Resilience of complex socio-technical systems

We live in a world of networks. The networks around us and we ourselves, as people, are part of the network of social relations between individuals. Examples of networks in the world are the Internet, the rail network, the subway, neural networks, the telephone network, or less concrete entities, such as the relations of knowledge and collaboration between people. The study of networks is therefore very important, given the wide variety of structures and systems of the real world that can be incorporated into the category of “complex networks”. In general, a graph or network is a very general approximation of a system constituted by many entities, called nodes (which may represent, in various cases, persons, computers, proteins, chemicals, etc.) linked to each other and interacting through connections (which may be, therefore, a cable between computers, hyperlinks between web pages, a collaboration between people, a reaction between chemical substances, etc..). Our society severely depends on multiple networks such as energy, telecommunications, transportation, emergency, water, food, and more. These networks are critically interdependent; for instance, the power network enables the communication network to run properly and provide coordination tasks to other networks that depend on it. The failure of any of these networks would create a cascade of failures throughout our whole society, resulting in a threat to national security and American lives. Our mission is to develop metrics to characterize the resilience of both single socio technical systems and a system of infrastructures systems by identifying a network representation for critical infrastructures with node resilience and between-nodes interdependencies to derive overall system resilience for different disruption scenarios where resilience is defined, as a property of these complex systems, by the National Academy of Sciences (NAS) as “the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events”. Example of real-world networks are shown in Fig.1 and Fig.2.

Fig 1. *US commuter network: here nodes represent US counties while edges between nodes represent the commuters between two counties. Visualization was done using Gephi.*

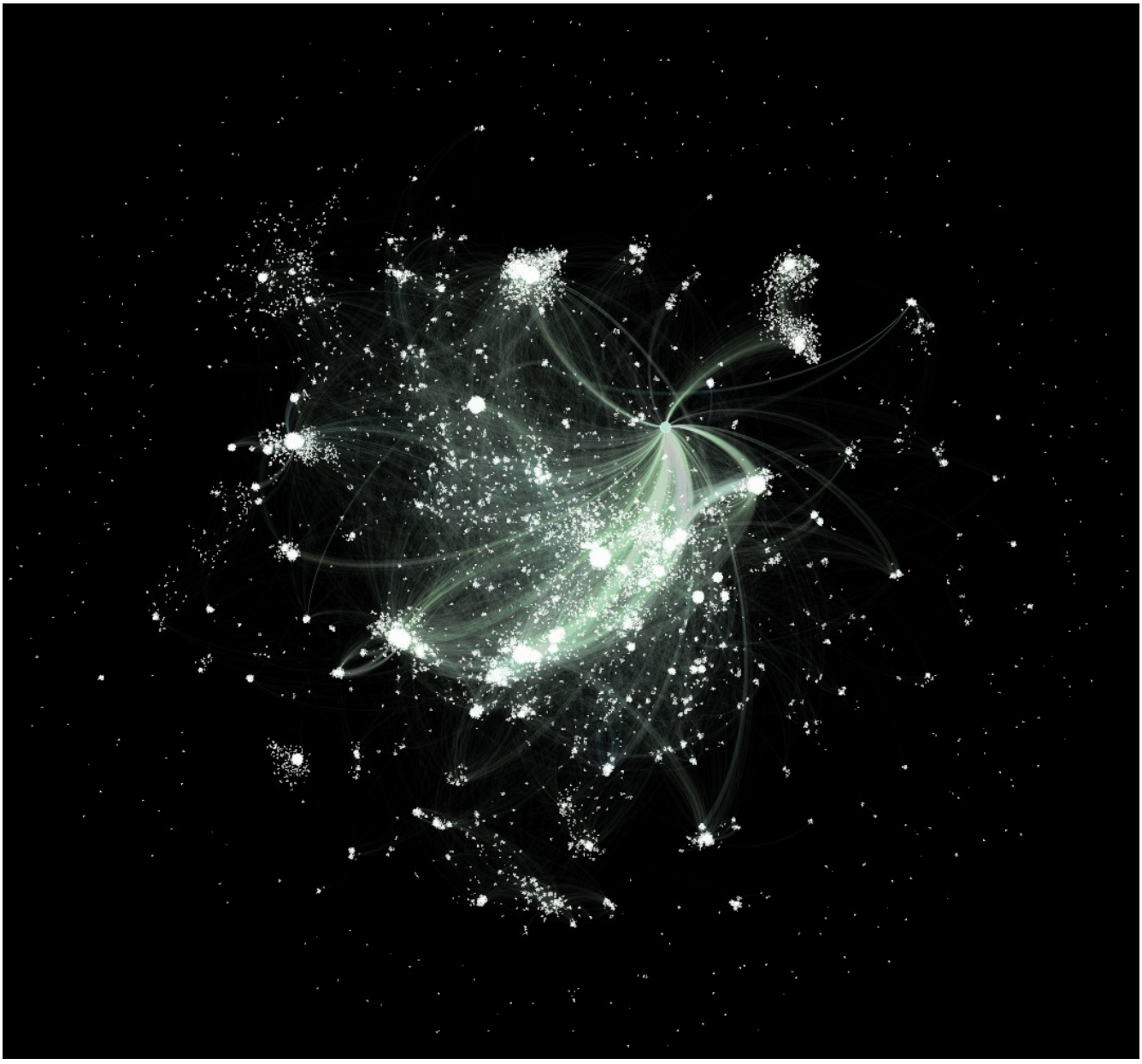

Fig 2. *Directed network from the Debian project where each node in the network indicates a software package, or a "service" that multiple packages could provide. Visualization was done using Gephi.*