

The Critical Neighbourhood Range for Asymptotic Overlay Connectivity in Ad Hoc Networks

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Abstract

We first motivate the use of ad hoc overlays. In particular, we argue that overlay routing could play a role in the spreading of ad hoc networks.

We then define a simple criterion for neighbourhood: two overlay nodes are neighbours if and only if there exists a path between them of at most R hops, and R is called the (overlay) neighbourhood range. A small R may result in a disconnected overlay, while an unnecessarily large R would generate extra control traffic. We are interested in the minimum R ensuring overlay connectivity, the so-called critical R .

We study conditions on R to achieve asymptotic connectivity of the overlay almost surely, i.e. connectivity with probability 1 when the number of nodes in the underlying ad hoc network tends to infinity (so-called dense networks) or when the size of the field tends to infinity (so-called sparse networks), under the hypothesis that the underlying ad hoc network is itself asymptotically almost surely connected.

For dense networks, we derive a necessary and sufficient condition on R , and for sparse networks we derive distinct necessary and sufficient conditions that are however asymptotically tight.

These conditions, though asymptotic, shed some light on the relation linking the critical R to the number of nodes n , the field size ℓ , the radio transmission range r and the overlay density D (i.e., the proportion of overlay nodes). These conditions can be considered as approximations when the number of nodes (resp. the field) is large enough. Since r is considered as a function of n or ℓ , we are able to study the impact of topology control mechanisms, by showing how the shape of this function impacts the critical R .

Keywords: ad hoc networks, overlay, connectivity, topology control.