

Tutorial: Managing and Engineering of Complex Situations

Mihaela Ulieru

Canada Research Chair in eSociety
Director Adaptive Risk Management Laboratory
The University of New Brunswick

<http://www.cs.unb.ca/~ulieru/>

This Tutorial will shed light on the disruptive advances brought by the ubiquity of computing and communication environments that link systems and people in unprecedented ways into the new kind of techno-social systems and infrastructures recently named *Cyber-Physical Ecosystems*. While pointing to fundamental biases that prevent traditional engineering school of thought from coping with the magnitude of scale and complexity of these new technological developments we attempt to lay out the foundation for a new way of thinking about systems design, coined *emergent engineering*. One major characteristic of cyber-physical ecosystems is that, given their very nature, they cannot be a priori defined but rather *emerge* from the interactions between a myriad of elementary components. We show how the emergence can be guided by balancing positive and negative feed-back which tunes the growth of new configurations that adapt the system to sharp and unexpected changes.

On this foundation we introduce the concept of Holistic Security Ecosystem as an overarching operational layer enabling the deployment of dynamic, short living emergency response organizations capable of reacting quickly to emerging crisis situations. Deployed 'on the fly' from units belonging to different organizations (military forces, police, firefighters, ambulance, provincial emergency response organizations, hospitals, etc.) coming together in a collaborative endeavor to address an emerging need (e.g. an evolving crisis situation) - holistic security ecosystems balance micromanagement of subordinates with the excessive independence of commanders based on a trusted overall operational picture shared via a reliable communications backbone. The realization is rooted in our Adaptive Risk Management platform for the analysis of interdependent systems and organisations via an operational picture of correlated collective dynamics - supporting strategic thinking and organisational leadership in a wide range of complex operations that go beyond the emergency response into trend analysis in global markets and enterprise dynamics for business operations.