Lilith: an Interconnection Architecture Based on Label Switching for Spontaneous Edge Networks

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Aims and Scope

We consider the problem of *spontaneous edge networks*. With this term we designate networks that interconnect hosts by means of different physical and link layer technologies and in which all or some of hosts are organized as a multihop ad hoc network. A spontaneous network can be connected to the global Internet or form an isolated group of hosts with internal connectivity. Such networks are becoming wide spread with the advent of various communicating devices at home and in offices as well as with the development of pervasive devices connected via different types of networks and integrated within the physical world.

Our goal is to define an interconnection architecture that supports TCP/IP applications without configuration or other technical effort from the user. The applications should work when a spontaneous network is connected to the global Internet or disconnected as well as when its topology changes due to host mobility or switching network interfaces. Moreover, the architecture needs to support different kinds of applications, especially those that generate time dependent traffic.

Layer 2.5 Spontaneous Networking

To address the issues raised in the case of spontaneous edge networks, we propose an interconnection architecture for spontaneous networks based on the following principles:

- we make all the hosts connected via different links to appear as one single IP subnet so that configuration protocols can use the subnet broadcast (IPv4) or the scoped multicast (IPv6) for all forms of discovery (addresses, names, services);
- we propose to interconnect hosts at layer 2.5, which enables us to easily integrate an ad hoc routing protocol;
- we use MPLS *(Multi Protocol Label Switching)*, the standard 2.5 layer and we establish LSPs (Label Switched Path) on demand;
- LSP paths transport packets between different links;
- the establishment of LSP paths is driven by a reactive ad hoc routing protocol.

We place interconnection at layer 2.5 because if we want to organize all hosts into one subnet, the interconnection should be done below layer 3 and above layer 2.

MPLS, the standard 2.5 layer allows us to leverage the existing expertise and implementations. We believe that when coupled with on demand establishment of LSP driven by an ad hoc routing protocol, MPLS provides several advantages: multiple paths for QoS traffic management and load distribution, possibility of testing LSP reachability and quality, and even QoS based routing.

Since we consider a spontaneous network as a single IP subnet, our architecture propagates layer 3 broadcasts or scoped multicast to all hosts. They can then be used for all configuration protocols. In particular, when the network is isolated from the global Internet, hosts can acquire addresses based on Auto IPv4 or stateless configuration IPv6 and use mDNS or LLMNR for name resolution. When connected to the border router, they benefit from DHCP service to learn the routable prefix. Moreover, protocols such as UPnP, SLP, or JINI can readily be used for service discovery.

An important aspect of wireless spontaneous networks is an ever-changing topology which causes routes to frequently appear and disappear. We address this issue by periodically exchanging the states of the LSP paths using the MPLS traffic statistics, thus enabling nodes to detect broken or error-prone paths. Emitters can then decide to try building a better path or use another one previously saved for backup.

To evaluate our approach, we have designed and implemented Lilith, a prototype of an interconnection node based on the Linux version of MPLS. It relies on a simple reactive ad hoc routing protocol for finding routes in a spontaneous network.

More materials

Additional information:
http://www-lsr.imag.fr/Les.Personnes/Vincent.Untz/lilith/