehicles are very expensive to instrument due to the use of high-end vehicle sensors. Having a highly cooperative intelligent infrastructure enables the realization of a lower cost automation of the driving task. The remaining challenge consists in realizing a demonstrator of high-speed highway automation.

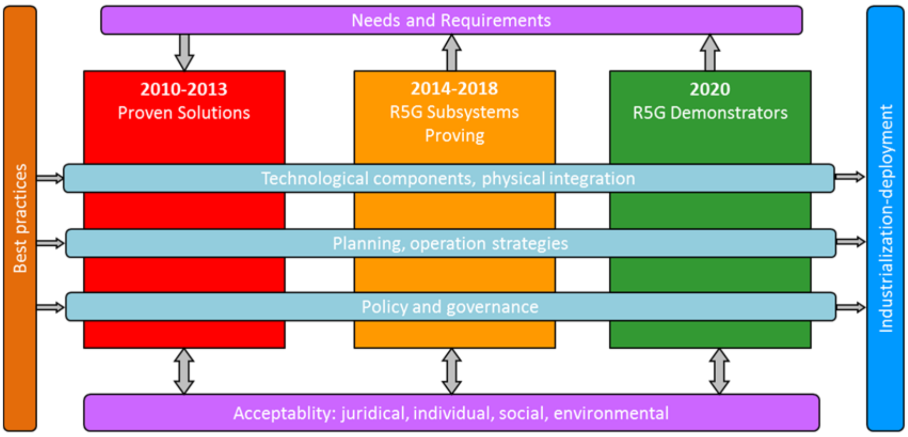

Figure 3 – Phasing of the R5G program.

Road and Energy

Different innovations can be used to better manage energy in the road sector. Firstly, low temperature asphalts as well as emulsion treated materials for secondary network mean energy saving as well as low rolling resistance pavements. Secondly, different technical solutions or concepts arise to-day to harvest energy from road: solar road, piezoelectric road, geothermic equipment of the surroundings etc. Solutions are also under development regarding winter maintenance of roads using geothermic heat storage or self-maintaining surface materials. Finally, inductive charging makes it possible to transfer the harvested energy to the passing electric vehicles.

Efficient and Self-Explaining Local Road Networks

The low volume roads call for a better speed management, which goes far beyond hotspot identification and automated speed enforcement. Inspection and audit procedures are still restricted (at least in Europe) to main roads. Concepts like self-explaining roads, forgiving roads or intelligent speed adaptation are dedicated to highly trafficked roads as well. In this demonstrator, we aim at developing a methodology to efficiently diagnose low volume road networks while still enhancing their safety level, for example by forecasting the friction level and the meteorological visibility, so as to deduce relevant speed recommendations.

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