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Self-Healing Strategy for Improving Robustness in Limited Resource

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Many real networks have a common topological structure called scale-free (SF) which is vulnerable to malicious attacks [1]. Moreover, these complex systems are frequently exposed to nature and man-made disasters. To overcome the serious problems, resilience-based system design attracts much attention recently. In particular, the concept of resilience means not only to absorb disturbance but also to reconstruct a system with adaptive capacity [2]. Thus, we propose a self-healing method based on enhancing loops for improving robustness in reconstructing to be a better structure as distinct from SF instead of recovering. Because removing all loops make network into tree structure which is fragmented easily by any attacks [3]. Furthermore, enhancing loops is effective on constructing the optimally robust onion-like structure [4]. First, rings are created as the simplest loop to maintain the larger connectivity in limited resource of links. Then, loops are enhanced on the rings by adding remaining healing links between extended neighbors of damaged nodes in distributed local process. We assume that some links emanated from removed nodes can be reused for healing. For several systems such as air-traffic, power-grid and Internet, in comparison with the conventional method [5], the reconstructed network by our method obtains both higher robustness of connectivity and efficiency of paths with a better structure than original one (see Fig.1).

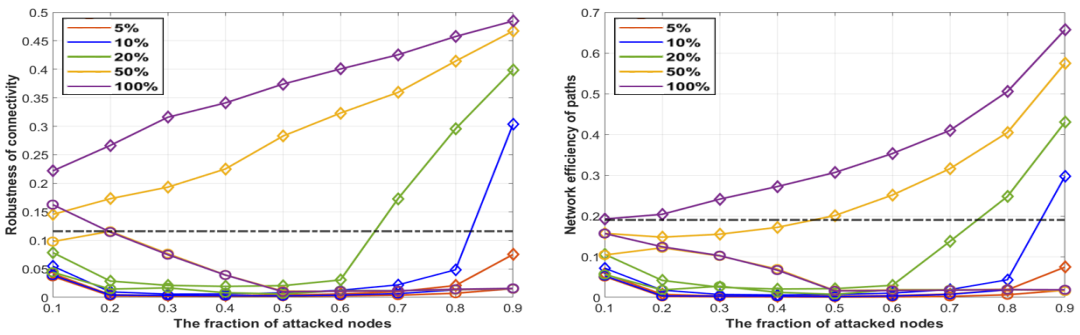

Figure 1: Result of our proposed (marked by diamond) and conventional (marked by circle) methods for air-traffic network. Colors are corresponded to 5~100% of reused links for healing. Black dot-dash line represents the result in the original network before attacks.

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