Advances in communication, embedded computing, sensor and actuator technologies, are leading to a new generation of Mechatronics systems and networks. Examples of these systems are fleets of simple cooperative mobile autonomous/robotic systems, large scale smart distribution networks (e.g., automated irrigation networks, smart oil/gas distribution networks), tele-surgery systems, tele-operation systems of autonomous vehicles, smart power grids, smart buildings, automated oil drilling systems, Internet of things, cyber physical systems, etc.

These emerging systems and networks are much more complex than the ordinary systems. Unlike the ordinary systems, in the above systems, there are interactions between control, communication and computation. In the above emerging complex systems, transmission of information between distributed components (e.g., sensors, controllers, actuators, etc.) via the commonly used communication technology, is subject to communication imperfections and/or limitations, such as data dropout, noise, limited bandwidth. In addition, these systems are very often equipped with processing devices, which are subject to limited computational power and memory and are subject to computational errors. However, the commonly used control techniques are not concerned with communication and computation limitations/imperfections. Hence, in the presence of communication/computation imperfections/limitations, the commonly used controllers are not able to stabilize the complex systems or result in a very poor performance. On the other hands, the commonly used communication protocols are based on block coding, which result in long coding delays; and hence, they are not suitable for real- time applications, such as measurement and control. In addition, as the size of dynamic systems is continuously increasing, the complexity of the control/communication algorithms must be managed properly in emerging complex systems and networks by implementing a suitable scalable design.

The above discussion reveals that there are interactions between control, communication, computation and scalability in emerging complex systems and networks. On the other hand, the available design methodologies for control, communication, and computation are developed independent of each other. Therefore, the available design methodologies cannot provide a satisfactory performance for emerging complex systems. That is, one of the main barrier in developing emerging complex systems and networks is the lack of integrated co-design frameworks, which balance interactions between control, communication, computation, and scalability in emerging complex systems to have the best performance without exhausting communication and computational resources. That is, scalable frameworks, which compensate the effects of communication and computation imperfections/limitations in the closed loop system, and allow real-time reliable communication of data, without exhausting communication and/or computational resources.

A logical approach to address this problem is to develop first less complicated frameworks (e.g., control/communication co-design) and then more complicated frameworks (e.g., control/communication/computation co-design), which are the objective of Networked Control Systems research team.