Computing in Time-Varying Networks

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There has been recently a large number of investigations devoted to the study of infrastructure-less highly dynamic networks. These include most types of *highly-mobile ad hoc networks*, such as pedestrian or vehicular networks, where the network's topology may change dramatically over time due to the movement of the nodes; *sensor networks* with sleep scheduling, where links only exist when two neighbouring sensors are awake and have power; and low-density ad hoc networks made up of satellites, where nodes are most of the time isolated and must rely on a store-carry-forward mechanism for their communications. These highly dynamic networks, variously called *delay-tolerant*, *disruptive-tolerant*, *challenged*, *opportunistic*, have in common that the assumption of *connectivity* does not necessarily hold, at least with the usual meaning of *contemporaneous end-to-end multi-hop paths* between any pair of nodes. The network may actually be disconnected at every time instant. Still, communication routes may be available over time and space, and make broadcast, routing, and distributed computing feasible.

Not surprisingly, an extensive amount of research has been devoted, mostly by the engineering community, to the problems of broadcast and routing in such highly dynamical environment. As part of these research efforts, a number of important concepts have been identified, and occasionally expressed within a more general scheme. Interestingly, closely related insights have been obtained in the investigations being carried out in some apparently unrelated areas of dynamic systems. This is for example the case of the study of complex real-world networks ranging from neuroscience or biology to transportation systems or social studies, e.g., the characterization of the interaction patterns emerging in a social network. In several cases, differently named concepts identified by different researchers are actually one and the same concept. Indeed, the concepts discovered in all these investigations can be viewed as parts of the same conceptual universe; and the formalisms proposed so far to express some specific concepts can be viewed as fragments of a larger formal description of this universe. A common point in all these areas is that the system structure - the network topology - varies in time. Furthermore the rate and/or degree of the changes is generally too high to be reasonably modeled in terms of network faults or failures: in these systems changes are not anomalies but rather integral part of the nature of the system.

This talk describes the current research effort to integrate the vast collection of concepts, formalisms, and results found. It also reviews the status of the research on distributed computing in time-varying networks, outlining the challanges, difficulties and promising directions.

X. Défago, F. Petit, and V. Villain (Eds.): SSS 2011, LNCS 6976, p. 4, 2011.