Digitalisation of Electrical power Systems: From cyber-physical modelling to real-time digital co-simulation

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Abstract:

Electrical power systems represent critical national infrastructure that interoperates with wider economic sectors including transport, communications, manufacturing, etc. Resilient and flexible power system operation are the key in ensuring the electricity generated from various energy sources can travel in secured energy networks to meet the electrical loads of these sectors. The large scale of low-carbon and renewable energy sources such as wind and solar, together with electric vehicles, energy storage and smart grids are integrated into the top and tail of future power systems. Such energy sources increase the size, complexity and uncertainty of power systems, leading to the risks of major system disturbances as well as challenges in real-time system operation.

This research work investigates the resilience and flexibility of power system operation using digital technologies as key solutions. The cyber-physical power systems are proposed as the next generation of digitalised power grid, with advanced modelling and simulation methods in order to integrate information and communications technologies into the future power systems. The digitalised power grid enables the data flow and information decisions across different layers of networked systems. The cyber-physical power systems models are investigated using graph theory. Real-time digital simulators are developed to improve the monitoring and computing techniques across cyber-physical power systems by means of co-simulation. This research work is expected to improve the resilient control and operation of energy networks and distributed energy sources.