MEDUSA, a functional model of Internet substructure

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Abstract: We consider the Internet at the level of its sub-networks (called Autonomous Systems, or ASes). All 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, obtained by k-pruning, which removes all sites with less than k neighbors until no such sites remain. Increasing k from 1 in steps of 1 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 core. The construction is unique, the k-core is maximal, and experiments show that the k-cores are indeed k-connected (a hypothesis which is proven for Erdos-Renyi graphs and plausible for dense scale-free graphs such the Internet IP-level and AS graphs. There are similarities and important differences with the "jellyfish" model introduced for the AS-graph by Faloutsis, hence our title for this model, coming from the Eastern Mediterranean. Its characteristics are a core which is the maximal non-vanishing k-core, a scale free region (the successive k-crusts) in which information flows steadily from the periphery towards the core, but also can propagate laterally for unlimited distances through peer connections, and a community of dependent nodes which project directly from the outside world into the core, without taking advantage of the scale-free region. We are in the process of exploring the extent to which this structure distinguishes different models of the Internet's formation, is a basis for projecting its evolution, and suggests new approaches to routing information in the Internet. This work was stimulated by the availability of Internet maps of unprecedented resolution from the DIMES and EVERGROW projects.