DESCRIPTION FOR THE GENERAL PUBLIC

The recent advancements in communication technologies brought, on an unprecedented scale, the possibility of expanding the range of services provided by the existing and new kinds of networked systems. Data transmission and storage networks, smart grids, production and logistic systems, remote control applications, and Internet of Things are becoming part of the critical infrastructure for securing the well-being and sustained progress of modern society. What was first the industrial practice only – to provide the factory automation for cost reduction and efficiency increase – becomes ubiquitous in the activities of common users. The control systems, especially those empowered with communication capabilities, enter the life of a contemporary citizen in various ways ranging from car electronics, through automated homes and offices, to ambient intelligence solutions for the assisted living and healthcare, and cooperating Internet of Things devices. If properly managed, in addition to ensuring economic benefits, the networked automation may positively influence everyday comfort and guarantee the desired level of safety at the foundation of personal happiness. However, deploying a distributed system strictly depends on the quality of communication taking place among the system actors. The underlying network infrastructure and protocols need to fulfill the application objectives regardless of inopportune network phenomena, like congestion, interference, or noise. Therefore, these systems need to continuously evolve in order to embrace the benefits of emerging technologies and to adapt to the new engineering challenges and business requirements, frequently facing a high level of uncertainty.

The application layer remedies for network perturbations are limited in scope and should be supplemented by lower layer solutions. One of such measures – explicitly addressed in the project – is to concurrently engage multiple channels of message and resource exchange in the multi-flow framework. It is also attractive from the economic perspective in the light of lowered costs of the associated infrastructure (networks, interfaces, and electronics) and expenditures for the physical deployment. A similar rationale applies to the intelligent logistic and road transport systems with multiple modes of transport – trucks, trains, ships – employed to leverage the environmental and systemic uncertainties. Unfortunately, inappropriate traffic distribution over the paths may cancel the potential advantages the multi-channel option offers. Not that one needs to wait for completing the relocation of all the parts belonging to a batch that is transferred over the channels with potentially disparate characteristics, which exacerbates the uncertainty of timely delivery. In contrast to the standard, frequently heuristic methods proposed so far to deal with multipath transport issues, in the project, new algorithms will be constructed on the sound mathematical foundations of the theory of dynamic systems. By design, they are expected to provide increased efficiency and reliability in the uncertain operating conditions for industrial, interactive, as well as standard applications. The implementation aspects will be considered explicitly in the design process so that adequate algorithm performance is confirmed when deployed in a physical system and real communication networks. The high-level abstraction that stems from incorporating the dynamic system theory will also allow for a seamless transition of promising results among related disciplines, e.g., an efficient control scheme addressing the congestion problem in a data transmission network adapted for a multi-modal supply chain system.