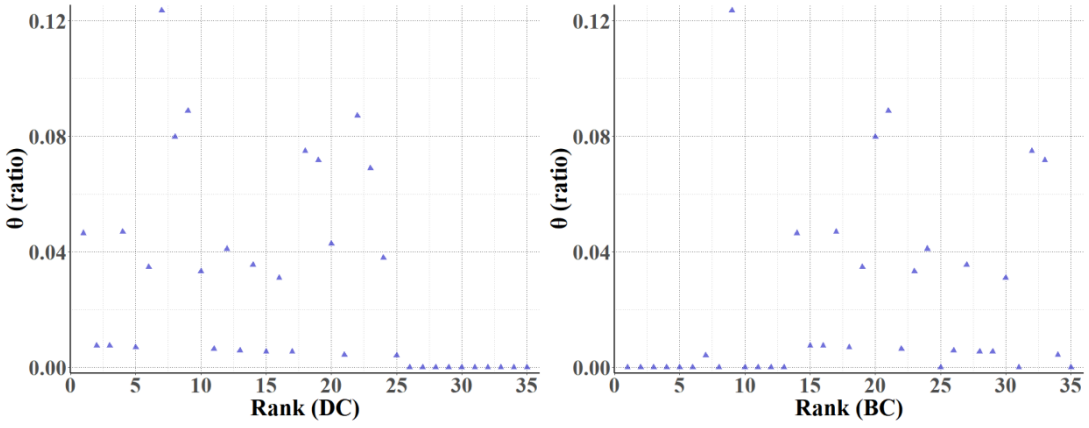
Supplementary materials

Pre experiment.

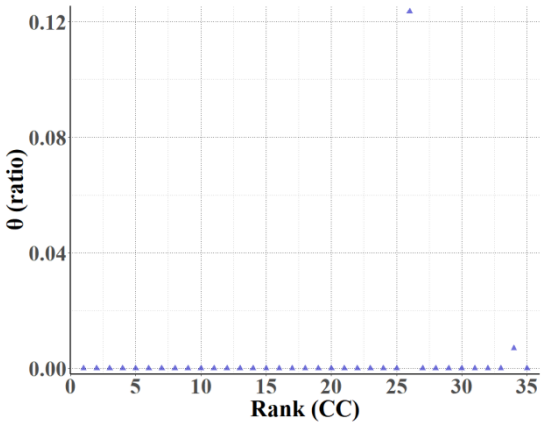
The purpose of the pre-experiment is to measure the effectiveness profile of each type of indicator for the discovery of critical nodes in this network by testing the evaluation metrics on a small set of nodes within the experimental network, to decide whether to select the relevant metrics as sub-indicators for CRITIC multi-attribute decision making.

In the pre-experiment, a single node is removed from the experimental network by a total of seven policies based on DC,BC,CC,NCC,H,KS and EC respectively, i.e., one individual node is removed from the network at a time, and the percentage of node failures in the network at that time is recorded.To reduce the pre-experimental complexity, only a small set of nodes is selected for removal. Figure S1 shows the node removal effect, the horizontal coordinate of the triangular node in the figure characterizes the importance ranking of that node under the current metric, and the vertical coordinate in the figure characterizes the percentage of node failures in the network.

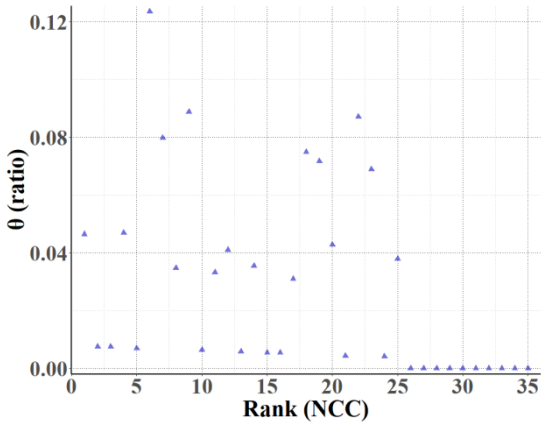


(a)

