GENI Futures: A Perspective from Cyber-Physical Systems

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Wireless and CPS GENI. While GENI has played critical roles in fostering the SDN industry and GENI has deployed various types of wireless infrastructures (e.g., WiMAX/LTE networks) which connect GENI backbone resources (e.g., rack servers) to network edge infrastructures (e.g., vehicles and sensors), there exist great potential for GENI to positively impact the future development of wireless networks and edge systems such as cyber-physical systems (CPS). For instance, there exist opportunities to rethink architectures and algorithms for mission-critical machine-type-communication (MTC) in 5G cellular networks, and it will be of great value to 5G research and experiments if future GENI wireless infrastructures can enable *deep programmability across the whole networking stack of cellular networks*. The experimentation and deployment of *CPS systems (e.g., those in smart transportation, smart power grid, and industrial automation)* can also benefit from GENI methodologies such as programmability and virtualization. Imagine the positive impact on vehicular networking and application research if networking researchers and application developers can have open, safe access to hundreds or thousands of vehicles on road; enabling virtualization in cyber-physical systems can enable this and can have transformative impact on the research, experiment, and deployment of CPS systems.

From experimental infrastructures to experimental science. Experimental infrastructures serve as important tools for bridging theory and practice. While GENI has established a wide variety of interconnected networking and computing infrastructures, how to most effectively utilize the GENI infrastructures require effective *methodologies that leverage the experimental "data" to drive the innovation and development of networked systems, especially high-confidence systems such as cyber-physical systems*. For instance, how to leverage measurement data in one context (e.g., industry plants, oil fields, or surface roads) to predict CPS system behavior in another context, and how to leverage measurement data in limited settings to better design CPS systems with predictable behavior in unpredictable settings.

Engaging communities of whole-technology-lifecycle. Operating and sustaining infrastructures such as GENI take a lot of resources such as fund, personnel, and time. For *long-term sustainability and relevance of GENI*, it is important to continue engaging communities of the whole technology lifecycle, including academia (faculty and students), industry, and end users. Ideally, it will be great if we pursue the ultimate goal of seamlessly merge infrastructures for production use and those for experiments and research while keeping the cost at a manageable level.

Cross-agency collaboration. Aligned with the aforementioned objective of broad community engagement, it will be beneficial for the *involved funding agencies to coordinate their programs*, for instance, having NSF and USDOT coordinate on initiatives (basic research as well as field trials) related to connected and automated vehicles and intelligent transportation systems in general, having NSF and DOE coordinate on initiatives related to smart power grid, and having NSF and DHS coordinate on initiatives related to cyber security.

Participation in planning workshop. I am interested in participating in the planning workshop to be held during December 10-11 in DC. My team member Dr. Yuehua Wang is also interested in attending.