Inter-dependent networks stress test

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Energy production systems are good examples of complex systems. Their infrastructure equipment requires ancillary sub-systems structured like a network—including water for cooling, transport to supply fuel, and ICT systems for control and management. Every step in the network chain is interconnected with a wider network and they are all mutually dependent. A team of UK-based scientists has studied various aspects of inter-network dependencies, not previously explored. The findings have been published in the *European Physical Journal B* by Gaihua Fu from Newcastle University, UK, and colleagues. These findings could have implications for maximising the reliability of such networks when facing natural and man-made hazards.

Previous research has focused on studying single, isolated systems, not interconnected ones. However, understanding inter-connectedness is key, since failure of a component in one network can cause problems across the entire system, which can result in a cascading failure across multiple sectors, as in the energy infrastructure example quoted above.

In this study, interdependent systems are modelled as a network of networks. The model characterises interdependencies in terms of direction, redundancy, and extent of inter-network connectivity.

Fu and colleagues found that the severity of cascading failure increases significantly when inter-network connections are one-directional. They also found that the degree of redundancy—which is linked to the number of connections—in inter-network connections can have a significant effect on the robustness of systems, depending on the direction of inter-network connections.

The authors observed that the interdependencies between many real-world systems have characteristics that are consistent with the less reliable systems they tested, and therefore they are likely to operate near their critical thresholds.

Finally, ways of cost-effectively reducing the vulnerability of inter-dependent networks are suggested.

More information: Fu, G. et al. (2014). Interdependent networks: Vulnerability analysis and strategies to limit cascading failure. *European Physical Journal B*. DOI: 10.1140/epjb/e2014-40876-y

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