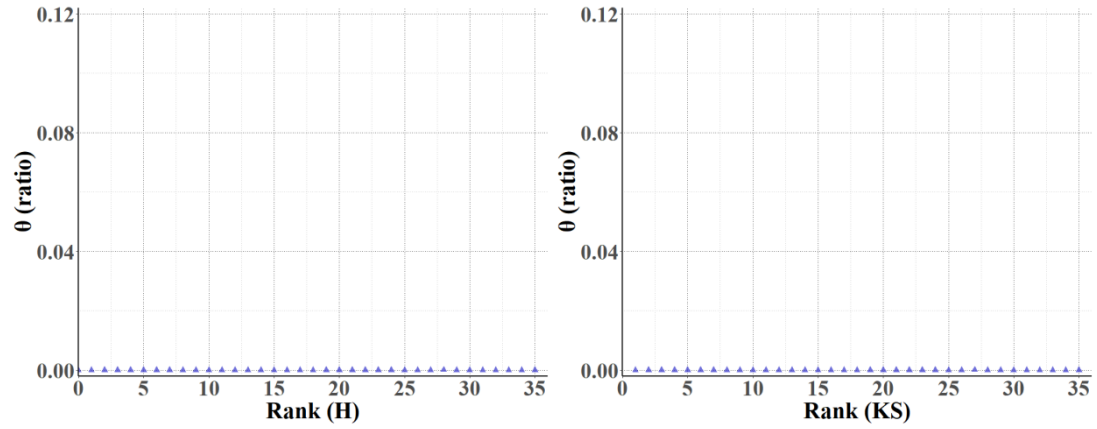
(b)



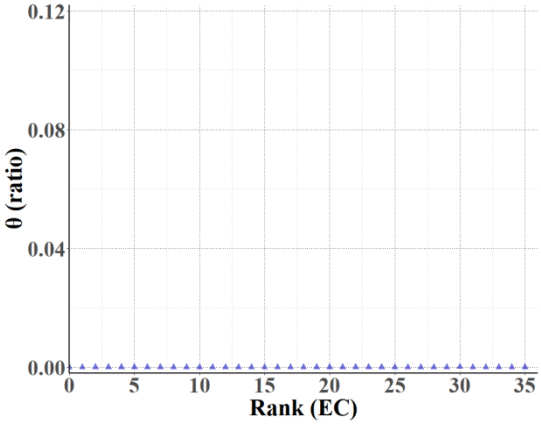
(c)



(d)



(e) (f)



(g)

Figure S1: Relationship between node importance ranking and network failure ratio in single node removal strategy

In Table 1 of the main text we classify this category into four categories based on the perspective of the assessment of nodal importance indicators.

(a) Adjacency importance [DC,H]

(b)Network topology location [CC,KS]

(c)Path centrality [BC]

(d)Node mutual information content [NCC,EC]

According to the principle of selecting sub-indicators in multi-attribute decision making, the input of homogeneous information should be reduced while ensuring the comprehensiveness of the evaluation of indicators as much as possible, so one important indicator is selected from each of the four types of indicators in this paper.According to the experimental results in Figure S1, it was found that after a small number of important nodes found based on DC,BC,NCC were removed, a certain percentage of node failures occurred in the experimental network, while H,EC produced a smaller percentage of node failures, so DC,BC,NCC is the CRITIC candidate method in this class of metrics.

For CC and KS metrics, both metrics are measured from the node network topology location perspective importance, and in the removal experiments, the proportion of node failures caused by both metrics is not significant, so further

comparison of CC and KS from the metric monotonicity (M) [1] perspective.Higher ranking monotonicity implies a smaller size of the set of moderate volume scores of the node output sequence and a finer granularity in making importance decisions.In this experiment, the top 10 percent of nodes in the physical device layer of the three-layer network topology are selected as the sorting set, and after calculating M(CC)=1.000 and M(KS)=0.296, CC is selected as the CRITIC candidate method in this class of indicators.

In summary, the candidate set of CRITIC sub-indicators is [DC,BC,CC,NCC].

References

[1] Bae J, Kim S. Identifying and ranking influential spreaders in complex networks by neighborhood coreness. Physica A: Statistical Mechanics and its Applications. 2014;395:549-559. doi:10.1016/j.physa.2013.10.047