A Model of Internet Topology Using k-shell Decomposition

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ABSTRACT

We consider the Internet at the level of its sub-networks (called Autonomous Systems, or ASes). Most previous studies have used the connection degree as the indicator variable to decompose the network into what one hopes will be nodes with distinct functions or roles. We consider instead a longer-ranged indicator of connectivity, the k-pruning procedure, which removes from the network all sites with less than k neighbors until no such sites remain. Increasing k from 1 in unit steps separates any network into "k-shells," leaving at each stage a "k-core", and defining a "k-crust" as the union of the k-shells lying outside of a particular k-core. Applying a k-pruning analysis to our network results in a new picture of the AS-graph structure. This distinguishes a relatively large, redundantly connected nucleus of nearly 100 ASes and two other components that flow data in and out from this core. One component is fractally interconnected through peer links; the second makes direct connections to the nucleus only.

Our proposed decomposition is shown to better represent the structure of the Internet than previously suggested ones. Moreover, our methods can be used to extract the structure of any general network of interest and in particular, to distinguish different models of the Internet's formation and be used as a basis for probing its evolution. The proposed Internet structure has also applications for the design of routing schemes.

This work was stimulated by the availability of Internet maps of unprecedented resolution from the DIMES and EVERGROW projects. The full paper can be found in cond-mat/0601240.