Providing End-to-End Connectivity Across Heterogeneous Networks

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The incremental adoption of IPv6, middle boxes (e.g., NATs, Firewalls) as well as completely new network types and protocols plot a possible future of the Internet: Manifold networks (e.g. IPv4, IPv6, Industrial Ethernet, sensor networks), which are not supposed or able to communicate directly. To allow communication between these networks, relays — devices located in multiple networks that behave like gateways — are required. These relays translate between multiple network domains (e.g., IPv4/IPv6 domain) and provide the necessary end-to-end connectivity. In this scenario it is likely that a message has to traverse multiple domains. To find a relay path to another device and allow end-to-end communication, the following issues need to be addressed: (1) detection of domain borders, (2) finding appropriate relay paths, (3) managing relays. We propose a solution towards these problems for the Spontaneous Virtual Networks Project (SpoVNet) based on virtual coordinates (e.g.,Vivaldi [2]).

SpoVNet is an integrated solution to support spontaneous deployment of network services and new technologies using overlays. These overlays can possibly overlap many different underlay network domains so end-to-end connectivity — even across network domain borders — is needed. This is implemented by a special component called the *Base Communication* that runs exactly once per device. In this talk we present an extension to the existing solution [1] in the *Base Communication* component:

First, we use unique network identifiers (Network IDs) to distinguish between different network domains. Such an identifier is initially set at random by the first device in a network and adopted subsequently by other devices. Second, virtual coordinates for all devices are calculated using and representing their latency relations and maintained in each network domain. Third, devices with relay capabilities announce their presence among other relays in each connected network domain. A Device that does not have relay capabilities discovers at least one of its closest relays. These relays are used to forward messages into foreign network domains.

When a message needs to be relayed Network ID and virtual coordinates of the destination are appended to the message and sent to a relay for forwarding. If the Network ID matches an ID of a network the relay is connected to, the message can be delivered directly to its destination. Otherwise an appropriate relay path to the destination must be selected. Relay paths are selected and optimized with respect to latency (see fig. 1). This is achieved by involving the virtual coordinates in this process. Consecutive relays in a path have virtual coordinates in the same network domain. The distances in these coordinate spaces represent the expected latency between these relays. A path is rated by adding the distances of all consecutive relay pairs in it. This approach is similar to [3], which is limited to the IPv6 domain and uses virtual coordinates to select low latency address pairs in IPv6 multihomed sites.

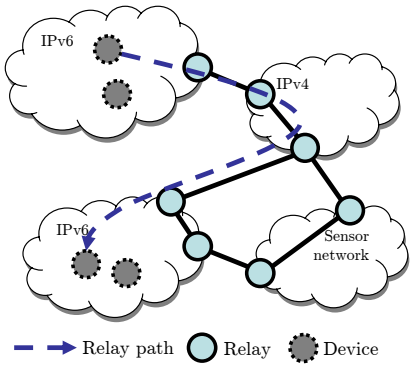

Figure 1: Relays connecting different domains

There are many problems to solve: For example, different Network IDs may be generated for the same network domain when two overlays are constructed independently in the same network domain. On the other Hand a network domain may intentionally get partitioned into two parts and re-connected by a relay device. With the solution presented in this talk we address those problems to provide best-effort end-to-end connectivity for overlays upon heterogeneous networks.

References

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